



PORTODIMARE

geoPORTal of TOols & Data for sustainable Management of coAstal and maRine Environment (ADRION205)

**DT2.3.1 Evaluating sea uses
sustainability in Emilia-Romagna (Italy)**

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List of abbreviations

AIS	Automatic Identification System
AZA	Module supporting Allocated Zone to Aquaculture Identification integrated into the GAIR
BPZ	Zone of Biological Protection
CEA	Module for Cumulative Effects Assessment integrated into the GAIR
CNR	Consiglio Nazionale delle Ricerche
CS	Case Study
EEA	Agency European Environmental
EBSA	Ecologically or Biologically Significant Marine Areas, as defined in 2008, the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 9)
EPA	Environmental Protected Area
EU	European Union
EUNIS	European Nature Information System
GAIR	Geoportal of Adriatic-Ionian Region (the main output of PORTODIMARE project)
ICZM	Integrated Coastal Zone Management, as defined by the Protocol on Integrated Coastal Zone Management to the Barcelona Convention (Council Decision 2010/631/EU)
LSI	Land-sea interaction(s)
MSF	Medium Scale Fishery Footprint
MSP	Maritime Spatial Planning, as defined by Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning
MUC	Module for Maritime Use Synergy and Conflict Analysis, integrated into the GAIR
NTC	National Technical Committee, established in Italy for the governance of the MSP process
PARTRAC	Module for supporting particles and contaminants dispersion tracking, integrated into the GAIR
PU	planning units
SO	specific objects
WAC	Western Adriatic Coastal Current
WP	Work Package of PORTODIMARE project (as described in the Application Form)

1 INTRODUCTION

The Adriatic and Ionian seas, as well as almost all the territorial waters, suffer from strong pressures related to different human activities, and need solutions to encourage the blue growth¹, being aware also of the major risks deriving by climate changes. To face these problems and drawing opportunities with an adequate point of view, it is necessary to achieve a suitable knowledge, also through dedicated analysis tools, besides tracking an integrated and cross-border approach for the coastal and marine management.

These have been the main goals of PORTODIMARE project, whose principal outputs are:

- the Geoportal of Adriatic-Ionian Region (GAIR), which integrates existing databases and new information specifically collected to support ICZM and MSP processes, and
- the ‘Tools for MSP’, which are software (modules) specifically oriented to address MSP issues, starting from the evaluation of conflicts between uses. The added value of these modules is that they can be used by a broad audience of stakeholders, thanks to several user-friendly interfaces directly accessible from the GAIR.

The step by step evolution of the GAIR have been described into the PORTODIMARE technical reports T1.1, T1.2, T1.3 and T1.4 delivered within the Work Package 1, and a complete manual for users is available within the GAIR in the section documentation <https://www.portodimare.eu/static/docs/index.html>. The main components of the GAIR are shown in Figure 1.

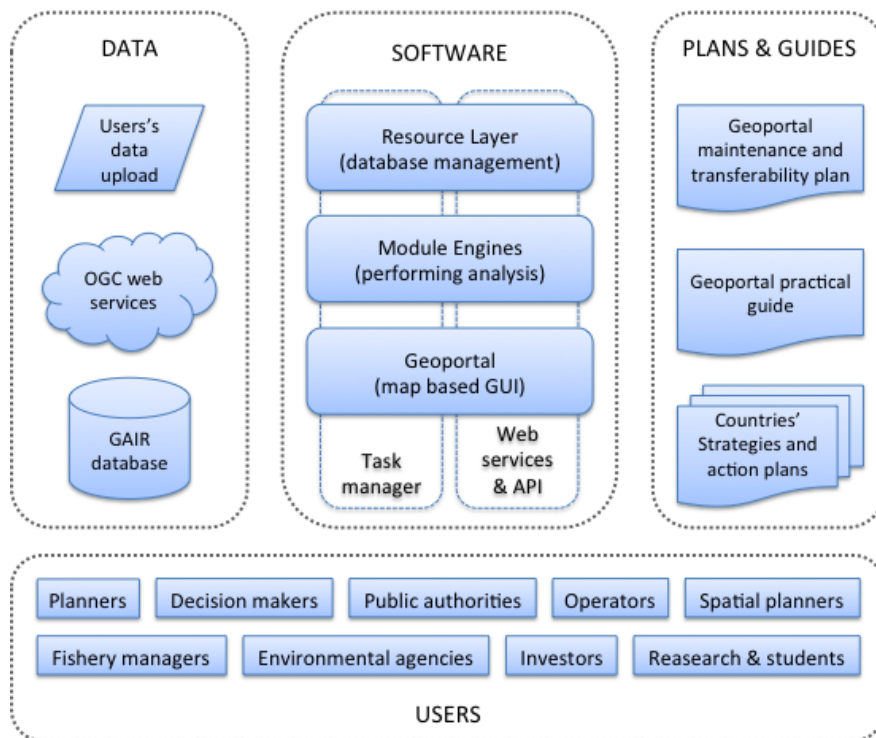


Figure 1 - Components of the Geoportal of Adriatic-Ionian Region (GAIR).

¹ the European Commission long term strategy to support sustainable growth in the marine and maritime sectors as a whole (<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52012DC0494>)



Both GAIR and Tools for MSP need to be tested in order to demonstrate their applicability for ICZM and MSP practices, and to show their effectiveness in supporting and improving the MSP planning procedure. The testing has been performed by six partners of PORTODIMARE in six different pilot areas; one of those is the seaside of Emilia-Romagna Region (i.e. the Case Study foreseen by activity AT2.3).

Since the PORTODIMARE Case Study overlaps, both temporally and in the content, with the activities that are going on at national level for the drafting of the maritime spatial plans in Italy, processed by the National Technical Committee (hereinafter NTC), Emilia-Romagna Region decided to work as far as possible in parallel, by combining the objectives and by testing both the operational methodologies foreseen by the two processes. This approach deals with the necessity of making the results of activity AT2.3 more tangible and, at the same time, to provide concrete and innovative support to the activities implemented by the NTC.

Finally, it is important to remind that PORTODIMARE activity AT2.3 was preceded by some important milestones, such as:

- the approval of ICZM regional guidelines in 2005 (deliberation of the Regional Council n. 645, 20/01/2005)
- several European projects which brought to a relevant data collection on the topics of ICZM and MSP in Emilia-Romagna (Plancoast, funded by INTERREG IIIB CADSES, 2006-2008; SHAPE, funded by IPA-Adriatic CBC, 2011-2014; ADRIPLAN, funded by DG MARE, 2013-2015)
- RITMARE, a National flagship Project funded by the Italian Ministry for University and Research, focused on marine and maritime research topics. Within RITMARE, the CNR (coordinator of the project) signed an agreement with Emilia-Romagna Region (administrative act n. 2274/2016) to carry out a concrete exercise of MSP, defining a vision, objectives and a portfolio of coherent planning measures (Barbanti & Perini, 2018; Barbanti *et al.*, 2017a, b).

The result of the exercise made within RITMARE, available on-line (<http://ambiente.regione.emilia-romagna.it/it/geologia/pubblicazioni/libri/tra-la-terra-e-il-mare-analisi-e-proposte-per-la-pianificazione-dello-spazio-marittimo-in-emilia-romagna>), constituted a reference and a goal for the activities of the NTC and certainly represents the starting point for the AT2.3 activity.

As a matter of fact, the limited economic, human and time resources available for this activity prevented the deepening of the knowledge framework and pushed towards the capitalization of the results coming from some previous Adriatic projects on MSP, such as the North Adriatic research carried out within the RITMARE and EU SUPREME projects.



2 AIM OF THE CASE STUDY

The purpose of activity AT2.3 of PORTODIMARE is to test the Geoportal of Adriatic-Ionian Region (GAIR) and its 'Tools for MSP' in a context of a real MSP process in the sea area facing the Emilia-Romagna coastline.

The general aim of the Case Study is to provide management and planning options for the present and future activities at sea, by enhancing sustainability of sea uses and quality of the maritime environment. To this purpose, it is mandatory to tackle the following aspects, as suggested by Judd *et al.* (2015):

- to predict and assess the multiple pressures/effects related to various sources of impacts;
- to describe such effects, their spatial and temporal scale;
- to identify the possible response of the environment;
- to understand and describe the relationships among pressure/effects, sources, and responses;
- to define assumptions and uncertainties to be considered.

Then, several specific objectives have been outlined for the activity, some of them not originally included in the needs and requirements foreseen by PORTODIMARE Application Form:

- to test the GAIR as tool for: data collection and management, thematic mapping; processing of data to feed the tools;
- to test the use of the following Tools for MSP, integrated in the GAIR:
 - CEA Module: Geospatial tools for Cumulative Effects Assessment; it is dedicated to the analysis and mapping the effects of single or multiple human activities on the sea space.
 - MUC Module: Geospatial tools for Maritime Use Synergy and Conflict Analysis; it allows the assessment and mapping of maritime use conflicts (constraints that are creating disadvantages to maritime activities) and synergies (multi-use potential).
 - PARTRAC Module: Geospatial tools for Particle Tracking simulation. It can be used to calculate the area of influence of a source of contamination by simulating the dispersion of particle. This analysis was not foreseen by the application form.
 - AZA Module: Geospatial tools for identifying Allocated Zones for Aquaculture. This analysis was not foreseen by the application form.
- to use the GAIR to process specific information needful to develop the knowledge framework supporting the Adriatic MSP, with particular regards to the offshore Emilia-Romagna Region. Such knowledge framework requirements were designed by the scientific pole supporting the NTC;
- to bring the know-how developed in PORTODIMARE to the Adriatic subcommittee for the MSP, by sharing the approach, methodologies, data and results.

3 CASE STUDY AREA

The Case Study site is the marine area facing the Emilia-Romagna Region, located in the Northern Adriatic Sea (Figure 2). It extends around 70 km from the coastline to the limits of the Italian continental shelf. The northern and southern limits fit with the boundaries of the 8° Maritime Rescue Sub Centre of Ravenna (Direzione Marittima). The total water surface is of 5256 km², and is characterized by three different jurisdictional zones: 8% inner water (from the shoreline to the baseline); 40% territorial water (within the 12 Nautical Miles); 52% high seas. Italy exercises its jurisdiction over the seabed, the subsoil, and the water column within the 12 NM. Moreover, according to the UNCLOS-1982², it also exercises the jurisdiction over the subsoil and seafloor up to the continental platform boundary. This was also foreseen by the Italy-Yugoslavia treaty (signed in 1968, ratified with DPCM n. 830-1969, later transposed by Croatia, Montenegro, and Slovenia).

In a context of MSP, it is crucial to underline how such boundaries are quite flexible and permeable for what concern economic and environmental aspects. It is also important to adequately consider the connection with bordering and transnational areas.

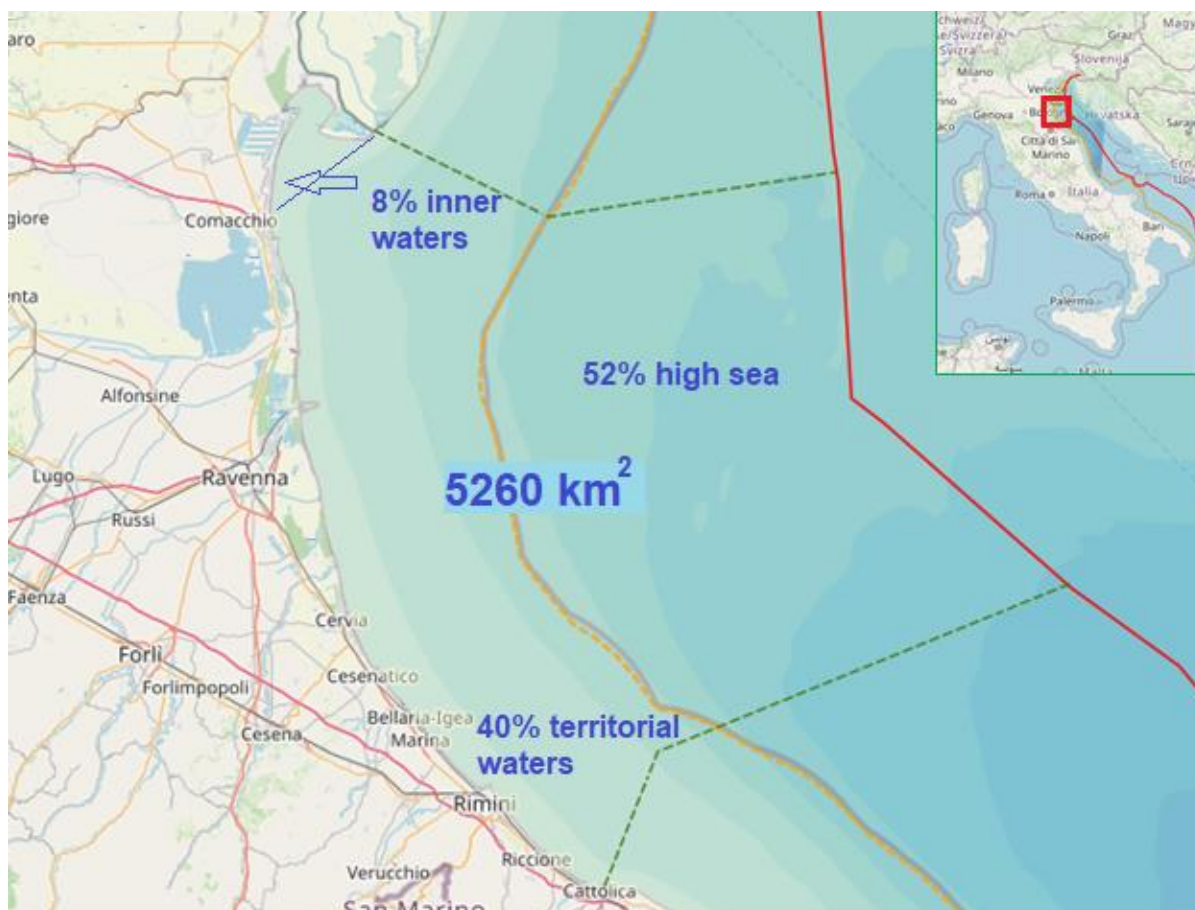


Figure 2 - Case Study area.

² https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf



4 MAIN PHYSICAL AND ENVIRONMENTAL FEATURES OF THE COASTAL AND MARINE ZONE

The Emilia-Romagna coastline extends for about 140 km, from the Po di Goro river mouth (including the sand-spit) to the southern boundary of the Region represented by the Tavollo river, that flows below the headland of Gabicce.

South of the actual Po delta, the coast is a long, arcuate, low, and sandy line, broken only by minor Apennines rivers and by the jetties of several harbours. In some parts, the beach is over 200 metres wide, while other sectors are completely eroded and have been replaced by seawalls. Behind the coastal system there are vast reclaimed areas, which lie below the medium sea level and partly consist of wetlands (Bertuzzi Valley, Comacchio Valleys, Ravenna Pialasse): they are home to natural ecosystems of inestimable value (see elevation map shown in Figure 3). This already critical setting becomes even more vulnerable due to the geodynamic processes, the coastal morphodynamics associated to sea storms and to the lack of sediment input from the rivers, reduced since the early '900 (Perini, L. and Calabrese, L., 2010). The combined effect of natural and anthropogenic subsidence, that locally reaches rates of 15-20 mm/y (ARPAE, 2018), before 1980 caused a land lowering for more than 1-2 meters in some areas of the Emilia-Romagna coastal plain, like some portions of the Po delta, of Ravenna Province and of Cesenatico. That was connected to an intensive extraction of water and methane water from the subsoil.

From the administrative point of view, the coast is managed by 4 Provinces (from the North: Ferrara, Ravenna, Forlì-Cesena and Rimini) and by 14 coastal Municipalities.

The sea space is characterized by shallow waters, with a maximum depth around 60 m, the seafloor gently sloping 0.02, and tidal excursions of $\pm 0,85$ m. The most intense sea-storms are related to the Bora winds blowing from the NE, while the storms aroused by the Scirocco wind (blowing from the SE) are often associated to storm surges (Perini *et al.*, 2011). The significant wave heights can reach 3,3 m (return time 1 year), 4.7 m (return time 10 years) and 5.9 m (return time 100 years) (Idroser, 1996). The surface waters circulation is from north to south (Western Adriatic Coastal Current - WACC), dominated by seasonal variations and influenced by Bora winds in the winter months. The WACC has more energy in the winter months than during summer and is responsible for the dispersion and deposition of the fine sediments brought into the sea by the Po river. Moreover, a longshore circulation is recorded from south to north, which is responsible of the northward sand belt transfer. As a matter of fact, in the overflow side of piers and groynes sediments accumulation is evident, whereas in the underflow side erosion processes occur (see an example in Figure 4).

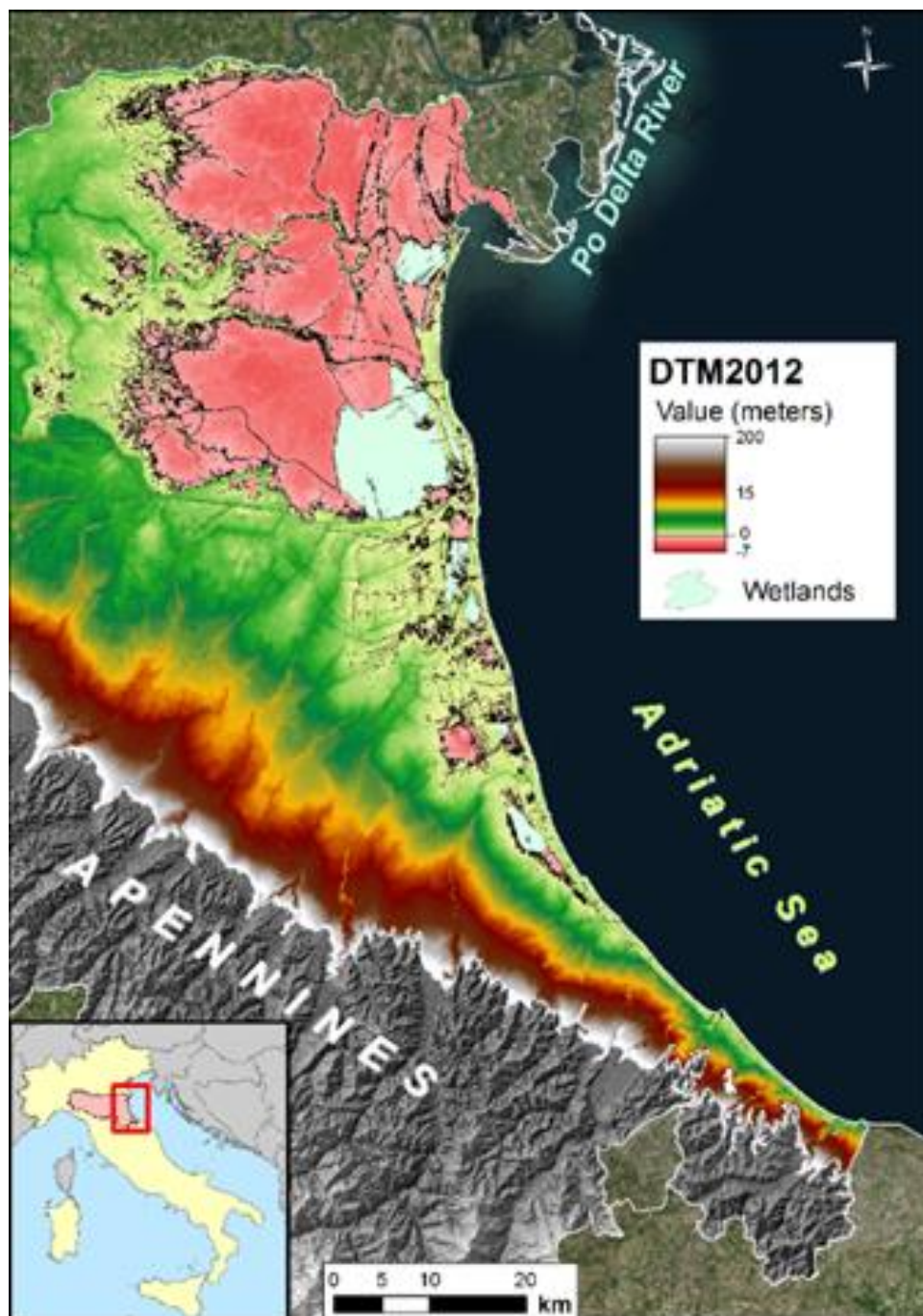


Figure 3 - Coastal plain characteristics; in pink are highlighted the lowland areas (below sea level) of Emilia-Romagna coastal plain.



Figure 4 - Asymmetry of the coastline due to the sediment belt interruption imposed by the Cesenatico pier; the overflow side is accreting while the underflow side lacks sedimentation (Perini *et al.*, 2008).

The abiotic characteristics of the sea area are strongly influenced by the Po River, whose fresh waters decrease the salinity of the coastal waters and bring along a large input of nutrients, especially during the river floods, with a consequent increase of the sea ecosystem productiveness and of the eutrophication process that seasonally affects the coast of Emilia-Romagna, causing strong negative impacts on the benthic ecosystem, on fishery and on the quality of bathing waters.

The sea area is part of the EBSA (Ecologically or Biologically Significant Marine Areas' of North Adriatic - Unep/MAP/RAC-SPA).

The biotic characteristics of the area are closely linked to the nature of the seabed. With reference to the EUNIS habitat classification (European Nature Information System), developed by the European Biodiversity Thematic Centre (ETC / BD) for the Agency European Environmental (EEA) (Figure 5), we can observe that the study area is characterized by 5 zones longitudinal to the shore line: Infralittoral fine sand, circalittoral muddy sands, circalittoral muddy sand, circalittoral sandy mud, circalittoral fine mud.

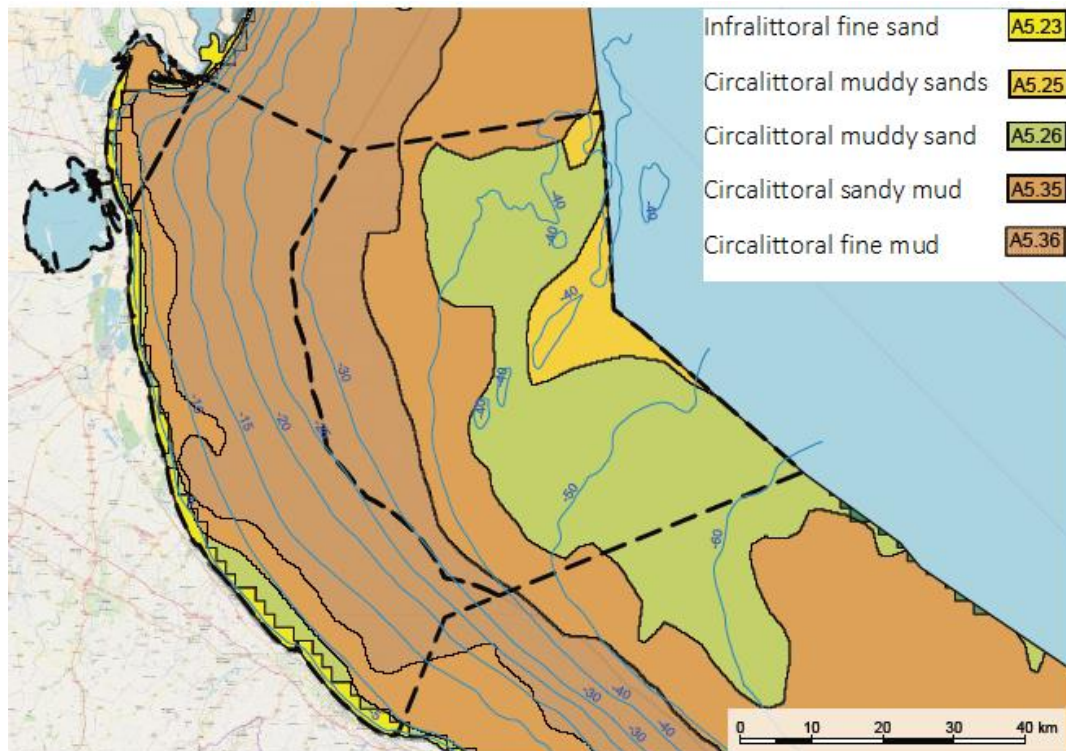


Figure 5 - EUNIS classification of the seabed.

The biocenosis present are all ascribable to infralittoral and circalittoral soft bottoms, while habitats are closely linked to specific abiotic conditions (grainsize, light penetration and oxidation).

The whole North Adriatic area represents a Mediterranean biodiversity hotspot, especially considering endemic fish species (Coll *et al.*, 2010). In the study area, indeed, we can find important 'Essential Fish Habitats' of high commercial value, with particular regards to *Solea solea*, *Pagellus erythrinus* and *Mullus barbatus* (Mediterranean sensitive habitat, final report, 2013)

Visual, aerial and satellite censuses have also highlighted the presence, permanent and/or in the context of migration routes, of protected marine birdlife, e.g. the endangered lamniform *Mobula mobular*, the extensive presence of marine turtles and marine mammals. Only one species of cetacean is resident in northern Adriatic, the bottlenose dolphin (*Tursiops truncatus*), while other mammals such as the common dolphin (*Delphinus delphis*) and the sperm whale (*Physeter macrocephalus*), are considered sporadic or errant. Also, the Loggerhead sea turtle (*Caretta caretta*) is an endemic species of the Northern Adriatic Sea. There are also cyclical presences during summer months and sporadic jellyfish blooms, and of the jellyfish *Carybdea marsupialis*, both offshore and onshore.



4.1 Coastal and sea Uses

The Emilia-Romagna coastal and marine zone is of strategic importance to all the regional territory: there, several important economies and sectors are well developed, both on land and at sea, and hence many human activities coexist in a very delicate equilibrium.

Tourism, with its related activities, represents the major economic asset of the Emilia-Romagna coastal zone. It contributes with the 11% to the regional GDP, 54 % of it from direct activities (housing, catering and more) and 46 % of indirect activities (transportation, commerce, entertainment, personal services). Employment in tourism activities in Emilia-Romagna involves about 160,000 employees, 9.8% of the overall total regional employees.

The regional coastline, indeed, is one of biggest tourist attractions in Europe, especially developed in the southern part of the Region (e.g. Rimini, Riccione), while the northern sector hosts large protected areas such as the Delta Po Man and Biosphere site by UNESCO. Data published by the National Institute of Statistics (ISTAT-2020) show that coastal tourism have been constantly increasing (before 2020) and, during 2019, the total arrivals in the 14 coastal municipalities amounted to 5.864.630 units, the 32% of which in Rimini (see Figure 6). Tourism primarily concern beach activities, shipping, fishing, and diving, even if cultural heritage sites visits (such as Ravenna, Comacchio, Rimini city) and green tourism are becoming more and more attractive by the time.

The accommodation capacity of the 'riviera' is quite relevant, both in the hotel and non-hotel sector. According to the census data 2018 it results that:

- Hotel accommodations amount to 3125; total beds 217067; the net occupancy index of rooms is 51.7%; the average bed usage index: 28.3% if seasonal closures (gross index) are not taken into account; 59.8% if referring to the actual opening periods (net index).
- Non-hotel sector: 52 camping and resorts for a total amount of 76951 beds; 5897 rental accommodations by tourist companies with 26698 beds; 56 holiday homes with 7157 beds; 17 hostels with 2789 beds; 131 bed & breakfast with 597 beds; 21 farms for 240 beds.

Many touristic infrastructures, however, were built along the coastline especially after the second World War, and the urban sprawl reached the 400% in the period 1943-2008, with reference to a coastal strip wide 1.5 km from the shoreline (Lorito *et al.*, 2010). Such exploitation has mainly interested the southern and central part of the region, often causing significant impacts to the coastal morphologies such as coastal dunes, that have been dramatically smoothed to leave space for buildings and beach resorts.

The regional coast boasts the presence of numerous ports and marinas distributed from north to south, entirely or partly dedicated to activities related to the sector intended as a combination of cruises, ferries and boating. The port of Ravenna is the main regional port, the eleventh port in the Adriatic basin in terms of cruise traffic, with more than 45,000 passengers per year and with an almost absolute prevalence of transits (98.5%) compared to boarding/landings (Tourism Responses, 2017). Inside the Port of Ravenna there is the Ferry Terminal which occupies an area of 125,000 square meters. and has two ferry berths with a seabed of 11.5 meters. In addition to the activity of the Ferry Terminal there is a Cruise Terminal. From an infrastructure point of view, the Emilia-Romagna Region is quite competitive in the Adriatic basin, with an average of 1 port for every 5 km of coast and 53 berths per km², Italy's third region after Friuli-Venezia Giulia (82) and Veneto (64) and fourth in the Adriatic. In fact, the Region has 5,353 berths, 3.4% of the national ones and a total of 4,708 units are registered (MIT-Nautical Pleasure Data 2017).

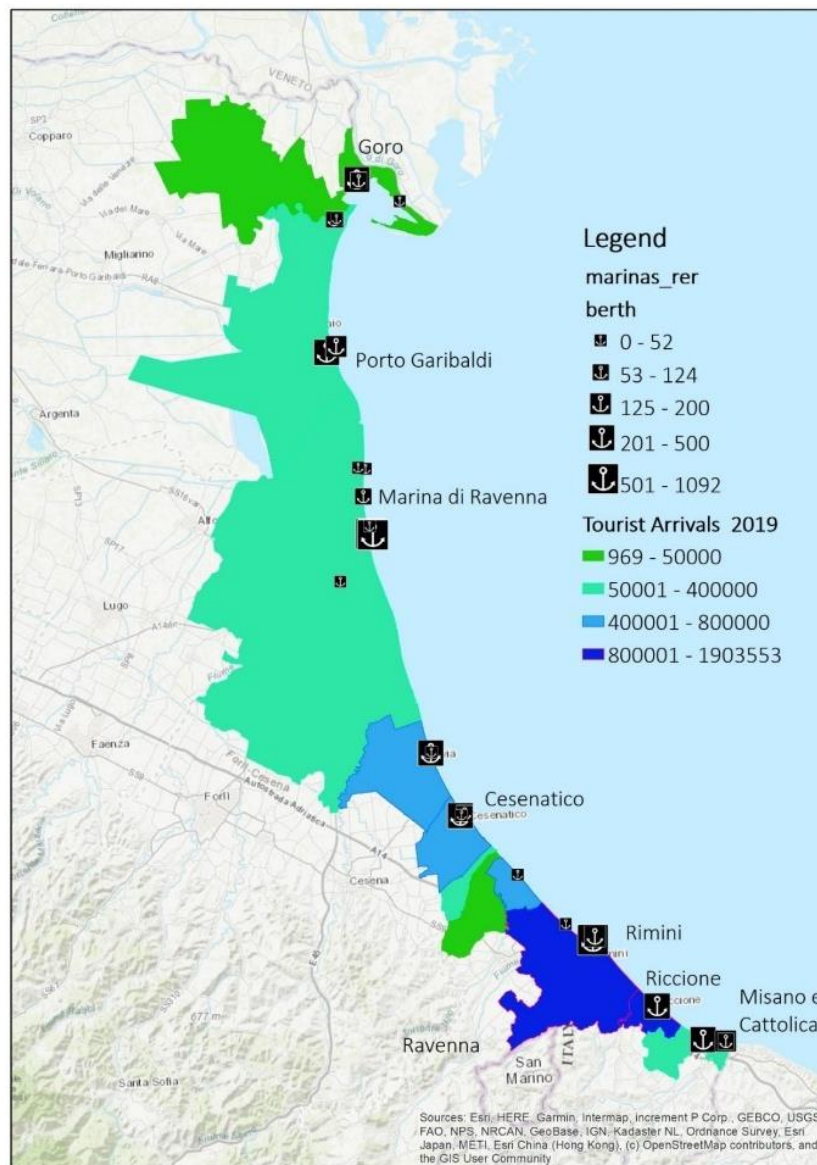


Figure 6 - Tourist arrivals 2019 and marinas.

Coastal erosion, sea flooding, subsidence, and the consequences of the climate change, such as the sea-level rise, are the most relevant risks to be faced. **Coastal defence** therefore represents a strategic issue for Emilia-Romagna, with a double purpose: protecting people and infrastructures from the sea-storms and preserving the 'beach system', being it a very important ecosystem and the first resource for tourism business. Considering the coastline between Cattolica and the Po di Volano river mouth, extending 108 km, the 36% of it shows a high susceptibility to coastal erosion phenomena (as shown in Figure 7) and the 35% to sea-flooding. Furthermore, around the 40% of beaches (the portion free from buildings) has a critical width lower than 50 meters, and more than 80% of them has an average elevation below 1.5 meters (Perini *et al.*, 2019). It is therefore clear why the 60% of the coast has been hardly protected during last century by using several types of defence structures (mainly breakwaters, groynes, embankments). In addition, the whole Goro Lagoon has been protected since the early '900 by sea-walls to contrast the overwash effects of sea storms. Nevertheless, the analysis conducted under the Flood Directive 2007/60 shows that, out of the total 78 km² of coastline that are at risk of flooding, 22 km² insist in the urban zones (Perini *et al.* 2015).

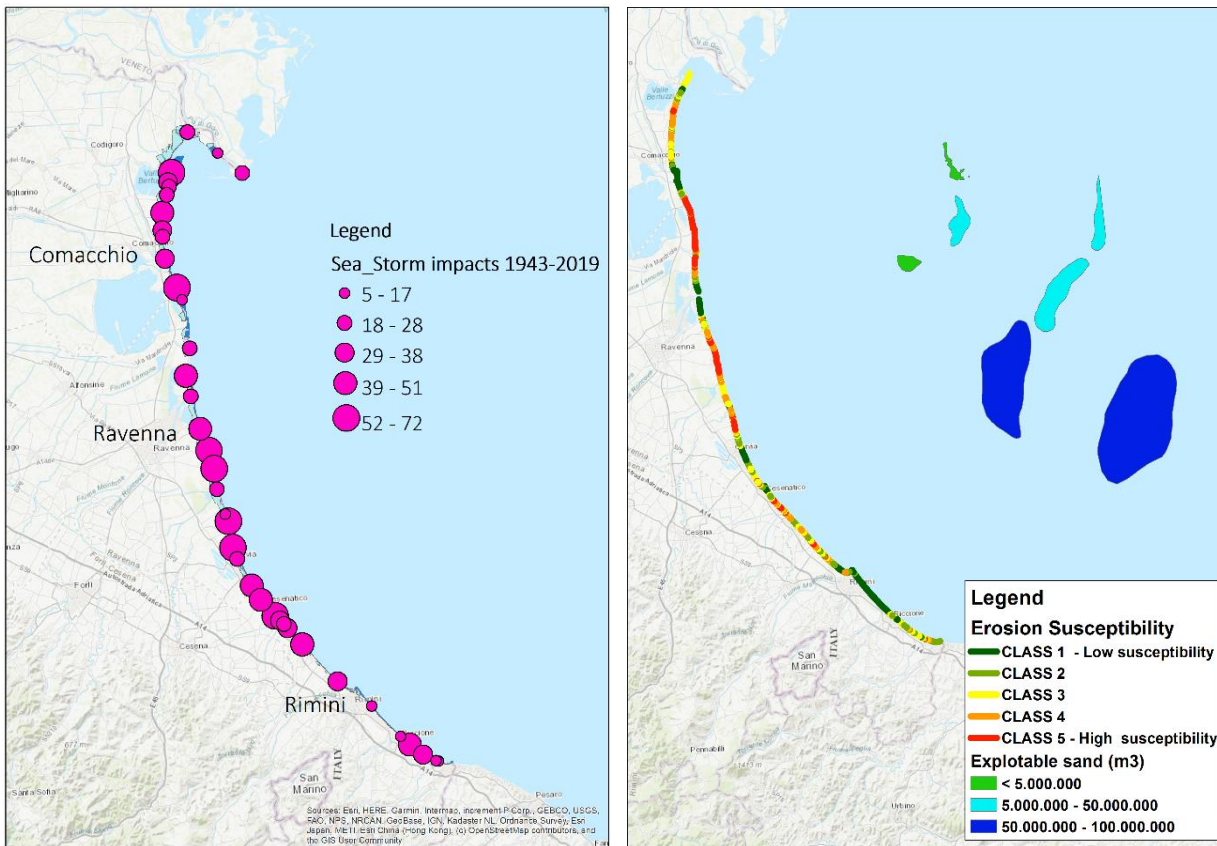


Figure 7 - Coastal risks: on the left, the number of sea-storms events impacting since 1946; on the right, the classification of coastal erosion susceptibility and the zoning of the offshore sand stocks.

A recent monitoring conducted by Emilia-Romagna Region through its agency for environmental protection (ARPAE) highlighted that the 18% of the littorals (i.e. 21 out of the 120 km monitored) is affected by beach erosion (ARPAE 2020). Such value is greatly mitigated thanks to the intensive sand nourishments realised during last years by the regional government (the so-called Progettone 3, dated 2016) and by minor interventions provided by the coastal Municipalities. Indeed, if such nourishments had not been realised, about the 26% of the coastline would have been now in erosion and a further 21% in a precarious state. Therefore, sand delivery is particularly important for beach maintenance, as it happened with the Progettone 3, when a total amount of 1.3 million m³ of sand were delivered in 7 different areas along the coastline. Sand was dredged from the ancient coastal deposits discovered on the seabed offshore of Emilia-Romagna.

The importance of such beach nourishments contribution was clear since the early 2000 and so, though the ICZM guidelines in 2005 (approved by DCR n. 645/2005), the Emilia-Romagna Region decided that sand nourishment would be the main counteraction to beach erosion in the future. Similarly, the Flood Risk Management Plan dated 2015, which contains several measures oriented to increase 'green solution' including the protection and restoration of coastal dunes, pointed out how beach nourishment could be a system to reduce sea-storms impacts because it increases the surface for the dumping of the waves.

This type of interventions are as a matter of fact essential if we consider the strong reduction of sediment input from the rivers, which brought to the rectification of the Emilia-Romagna shoreline since the early decades of the '900s (Calabrese *et al.*, 2010), and also considering the strong impacts of subsidence and sea-level rise.



Such analysis has been carried out within a study that highlighted a possible increase of the areas at risk of sea-flooding by 10% in the year 2100, for the sole contribution of subsidence, and by 30% if we combine subsidence and sea level rise in the pessimistic scenario IPCC AR5- Rcp 8.5 (Perini *et al.*, 2017)

Several **Environmental Protected Areas (EPA)** have been established along the Emilia-Romagna coastline, while the marine area still includes very local protected sites (see Figure 8).

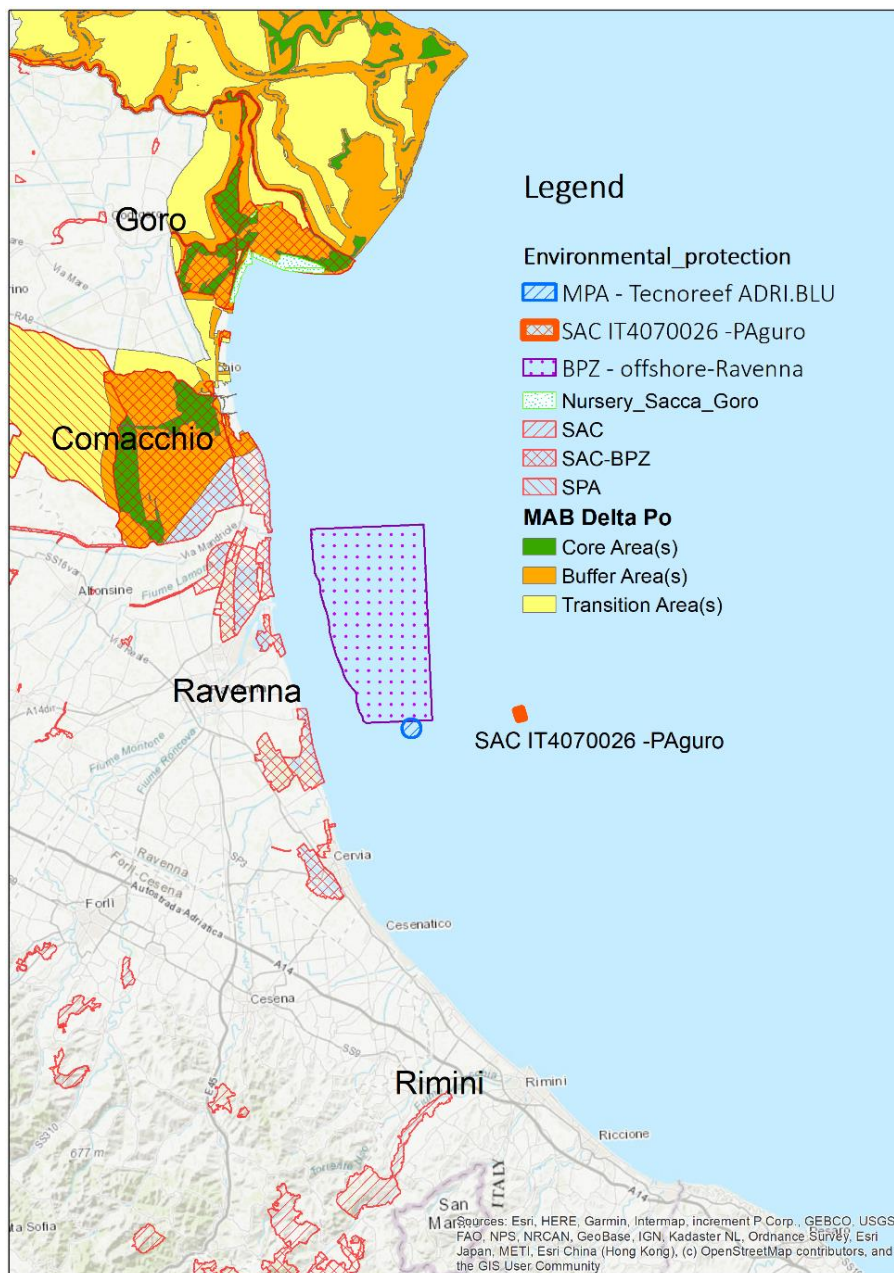


Figure 8 - Coastal and marine environmental protected areas.



On land, the EPA include the Emilia-Romagna portion of the Po Delta Man and Biosphere Reserve, declared in 2014 because of its characteristics and history, representing an emblematic territory characterised by symbiotic man-nature relationships. Previously, the same area was included into the regional park of the PO delta - Emilia-Romagna (established by Regional Law No. 27 July 2, 1988), stretching from the Po di Goro river mouth to the salt flats of Cervia. It includes the ancient PO river delta, for a total surface of 53.978 hectares split between the provinces of Ferrara and Ravenna. A large portion of the territory is included in the Special Areas of Conservation (SAC) and in the Special Protection Areas (SPAs) of the Natura 2000 network: numerous wetlands, coastal habitats, ancient and recent dunes, wooded areas and pine forests and is rich in biodiversity for its animal species (fauna, minor fauna, ichthyofauna, birds, amphibians, reptiles) and floristic vegetation. The landscape of the Delta was recognized in 1999 by UNESCO as a cultural landscape of world value not only for its natural reserves, but for the overall ecosystem matrix.

The major features of the Po Delta influence anthropic pressure, gradually decreasing from upstream (reclaimed lands) to downstream (active delta), as well as human activities. In particular:

- urban settlements (medium to small size) concentration is greater upstream;
- agricultural activities are mainly characterizing the transitional areas;
- more traditional activities are concentrated on the active Delta environments, i.e. traditional fishing (wetlands), shellfish gathering (lagoons), extensive fish farming (transitional waters).

At sea, there are the following types of Environmental protected zone:

1. The **Biological Protection Zone** - BPZ- "offshore-Ravenna" was established by decree of the MIPAAF of March 16, 2004 (and subsequent amendments in the 2006 and 2009) with the aim to protect and repopulate biological species through a set of measures aimed at regulating the fishing-effort. Within it, indeed, it is forbidden industrial fishing, while small-scale fishing and recreational one, except for underwater catch, are allowed.
2. The **SAC IT4070026** included into the Natura 2000 network, which is a wreck of the "Paguro" drilling platform. It sank in 1965, about 12 miles offshore Marina di Ravenna, owing to the eruption of underground methane gas. The area is a rectangle of 66 hectares located in the centre of the Biological Protection Zone established by the Decree of the MIPAAF of 21 July 1995, with which basically coincides.
3. Four **marine areas of biological protection** (MPA.) aimed at maintenance of biodiversity and increase in fishery resources, materialized through submerged artificial barriers (Tecnoreef). The first installations, dated 1987, are located in front of Porto Garibaldi, and 2.8 miles offshore Cattolica. Following, as part of the project Community Adri.Blu and implementing measures two additional areas for fish restocking have been established; one at a distance of 5.5 miles from Bevano river mouth (regional act No. 5401 of 04/18/2006) and the other at 2.1 miles off Riccione (regional authorization act No. 63/2007).
4. Finally, the **nursery areas**, in front of the Sacca di Goro was established in 2006 (regional act n. 17538 dated 04/12/2006) for the reproduction of mollusc's bivalves,

Aquaculture represents another important asset (see Figure 9). Emilia-Romagna, indeed, boasts the highest regional production in Italy, with 40,000 tons/year catch (about 45% of national production) in 2013. With reference to the production of mussels and clams, together with Veneto Region, it reaches about 66% of the national shellfish farming (MIPAAF, 2015). Aquaculture consists of breeding of the 'Voracious clam of Asian origin' (*Tapes philippinarum*) and of Mediterranean mussel (*Mytilus galloprovincialis*). The fish breeding farms in cages, instead, are less widespread and concentrated mainly in the Comacchio lagoon areas. The total amount of aquaculture licences is 165, of which 114 spread inside and the immediate outside of the Sacca di Goro lagoon (which extends around 4900 hectares) (Figure 9). They are specifically dedicated to the breeding of the 'vongola verace' (*Venerupis decussata*).

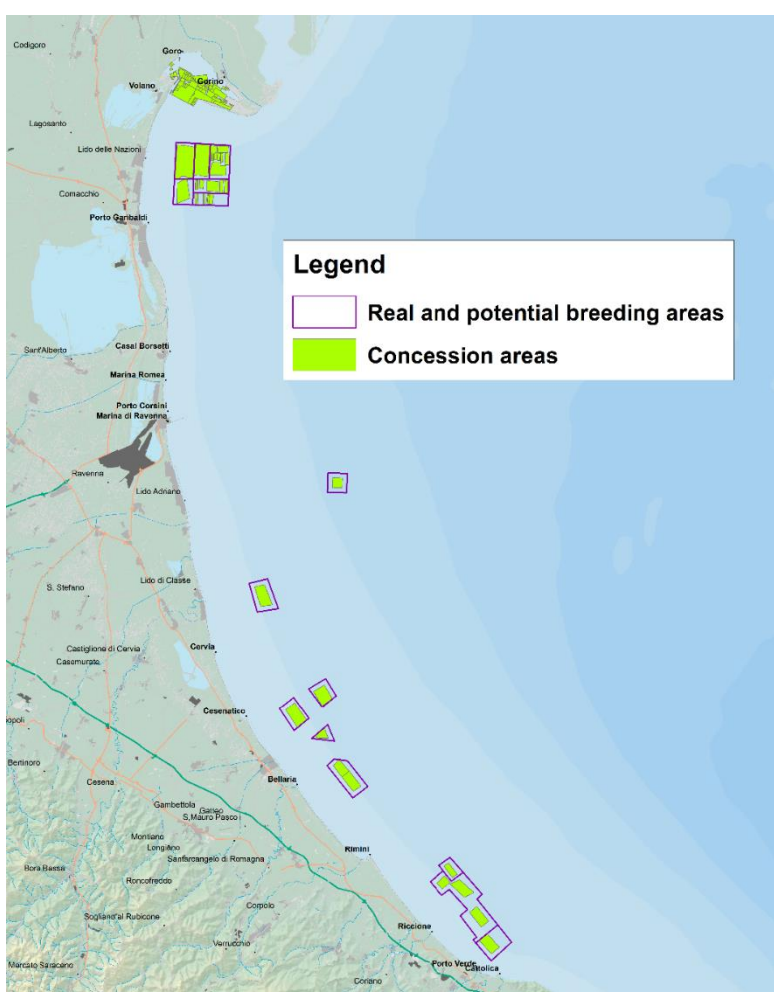


Figure 9 - Aquaculture in Emilia-Romagna.

Concerning **fishing**, the prevailing activities are small-scale fishery (SFF or artisanal fishing), and bottom trawler fishing. SFF boats have length under 12 m, using passive fishing gears, such as gillnets, trammel nets and traps. The firsts are used for the capture of target species like the *Solea solea* and the shrimp. The traps, such as pots and 'cogolli', are used in catching cuttlefish (*Sepia officinalis*) while 'baskets' are used for catching sea snails (*Tritia mutabilis*). All these artisanal fishing activities are predominantly exercised close to the coast, seldom exceeding the limit of 6-7 nautical miles. Bottom trawling relates to demersal species, it is practiced with bottom trawls or bottom traps. The latter are active fixed-mouth tools for benthic species such as *Solea* and *Pectinidae* (*Pecten jacobaeus* and *Aequipecten opercularis*). In addition,

it is also common the trawling for pelagic species, mainly anchovies and sardines (*Engraulis encrasicolus* and *Sardina pilchardus*): this activity is carried out by single boats or by two boats in parallel (pair trawling). The current rules forbid any type of trawling activity within the 3 nautical miles from the coast and set the minimum catch sizes for several commercial species.

Another important industry is represented by **oil and gas** extraction and distribution that, for what concern the offshore compartment, have developed in Italy in the 60s starting from Emilia-Romagna Region. Considering both on land and at sea infrastructures, in Emilia-Romagna 857 wells have been drilled in the period 1960-2012 out of a national total of 3440.

Although gas production has fallen since the 2000s, in the offshore Emilia-Romagna Region there still are several active permits and wells. Only considering the area from the shoreline to the 12 NM (territorial waters) there still are 15 oil and gas exploitation licences (see Figure 10), six of them no longer in exercise, and other 10 licence are present offshore, up to the continental shelf boundary. The two largest gas-fields are Garibaldi and Agostino, located in front of Ravenna at 8-13 nautical miles (NM) from the coast. Both have been exploited since 1970, and the total production reaches around 86 billion standard cubic meters (Sm³ - gas volume in m³ in standard conditions of pressure and temperature), which represent about 30% of the total. In the whole sea area, are still presents 61 platforms, of which 5 as support of drilling activity and 3 not in exercise. Most of them, 49, are distributed within the 12 NM.

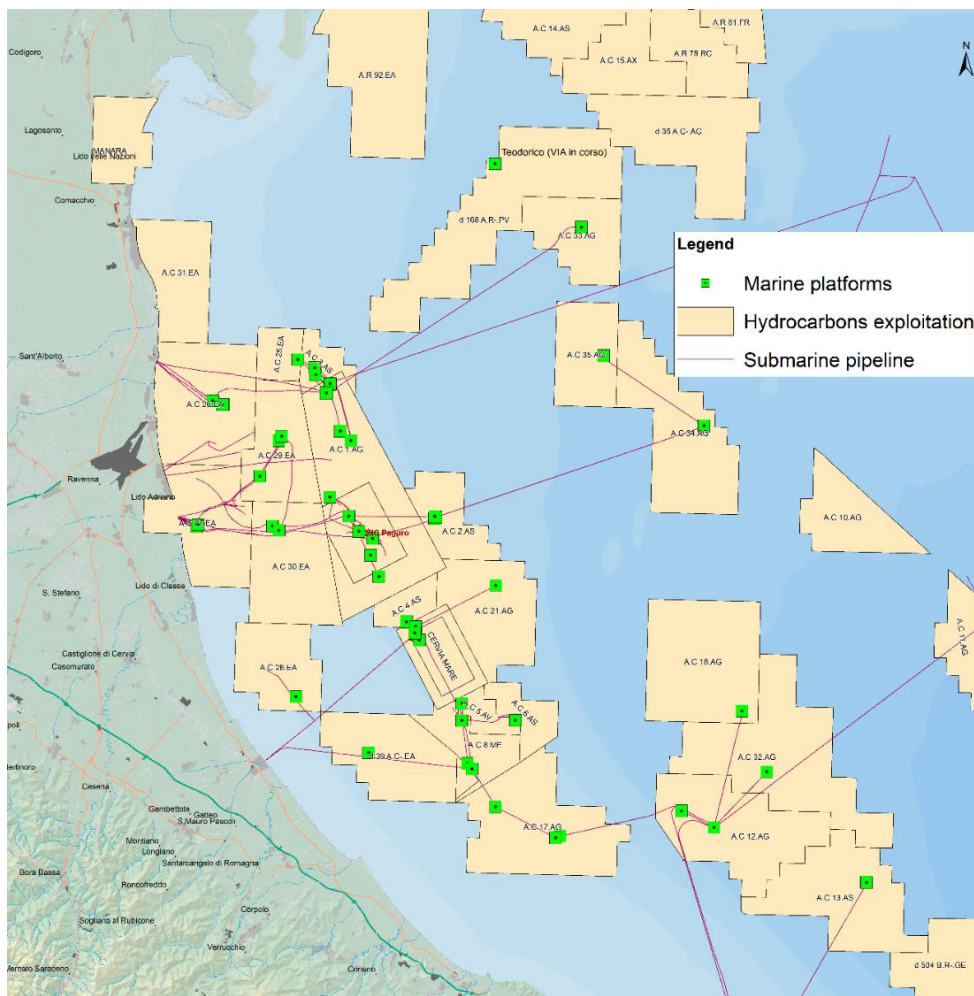


Figure 10 - Oil and Gas permissions, platforms and pipelines.

The **maritime compartment**, represented by the passengers and cargo, is mainly connected to the National Port of Ravenna, which has been strongly enlarging and developing during the last years. Indeed, it boasts connections all over the world, especially through the Mediterranean and Black Sea. Moreover, there are 5 regional ports (Cattolica, Rimini, Cesenatico, Porto Garibaldi e Goro), 4 municipal harbours (Riccione, Bellaria, Cervia and Gorino) and 27 marinas, some of them built-in inside the mentioned harbours. All the ports perform a series of functions (fishing, tourism, commerce, etc.) often superimposed and connected to the territorial context in which they are inserted (tertiary and residential). The cargo sector also includes the commercial transport along the 'Padano-Veneto waterway system' that is part of the "Mediterranean" corridor 3. Within Emilia-Romagna Region the Waterway of Ferrara offers the opportunity to reach the Adriatic Sea by following the Po up to Ferrara, and then navigating the 70-km-long Waterway of Ferrara to Porto Garibaldi. From there, following the coastline, it is possible to connect with the port of Ravenna.

Military: the Emilia-Romagna coastal zone is site of two military zones (Figure 11). The first one is located at the Reno River mouth (ECHO 346) that is the biggest land-sea shooting site in Italy. It includes zones permanently forbidden to anchoring and fishing activities (Maritime District of Ravenna- Ordinance) and areas temporarily barred from sailing and fishing during shooting exercises. The second is an area in front of the Riccione coast "ECHO 345" which is not currently in use.

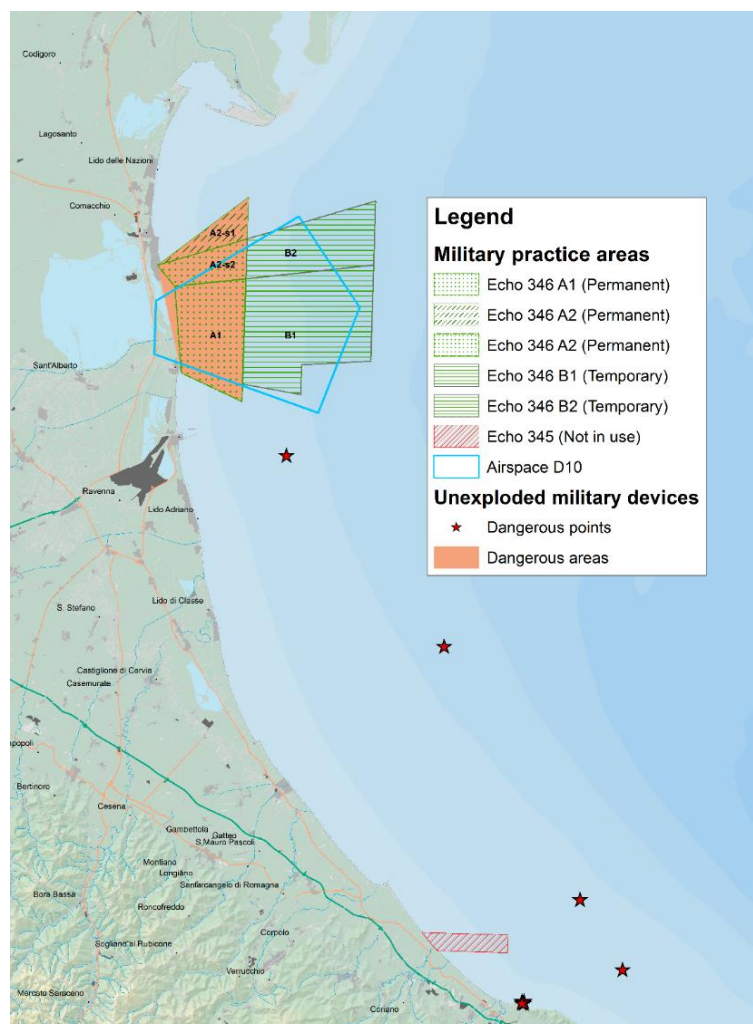


Figure 11 - Military areas.



4.2 Land-sea interaction: key issues

Article 7 of the MSP Directive 98/2014, dealing with land-sea interactions (LSI), suggests that the maritime spatial planning process include this topic as part of the plan, or else it can delegate the topic to other formal or informal processes, such as the integrated coastal management (ICZM).

Marine and coastal activities, indeed, are often closely interrelated, and MSP can play a very useful role in determining perspectives related to the sustainable and integrated management of human uses at sea, to the preservation of life and environment, to the reduction of the fragility of coastal ecosystems and erosion, and to social and economic factors. Maritime spatial planning should aim at integrating the maritime dimension of some coastal uses or activities and their impacts, and ultimately allow an integrated and strategic vision.

Despite such arguments, a unique definition and conceptualization of LSI has not been established yet. However, recent projects such as SUPREME and SIMWESTMED, developed some useful guidelines highlighting the components to consider, and the processes and areas of interest. (<https://www.msp-platform.eu/practices/land-sea-interactions-framework-iczm-and-msp>).

The general Framework for LSI developed by EC DG MARE describes “LSI as a complex phenomenon that involves both natural processes across the land-sea interface, as well as the impact of socio-economic human activities that take place in the coastal zone” (EC DG MARE, 2017). In Fact, there are several aspects that bind the land and marine components, both as regards the anthropic uses of the coast and the sea, and as regards the natural dynamics, which are often accelerated or made worst by the anthropic impact.

LSI could be classified into the following groups:

- **Land-sea natural processes:** often influenced/accelerated by human activities: flow of water and movement of organisms between land and sea ecosystems; loss of coastal /marine ecosystems; coastal erosion and sea flooding processes, sea level rise, the subsidence of the coastal plains; reduction of sediment input by the river, etc.
- **Land and sea uses and activities:** almost all maritime uses need supporting structures on land (e.g. ports for ships) while some of the land uses need structures at sea such (e.g. tourism); moreover some activities at sea impact the coastline and vice versa (e.g. oil and gas production accelerate land lowering of the coast).
- **Land and sea planning and management processes;** land and sea activities should be planned in a harmonized manner considering the land-sea continuum, thus implying the alignment of the general objectives and the methodologies used.
- **Land-sea socioeconomic interactions;** people living along the coast benefit from coastal and marine resources, operate in the economic sectors that develop both on land and at sea, thus driving land-sea processes; furthermore, people exchange their experiences, knowledge and culture with the neighbouring Countries.

It therefore becomes essential within the MSP process to focus on the regional hot-spots and on the dynamics underway: this is one of the driving points of the methodologies approved by the NTC.



Basing on the above mentioned concepts and following the national Guidelines for Maritime Spatial Planning (Decree of the Presidency of the Council of Ministries of 1 December 2017), the NTC identified the most relevant areas in terms of land-sea interactions, which are:

- **river basins** relevant on the basis of their identification according to the water framework directive (decree 152/2006);
- **terrestrial and marine protected areas**, including **SCIs** (Sites of Community importance), **SACs** (Special Areas of Conservation), and **SPAs** (Special Protection Areas) of the Natura 2000 network;
- **UNESCO sites**;
- **coastal areas** with high landscape/marine value;
- areas with important coastal maritime **infrastructures** (e.g. ports).

For what concern Emilia-Romagna territory, two main hot spots have been identified (see Figure 12):

- the **Po delta** (mostly located in the Veneto Region): it is characterized by a high environmental and historical value, and it has been recognized as a site of the UNESCO MAB (Man & Biosphere reserve). Main human activities in this area concern agriculture, aquaculture, fishing, and tourism. Here, natural and human-induced processes (such as anthropic subsidence) strongly influence land and ecosystems loss. It is an area relevant for the river outflow in terms of water, sediment, and pollutants.
- the **Ravenna harbour and surrounding zone**: it is characterized by the presence of environmental protected areas and by particularly important historical heritages, which represent an attraction to the coastal tourism. Unfortunately, both these elements are remarkably close to the industrial zone of Ravenna harbour, which is one of the biggest in Italy. The off-shore area still hosts several oil and gas wells, very close to the shoreline (e.g. Angela-Angelina platform), which influence both the local subsidence, that reaches some of the higher rates in the Region, and the coastal erosion.

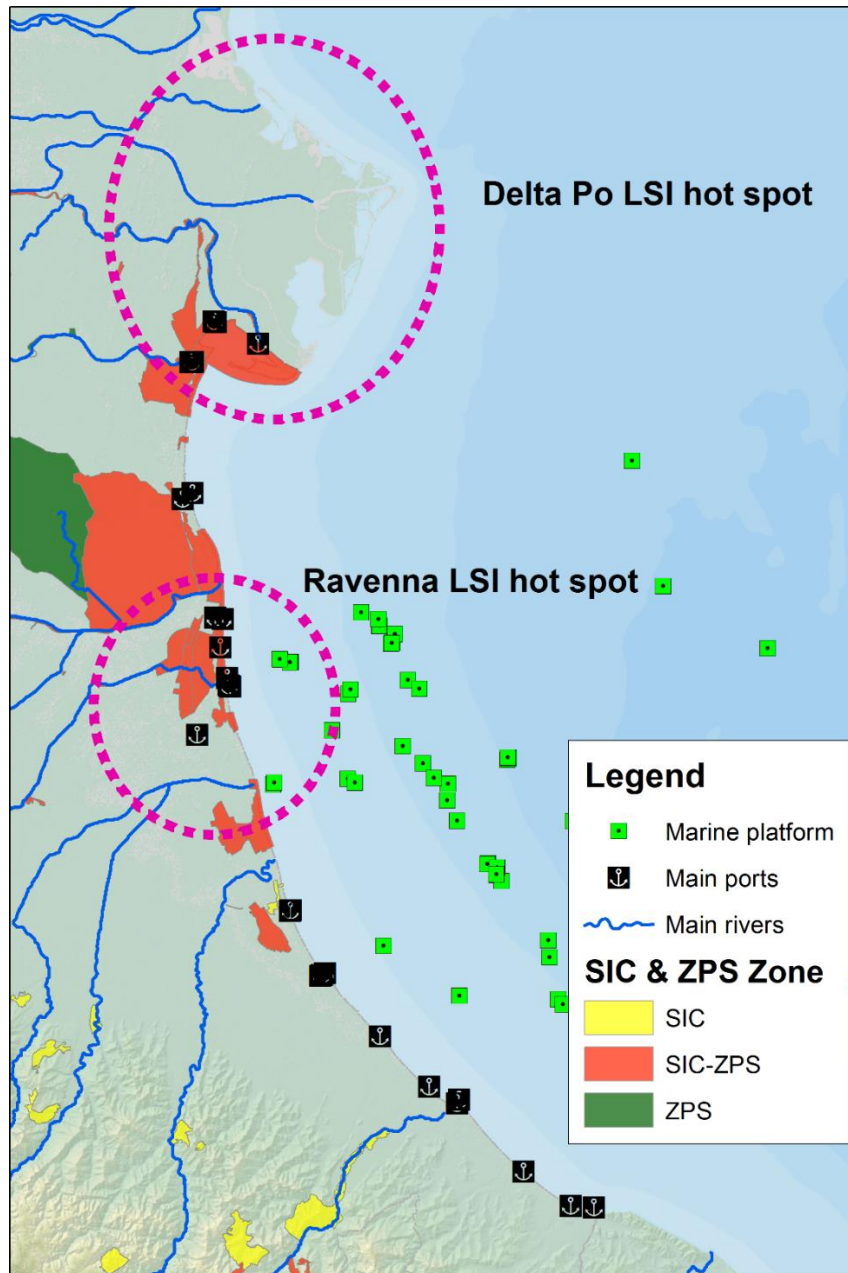


Figure 12 - Land-sea interaction hotspots in Emilia-Romagna.



5 WORKFLOW

The workflow adopted for the elaboration of the Emilia-Romagna Case Study integrates the methodology proposed by the scientific pole within the National Technical Committee (NTC), and PORTODIMARE project activities and commitments. In particular, the work was organised in 5 subsequent operational steps, articulated into several actions.

Step 1 is common to both objectives (NTC and PORTODIMARE), although with a slightly different approach, Step 2 and 4 are only subject of PORTODIMARE project; Step 3 and 5 are required mainly by NTC, while PORTODIMARE project foresees as an output an Action Plan for MSP, elaborated into the report T2.8.3.

Step 1: Testing the GAIR to create a knowledge framework: it includes the updating of necessary data and metadata; processing of thematic maps required for MSP analysis within PORTODIMARE and those necessary to support the Adriatic-MSP Plan according to D. Lgs. 201/2016

Step 2: Testing the Tools for MSP, in the present condition. In particular, the following analysis have been performed: analysis of cumulative effects assessment using CEA Module; multi-use synergies and conflicts analysis using MUC tools; research of suitable new zones for aquaculture, by testing AZA tool; finally it was tested the application of PARTRAC tool, to simulate the dispersion of particles from a source of waste.

Step 3: Setting up of a planning vision and objectives: starting from results of previous studies, such as Ritmare project; a **common and long-term vision** for coastal and marine areas must be drawn, as well as specific objects declined to the 'planning sub-units', into which the CS area has been split, with reference to the planning methodology approved by the NTC

Step 4: Testing the Tools for MSP, in the managed scenario. With reference to the strategic objectives and the derived planning units, and considering possible new sea uses, it has been performed a new analysis of the cumulative effect assessment (CEA Module) and of multi-use synergies and conflicts analysis using MUC tools.

Step 5: Elaboration of some Indication for MSP plan in the Emilia-Romagna sea zone; defining a set of possible Strategies and Measures oriented to reduce conflicts among uses, pressures on the environment, to increase knowledge, and prepare the basis for a sustainable blue growth.

The following paragraphs describes in detail how the different steps have been implemented.



6 GAIR testing to create a knowledge framework: Step 1

The initial activity of Case Study T2.3 concerned the testing of the Geoportal of Adriatic-Ionian Region (GAIR) as specific tool to develop the necessary knowledge and maps for the Maritime Spatial Planning.

As the basis for an MSP and ICZM processes, indeed, it is essential to develop a strong and reliable knowledge framework, dealing with all the anthropic and environmental aspects to be considered within the plan. On this topic the PORTODIMARE project provided specific reports, as results of WP1 (activities T.1.1-T1.2), dedicated to data needs, and to the inventory of existing portals where to discover suitable information (activity T1.3). In particular, the project report DT1.2.1, offered a complete list of category, subcategory, and specific layers necessary to correctly implement ICZM/MSP processes.

Moreover, PORTODIMARE activities T1.6 to T.12 produced a detailed analysis of the needed and available information to implement the 'Case studies', with regards to the inputs data needed for the Tools for MSP run.

6.1 Data collection and management

Following such indications, the first step towards the implementation of the Case Study T.2.3 was a 'knowledge GAP analysis', focusing on the general information needed for ICZM and MSP and with reference to the specific domain of Email-Romagna (ER) sea area. Such activity was done in parallel with activity T1.5 implementation (GAIR development). Another review of available data was conducted by paying attention to the dataset needed for the tools run and for the elaboration of the fourteen 'Maps' required by the national planning.

The resulting situation of available information was as follows:

- Some layers, especially the ones concerning the environmental aspects and the sources of pressures, were not available at the regional domain scale. For them we opted to use the information available at a larger scale, considering that, within the GAIR, multiple datasets on the topic had been collected at the scale of the Adriatic basin. These resources were mainly coming from research activities or from international platforms which publish thematic layers by integrating contributions from research and institutions (e.g. Ritmare, EMODnet, etc.)
- Several other datasets were already available to the ER domain, because elaborated and/or collected within previous projects, such as SHAPE (funded by Adriatic IP CBC, 2011-2014) and Ritmare (flagship project funded by the Italian Ministry for Research, 2017). Both projects have been capitalised during activity T1.5, by directly uploading their datasets into the GAIR. The processing of such data within the GAIR only concerned the editing of styles and permissions, and in some cases the improving of metadata.
- Several other new information layers (see Table 1), subject of more recent surveys or monitoring activities, have been acquired or updated, thus testing dedicated functionalities of the GAIR. In some cases, it was however required to pre-process data through some GIS software's. For example, tabular information have been transformed into spatial data; other information, acquired on the field, had to be processed and converted into thematic layers. The procedure followed included:
 - Data uploading into the GAIR. This functionality is restricted to authenticated users with specific permission and allows to import into the GAIR the geographical information (raster or vector spatial data), stored in another source.



- Data editing, aimed at implementing:
 - Styles, directly within GAIR, or, sometimes using the importer from GIS;
 - Metadata. Compiling all those mandatory (such as Title, abstract; category, etc.) and, at least, some of the optional information (domain; portal, etc.);
- Editing the permissions of the single layer.

Tourism	Arrivals 2018 and 2019	https://www.portodimare.eu/layers_ext/geonode:Tourism_2019_Emilια_Romagna_Region#/
Aquaculture	shellfish farms - updated 2020	https://www.portodimare.eu/layers_ext/geonode:_2019_shellfish_farms_in_eztyo#/ ;
Coastal risks (according to EU 2007/60)	Coastline 2014 Sea storms impacts (1946-2019) Beach Erosion (2006-2012) Coastal defence (2018) Sand volumes dredged - offshore (2002-2016)	https://www.portodimare.eu/layers_ext/geonode:coastline_2014_emilia_ro_iypxh#/ https://www.portodimare.eu/layers_ext/geonode:Localita_Colpite_2019_bis#/ https://www.portodimare.eu/layers_ext/geonode:Beach_Erosion#/ https://www.portodimare.eu/layers_ext/geonode:coastal_defence_2018_emi_wdqdb#/ https://www.portodimare.eu/layers_ext/geonode:localisation_and_volume_ixhds#/
Stoking areas for dredged sediments (D. Lgs. 152/2006)	Dumping and disposal areas	https://www.portodimare.eu/layers_ext/geonode:dumping_site#/
Environmental monitoring	Tursiops sighting (2018) Proposed SIC (2019)	https://www.portodimare.eu/layers_ext/geonode:tursiops_sighting_emilia_eugeo#/ https://www.portodimare.eu/layers_ext/geonode:Proposed_SIC_RER#/

Table 1: New dataset (or updated ones) implemented into the GAIR.

The Emilia-Romagna region domain presently contains **46 datasets**, **38** of which specifically settled to the marine area or the coastline (see Figure 13).

The screenshot displays the web application interface for editing metadata. The top navigation bar includes 'Data', 'Maps', 'Case Studies', and 'About'. The main content area is titled 'Proposed_SIC_RER_2019' and shows a map with a purple polygon representing the site boundaries. The left sidebar contains options like 'Download Layer', 'Metadata Detail', and 'Editing Tools'. Below the map, there is an 'Abstract' section and a 'Maintenance Frequency' field.

The second part of the screenshot shows the 'Metadata for Proposed_SIC_RER_2019' page. It features a 'Completeness' bar at 92% and a progress indicator with four steps: 1. Basic Metadata (Mandatory), 2. Location and Licenses (Mandatory), 3. Optional Metadata (Optional), and 4. Dataset Attributes (Optional). The 'Optional Metadata' step is currently active, showing fields for 'temporal extent start', 'temporal extent end', 'Responsible Parties', 'Point of Contact', 'Owner and Permissions', and 'Owner'. The 'Edition' field is set to '2019-design' and is marked as 'Starred'. The 'Purpose' field contains the text 'Areas proposed for SIC declaration'. The 'Supplemental information' field is currently empty.

Figure 13 - Example of data and metadata editing.



6.2 Maps elaboration

The very innovative side offered by the GAIR Geoportal, compared to others dedicated to the MSP topic, is the possibility to process cartographies and therefore to perform multilayer spatial analysis, essential for the planning process.

Within the Case Study T2.3 a specific task was dedicated to the elaboration of twelve maps, part of the list of fourteen maps required by the National MSP plan, that follows methodology approved by the Italian MSP Technical Committee (see Figure 14 for an example).

Table 2 shows the complete list of the maps, including those still missing, and provides the direct access to the GAIR where is possible to look, browse, and analyse the maps:

N°	Title	layers	Direct URL within the GAIR
1	Emilia-Romagna CS Boundaries - Map 1	Coastline, territorial waters, continental platforms; other significative boundaries	https://www.portodimare.eu/maps_ext/2607#/
2	Emilia-Romagna CS _MAP2_Transport	Besides CS boundaries; traffic density 2017; Ports and Harbours; Anchorage areas	https://www.portodimare.eu/maps_ext/2738#/
3	Emilia-Romagna CS_MAP3_Energy	Besides CS boundaries; energy resources in the area: oil & gas permits, platforms, cables, and pipelines	https://www.portodimare.eu/maps_ext/2743#/
4	Emilia-Romagna CS_MAP4_Aquaculture	Besides CS boundaries; Aquaculture permits - farms - nursery zones - ports	https://www.portodimare.eu/maps/2744/edit#/
5	Emilia-Romagna CS_MAP5_Fishing	Besides CS boundaries, it contains information on fishing fleets, small scale fishery; 3 nautical miles and fishing efforts (OTB-TBB)	https://www.portodimare.eu/maps_ext/2734#/
6	Emilia-Romagna CS_MAP6_Coastal risks	Besides CS boundaries, it contains information on coastal risks and Offshore sand deposits exploited for beach nourishment	https://www.portodimare.eu/maps_ext/2735#/
7	Emilia-Romagna CS_MAP7_Tourism	Besides CS boundaries, it contains: Tourist presence for coastal municipality (2019); marinas; bathing waters quality	https://www.portodimare.eu/maps_ext/2737#/
8	Emilia-Romagna CS_MAP8_Protected Areas	Besides CS boundaries, it contains: Coastal and marine protected areas (SIC-Natura2000-ATB)	https://www.portodimare.eu/maps_ext/2747#/

9	Emilia-Romagna CS_MAP9_Protected Areas	It should contain: main forecasts of landscape plans and areas of archaeological interest	Waiting for data from National level
10	Emilia-Romagna CS_MAP10_Military	Besides CS boundaries, it contains: Permanent and temporary military areas; danger zone; foul areas; wasted disposal dumped munitions	https://www.portodimare.eu/maps_ext/2748#/
11	Emilia-Romagna CS_MAP11_Research	Besides CS boundaries, it contains position of the sea state control stations: wave buoy and platforms where sea-level gauges are installed	https://www.portodimare.eu/maps_ext/2753#/
12	Emilia-Romagna CS_MAP12_Habitat	Besides CS boundaries, it contains: EUNIS classification and Habitat	https://www.portodimare.eu/maps_ext/2754#/
13	Emilia-Romagna CS_MAP13_Pelagic species	Besides CS boundaries, it contains: predicted presence of Tursiops and Caretta Caretta; and Tursiops sighting 2018	https://www.portodimare.eu/maps_ext/2749#/
14	Emilia-Romagna CS_MAP14_Indicators of contaminated waters sources	Distribution of synthetic indicators relating to the state of water contamination	Still missing information

Table 2: List of maps for MSP, with reference to Emilia-Romagna sea, implemented into the GAIR



Figure 14 - Example of map Emilia-Romagna CS_MAP5_Fishing processed within the GAIR.



7 ANALYSIS OF THE PRESENT CONDITIONS - TOOLS FOR MSP APPLICATION: STEP 2

7.1 CEA Module

Objectives: the Cumulative Effects Assessment analysis has been performed in order to inform the planning process on the present propagation of pressures generated by one or multiple anthropogenic uses and to assess the spatial distribution of impacts exerted by one or multiple pressures on one or multiple environmental receptors.

7.1.1 Method and data

The PORTODIMARE Geoportal allows to perform Cumulative Effects Assessment analysis based on the Tools4MSP CEA modelling framework (Menegon *et al.*, 2018a). The Tools4MSP CEA is an MSP-oriented open source software suite for geospatial analysis, which provides multi-objective toolsets for MSP (for more detail see Depellegrin *et al.*, 2017; Menegon *et al.*, 2018c).

The Tools4MSP CEA approach incorporates a key aspect of the environmental risk assessment discipline which is the explicit identification and understanding of the source-pressure-pathway-receptor linkages (Judd *et al.*, 2015; Stelzenmüller *et al.*, 2018). More in detail, the linkages are modelled through two independent but concatenate tasks:

- pressures assessment: from human uses to pressures. It estimates the propagation of pressures generated by one or multiple anthropogenic uses.
- effects/impacts assessment: from pressures to impacts. It allows to spatially assess the spatial distribution of impact exerted by one or multiple pressures on one or multiple environmental receptors.

According to the general method adopted by PORTODIMARE Geoportal, CEA analysis has been carried out following the Case Study-driven approach, where the “Case Study” is a coherent and harmonized set of geospatial layers (and other documentation) available at different geospatial scales (Adriatic-Ionian Region, national, regional, local, testing site or case study level) and resolutions.

The default Case Study is directly available through the GAIR:

- T2.3 Emilia-Romagna Case Study <https://www.portodimare.eu/casestudies/34/>

Following Farella *et al.* (2020), all datasets have been rasterized in a regular grid with a cell resolution of 250 x 250 m. The units of the spatial indicators U and E are presence/absence (e.g. aquaculture), weighted dummy (e.g. land-based activities) and intensity indicators (e.g. maritime traffic). Intensity indicators were transformed using $\log [x + 1]$ to avoid an over-dominance of extreme values and all datasets rescaled from 0 to 1 in order to allow direct comparison on a single, unitless scale.

The following tables describe the 11 human uses (U) and the 4 environmental components (E) considered in the study area, including the references to the layer published through the PORTODIMARE Geoportal.



Human use	Description	Unit	Source
ACQSHEL - Aquaculture	Aquaculture (RER - 2020)	P/A	2020 shellfish farms in Emilia-Romagna (IT)
PIEPLN - Cables and Pipelines	Submarine pipelines	P/A	Pipelines (Emilia-Romagna Region)
TBOAT - Coastal and Maritime Tourism	Bathing waters	P/A	Bathing waters monitoring network
	Marinas - Italy	Nr of berth	Marinas - Italy - Published 2014
LBA - Land Based Activities	Modelled land-based pressures from rivers into the Adriatic Sea (including inputs of fertilizers and other nitrogen and phosphorus-rich substances, organic matter, introduction of non-synthetic substances, compounds and other substances)	Index (1 - high contribution to 0 - no contribution)	
SHIPDENS - Maritime Transport	Adriatic traffic density (July 2014-June 2015)	Ship passages/cell	Adriatic traffic density July 2014 - June 2015
IPOINTS - Naval base activities	Cruise Ports data (year 2015)	Nr of cruises	Cruise Ports - Italy 2015
	Main Ports (Total shipped goods, year 2016)	Tons	Main Ports Stats 2015-2016
OSDEP - Offshore sand deposits	Offshore sand dredged	P/A	Localisation and volume of dredged sands offshore (Emilia-Romagna Region)
OGEXTR - Oil & Gas extraction	EMODNET Hydrocarbon Extraction - Offshore Installations	P/A	O&G extraction platforms - Italy Oil and gas marine terminals Emilia-Romagna (IT)
SSF - Small scale fishery	Small scale fisheries (e.g. Set gillnets, purse seines, traps, etc.)	Total operations	Small scale fisheries (It RER VEN FVG) GNS - Reti a imbrocco - 2015 (It RER VEN FVG) PS - Circonazione - 2015 (It RER VEN FVG)



Human use	Description	Unit	Source
HYDREDGES - Hydraulic dredges	Hydraulic dredges for clam fisheries	Total operations	DRB - Draghe idrauliche - 2015
PTM - Mid-water pelagic trawling	Mid-water pair trawl from AIS data (year 2015)	Swept area (km ²)	PTM - Volanti - 2015
OTB - Trawling OTB	Bottom otter trawl from AIS data (year 2015)	Swept area (km ²)	OTB - Bottom otter trawl - 2015
TBB - Trawling TBB	Beam trawl from AIS data (year 2015)	Swept area (km ²)	TBB - Rapidi - 2015

Table 3: list of the human uses incorporated into the Emilia-Romagna Case Study

Environmental component	Description	Unit	Source
Marine seabed habitats	EUNIS A5.23 - Infralittoral fine sands	P/A	EUSeaMap (2019) Broad-Scale Predictive Habitat Map - AIR section
	EUNIS A5.25 - Circalittoral fine sands		
	EUNIS A5.26 - Circalittoral muddy sand		
	EUNIS A5.33 - Infralittoral sandy mud		
	EUNIS A5.35 - Circalittoral sandy mud		
	EUNIS A5.36 - Circalittoral fine mud		
MAM - Marine mammals	<i>Tursiops truncatus</i> predicted density in the Adriatic Sea (2010-2013)	Density (nr of animals/100 km ²) categories	Tursiops truncatus predicted density in the Adriatic Sea (2010-2013)
NURSPAWN - Essential Fish Habitats (areas where recruits/adults concentrate:	<i>Engraulis encrasicolus</i> (European anchovy) spawners and recruits	Probability of occurrence	Engraulis encrasicolus (European anchovy) recruits



Environmental component	Description	Unit	Source
nursery/potential spawning areas; Moore et al., 2016)			Engraulis encrasicolus (European anchovy) spawners
	<i>Pagellus erythrinus</i> (Common Pandora) recruits		Pagellus erythrinus (Common Pandora) spawners
	<i>Solea solea</i> (Common sole) spawners and recruits		Solea solea (Common sole) spawners Solea solea (Common sole) recruits
	<i>Trachurus mediterraneus</i> (Mediterranean horse mackerel) recruits		Trachurus mediterraneus (Mediterranean horse mackerel) recruits
	<i>Trachurus trachurus</i> (Atlantic horse mackerel) recruits		Trachurus trachurus (Atlantic horse mackerel) recruits
	<i>Sardina pilchardus</i> (European pilchard) spawners and recruits		Sardina pilchardus (European pilchard) spawners Sardina pilchardus (European pilchard) recruits
	<i>Scomber colias</i> (Atlantic chum mackerel) spawners and recruits		Scomber colias (Atlantic chum mackerel) spawners Scomber colias (Atlantic chub mackerel) recruits
	<i>Mullus barbatus</i> (Red mullet) spawners and recruits		Mullus barbatus (Red mullet) spawners Mullus barbatus (Red mullet) recruits
	<i>Scomber scombrus</i> (Atlantic mackerel) recruits		Scomber scombrus (Atlantic mackerel) recruits



Environmental component	Description	Unit	Source
TURT - Turtles	<i>Caretta caretta</i> predicted density in the Adriatic Sea (2010-2013)	Density (nr of animals/100 km ²) categories	Caretta caretta predicted density in the Adriatic Sea (2010-2013)

Table 4: list of the environmental receptors incorporated into the Emilia-Romagna Case Study

Regarding the “Pressures assessment”, in total 15 pressures were taken into consideration according to the MSFD Annex III (2017/845/EU). The definition of anthropogenic pressures and their propagation from the sources was developed by using different modelling approaches. Land-based pressures to the marine environment from rivers and coastal cities were modelled by using the open-source 3-D hydrodynamic model SHYFEM (Shallow water Hydrodynamic Finite Model; Umgiesser *et al.*, 2004), reproducing the dynamics of substances from rivers into the Adriatic Sea (Depellegrin *et al.*, 2017). Where robust knowledge on the pressure propagation was absent, the Tools4MSP CEA model adopts an isotropic convolution distance model proposed in Menegon *et al.* (2018a) which can be applied to any human use independently from its spatial structure (point, polygon or line feature). Such a simplified model requires two input parameters for each use-pressure combination: “buffer distance” and “pressure weight”. Such parameters are expert-based, and they were derived from the stakeholder engagement. Figures 15 shows the pressure weight and the buffer distance values for each use-pressure combination adopted for the Emilia-Romagna Case Study.

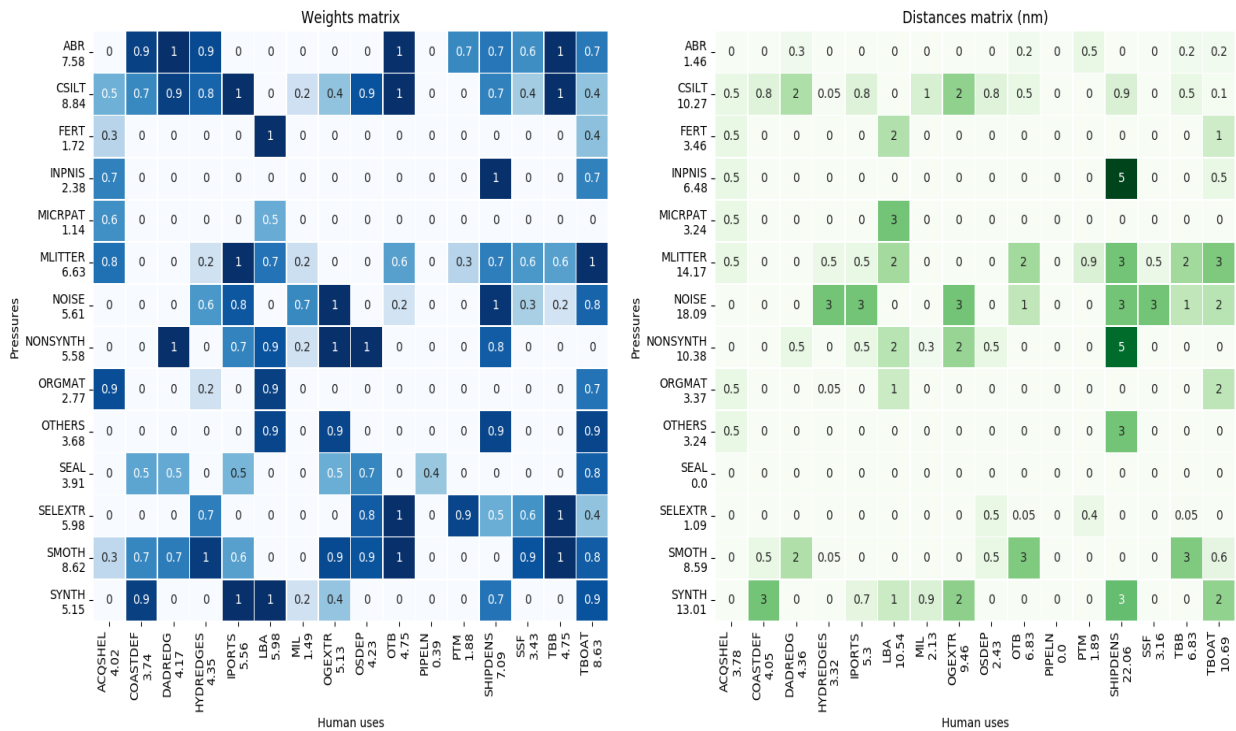


Figure 15 - Weights matrix (left) and distance matrix (right) reporting the respectively the “pressure weight” and the “buffer distance” values for each human use - pressure combination.



For a more detailed description (e.g. equations) of the pressure indicators and propagation we refer to Menegon *et al.* (2018a, 2018b) and the Tools4MSP CEA online documentation³.

The effects/impacts assessment task is based on sensitivity/vulnerability scores which represent the “likelihood of change when a pressure is applied to a feature (receptor) and is a function of the ability of the feature to tolerate or resist change (resistance) and its ability to recover from impact (resilience)” (Tillin *et al.*, 2010). Similarly, to buffer weights and pressure distances, the sensitivities scores are expert-based, and they were derived from stakeholder engagement. In Figure 16 the sensitivity matrix for each combination of different pressures and environmental components is presented.

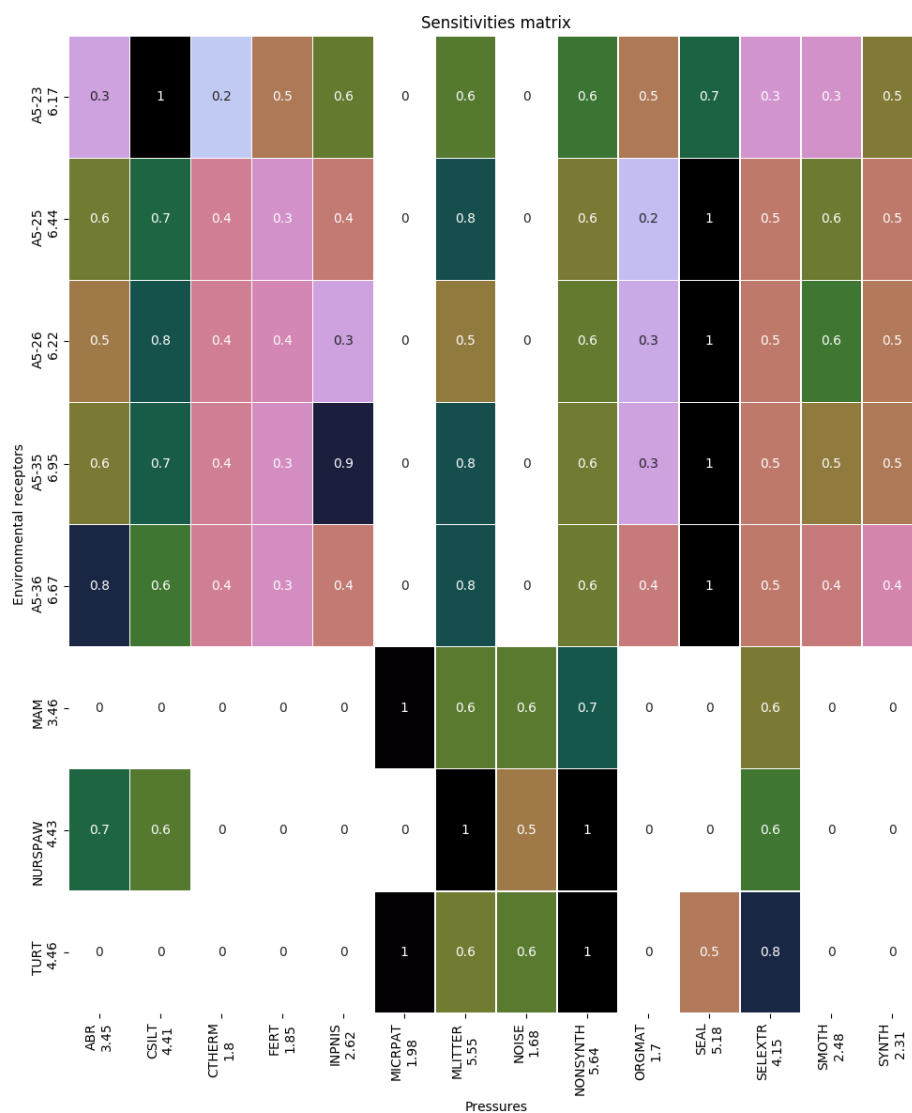


Figure 16 - Sensitivity scores for each pressure -environmental receptor combination.

³ <http://docs.tools4msp.eu/modules/cea/index.html>



The main output of the Tools CEA module is the geospatial distribution of CEA score (CEAScore), a bidimensional GeoTIFF raster file representing the overall Cumulative Effects score in each raster grid cell. Three additional geospatial outputs are generated were the overall CEA is split according to the MSFD pressure classification:

- CEA score exerted by MSFD Substances, litter and energy pressures (MAPCEA-MSFDSUB): Inputs of fertilisers and other nitrogen and phosphorus-rich substances, Inputs of organic matter, Introduction of non-synthetic substances and compounds, Introduction of other substances, Introduction of radio-nuclides, Introduction of synthetic compounds, Marine litter, Underwater noise.
- CEA score exerted by MSFD Biological pressures (MAPCEA-MSFDBIO): Food availability, Introduction of microbial pathogens, Introduction of non-indigenous species and translocations, Selective extraction of species, including incidental non-target catches.
- CEA score exerted by MSFD Physical pressures (MAPCEA-MSFDPHY): Abrasion (surface, light, heavy), Changes in siltation, Heat effect (due to cabling), Removal of substratum (extraction), Sealing, Significant changes in electromagnetic field, Significant changes in salinity regime, Significant changes in thermal regime, Smothering

In order to facilitate the interpretation of results, other outputs are made available by the module:

- Barplot of CEA score for Human Use (BARCEAUSE). A table/barplot representing the contribution (in percentage) of human uses (U) to the overall CEA score for the whole area of analysis.
- Barplot of CEA score for Environmental Receptor (BARCEAENV). A table/barplot representing the contribution (in percentage) of environmental receptors (E) to the overall CEA score for the whole area of analysis.
- Barplot of CEA score for exerted pressure (BAPRESCORE). A table/barplot representing the contribution (in percentage) of exerted pressure (P) to the overall CEA score for the whole area of analysis.
- CEA score for each U-E combination (HEATUSEENVCEA). A table/matrix representing the contribution (in percentage) of the single pairwise combination of human use (U) and environmental receptor (E) to the total CEA score (for the whole area of analysis).
- CEA score for each P-E combination (HEATPREENVCEA). A table/matrix representing the contribution (in percentage) of the single pairwise combination of pressure (P) and environmental receptor (E) to the total CEA score (for the whole area of analysis).
- Heatmap of Pressure scores due to human uses (HEATUSEPRESCORE). A table/matrix representing the contribution (in percentage) of the single pairwise combination of human use (U) and pressure (P) to the total CEA score (for the whole area of analysis).
- Distribution of CEA score (HISTCEAScore). A table/histogram representing the number of grid cells for each class of CEA score.

Finally, the graphical user interface allows the users to individually select the layers (human uses or environmental receptors) to be incorporated into the analysis.

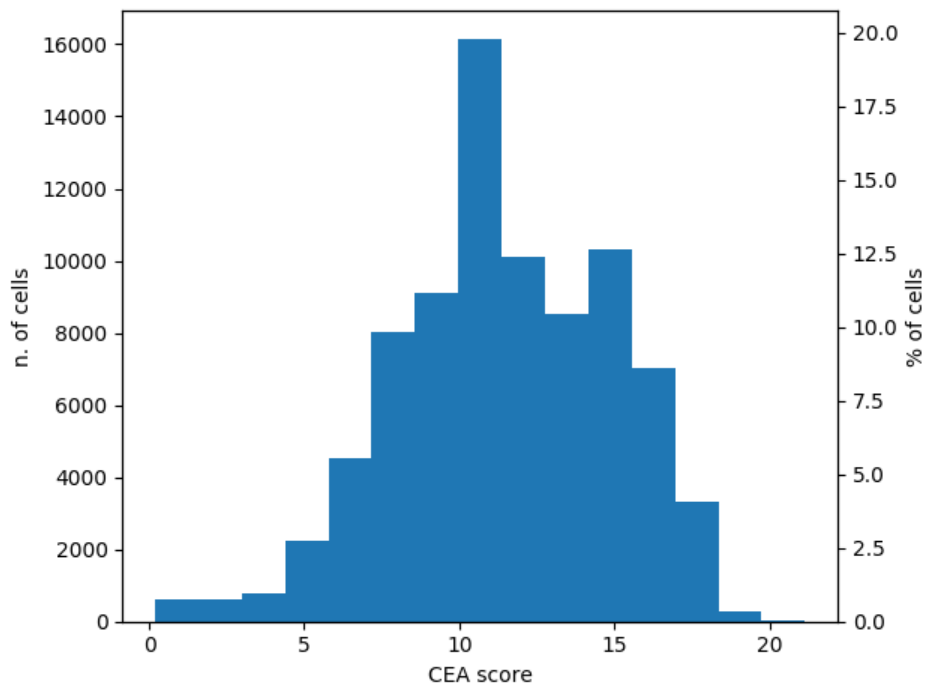


Figure 18 - histogram representing the number of grid cells (left axis) and the percentage over the total cells (right axis) for each class of CEA score.

In the CS area the complex system of **marine transportation** is the most influential maritime use exerting relevant pressures, especially because it causes the introduction of non-indigenous species, marine litter, underwater noise and substances (Figure 19) and is impacting mainly Essential Fish Habitats (NURSPAW), Circalittoral fine mud (A5.36) and Turtles and Mammals (Figure 20a).

The full set of **trawling activities** reaches a total CEA score higher to the one generated by maritime transport: bottom otter trawlers (OTB), mid-water pelagic (PTM) and “rapido” beam trawlers (TBB) impact the area mainly by generating abrasion, change in siltation, smothering and selective extraction of species.

Land based activities’ pressures (e.g. microbial pathogens, marine litter, and introduction of organic and inorganic substances) are strongly related to riverine inputs (e.g. Po river Delta) and have a significant influence on the overall CEA score.

Port activities are concentrated in the Ravenna area, locally exerting low CEA scores (in particular underwater noise). Coastal and maritime tourism influence coastal areas only within the 10 NM, exerting a wide set of pressures (e.g. marine litter, underwater noise, introduction of both organic and synthetic components).

The spatial distribution of other important human activities (aquaculture, gas extraction, infrastructures, small scale fisheries, military areas) is not so wide, with consequent lesser contributions to the total CEA score, although high absolute scores may be found in their proximity.

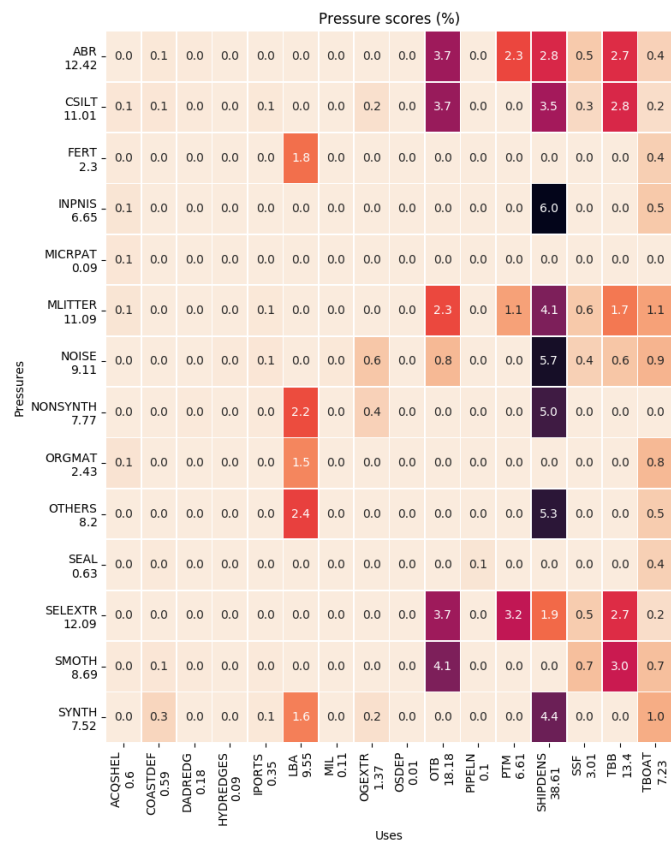


Figure 19 - Matrix representing the contribution (in %) of the single pairwise combination of human use (U) and pressure (P) to the total Pressure score, for the whole area of analysis.

Key nursery and spawning areas for species of commercial interest for fisheries (EFHs - NURSPAW) are together widespread in the CS area and represent the environmental components which are the most exposed to anthropogenic pressures (e.g. abrasion, pollution, marine litter). Soft bottoms, both muddy and sandy, represent the second environmental component among the most exposed to anthropogenic pressures (e.g. abrasion, pollution, marine litter) in the area.

Marine mammals and turtles are present in the whole CS area, following seasonal variations. The whole set of human activities (especially trawling and traffic) generate high cumulative effect scores on sea turtles, while mammals are affected but to a lower extent due to both lower densities and sensitivities to specific pressures (see Figure 20).

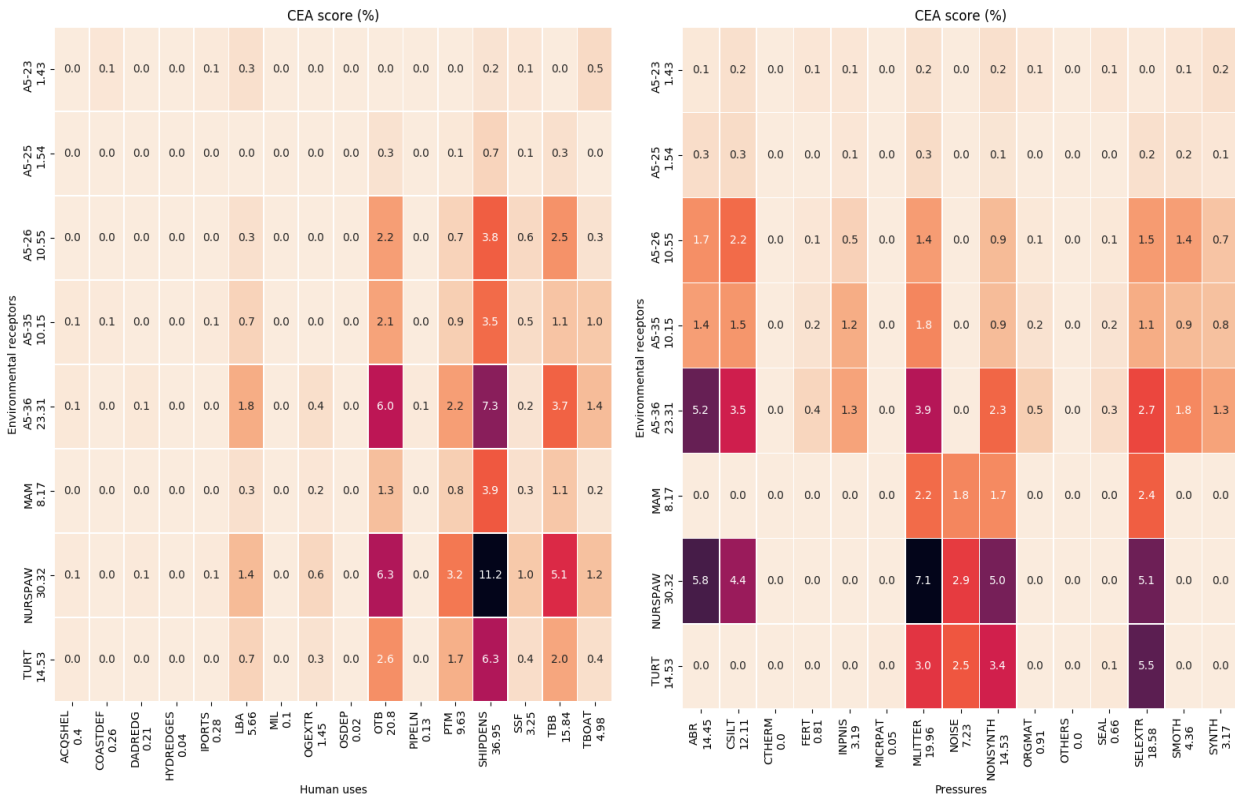


Figure 20 - Matrixes representing the contribution (in %) of the single pairwise combination of human use and environmental receptor (left) and of pressure and environmental receptor to the total CEA score (for the whole area of analysis).

Pressures generated by the introduction of substances, litter, and energy show higher scores in the CS area, with an important hot-spot close to the port of Ravenna (see Figure 21)

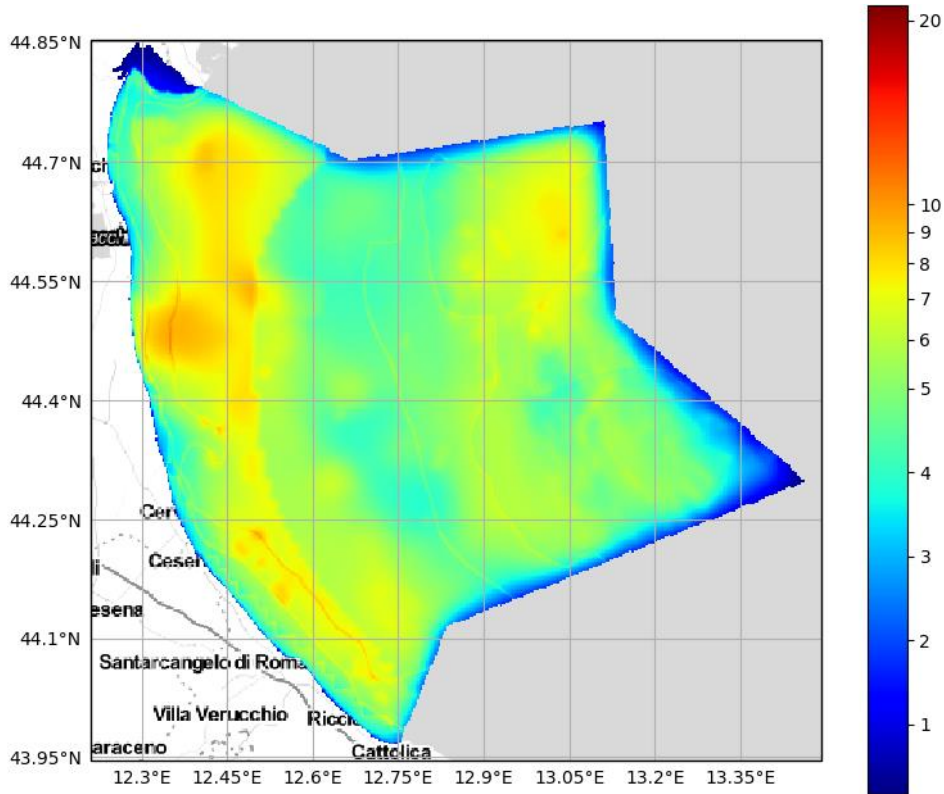


Figure 21 -Spatial distribution of CEA scores exerted by MSFD Substances, litter and energy pressures (MAPCEA-MSFDSUB): Inputs of fertilisers and other nitrogen and phosphorus-rich substances, Inputs of organic matter, Introduction of non-synthetic substances and compounds, Introduction of other substances, Introduction of radio-nuclides, Introduction of synthetic compounds, Marine litter, Underwater noise.

Biological pressures and physical pressures show low scores and are respectively highly related to land-based activities and fixed structures (platforms, cables and pipelines), while trawling activities strongly influence both the categories (Figures 22 and 23).

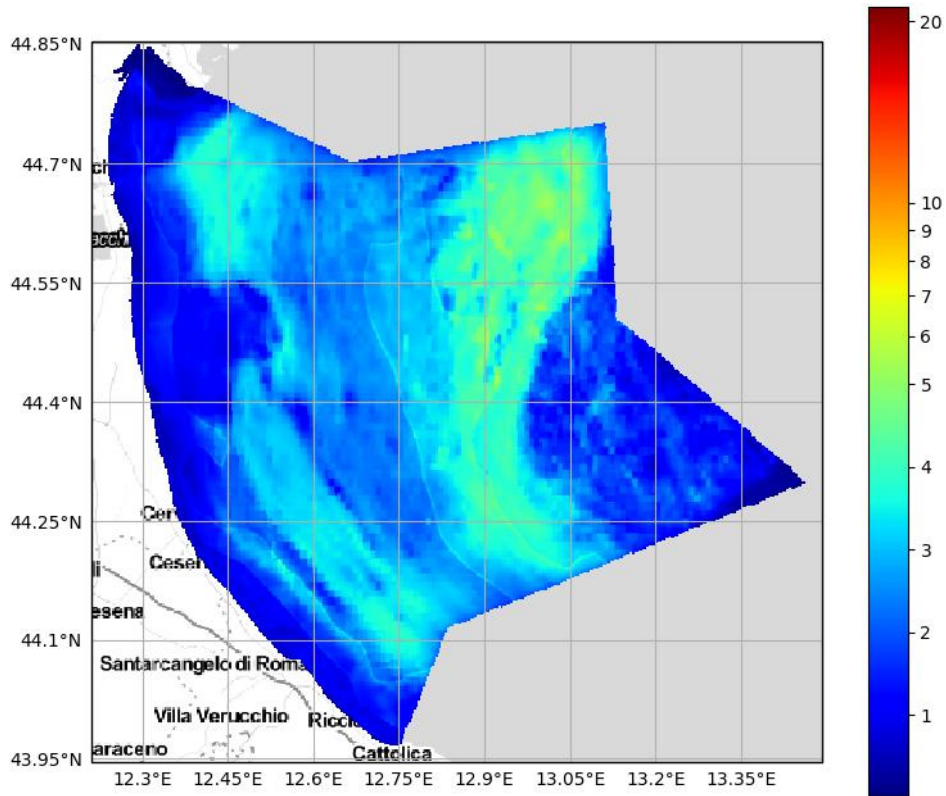


Figure 22 - Spatial distribution of CEA scores exerted by MSFD Biological pressures (MAPCEA-MSFDBIO): Food availability, Introduction of microbial pathogens, Introduction of non-indigenous species and translocations, Selective extraction of species, including incidental non-target catches (bycatch).

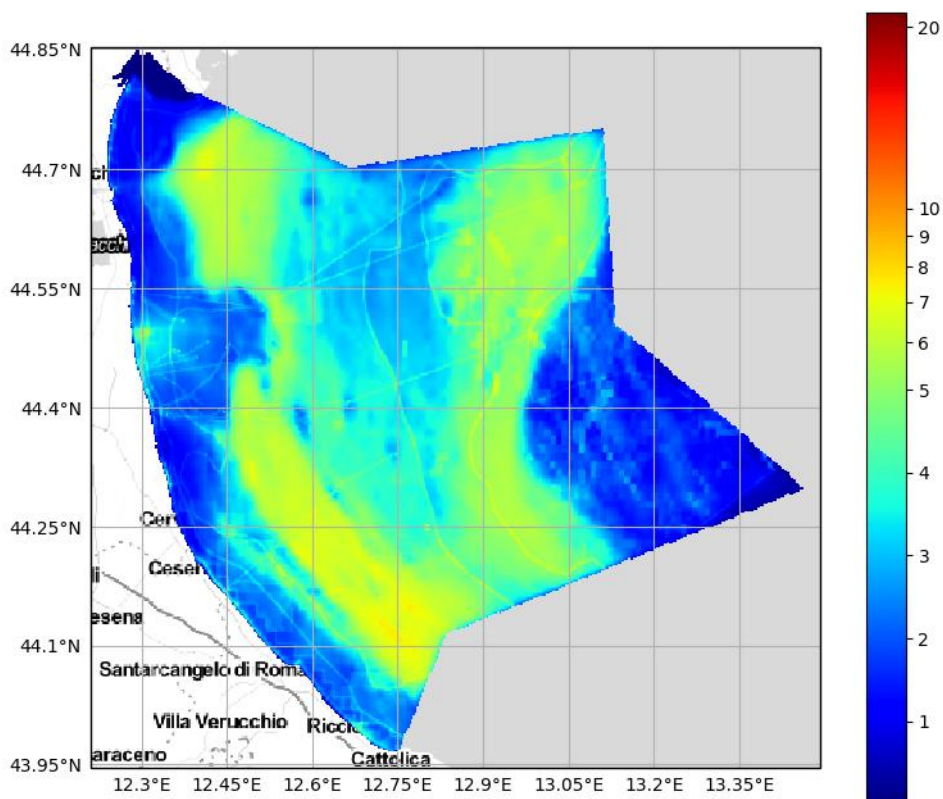


Figure 23 - Spatial distribution of CEA scores exerted by MSFD Physical pressures (MAPCEA-MSFDPHY): Abrasion (surface, light, heavy), Changes in siltation, Removal of substratum (extraction), Sealing, Significant changes in salinity regime, Significant changes in thermal regime, Smothering.



The ranking of exerted pressures over the entire study area is represented in figure 24, highlighting the strong role of the mechanical damage (abrasion and changes in siltation) and selective extraction, together with introduction of marine litter and non-indigenous species.

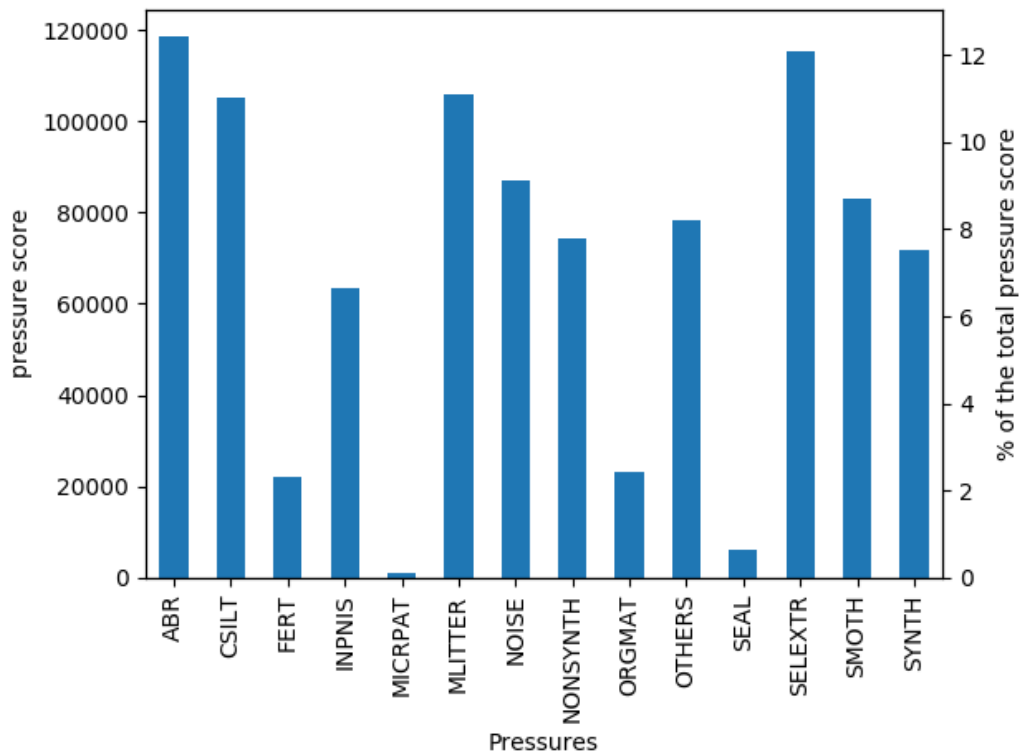


Figure 24 - Barplot representing the ranking of exerted pressures over the entire study area. Results are represented in pressure scores (left axis) and in percentage (right axis). ABR: abrasion; CSILT: Changes in siltation; FERT: Inputs of fertilisers and other nitrogen and phosphorus-rich substances; INPNIS: Introduction of non-indigenous species; MICRPAT: Introduction of microbial pathogens; MLITTER: Marine litter; NOISE: Underwater noise; NONSYNTH: Introduction of non-synthetic substances and compounds; ORGMAT: Inputs of organic matter; SEAL: Sealing ; SELEXTR: Selective extraction of species, including incidental non-target catches; SMOTH: Smothering; SYNTH: Introduction of synthetic compounds.



7.2 MUC module

Objectives: the Maritime Use Conflict analysis (MUC) module run has been performed in order to identify current interactions between human uses in terms of conflicts.

7.2.1 Method and data

The PORTODIMARE Geoportal allows to perform the Maritime Use Conflict analysis (MUC). This is based on the Tools4MSP MUC tool, derived from a methodology developed within the COEXIST Project - Interaction in European coastal waters: a roadmap to sustainable integration of aquaculture and fisheries (COEXIST, 2013; Gramolini *et al.* 2010). The methodology enables the identification of current/potential human uses and assesses their interaction in terms of conflicts. Figure 25 shows potential conflict score related to the Adriatic Sea.

The MUC score on a single grid of analysis is calculated by summarizing the potential conflict score between each combination of uses which are present in that cell. According to the original methodology, the potential conflict score between two uses is expert-based and can vary from 0 to 6. For a more detailed description (e.g. equations) of the MUC assessment we refer to Menegon *et al.* (2018b) and to the Tools4MSP MUC online documentation⁴.

⁴ <http://docs.tools4msp.eu/modules/muc/index.html>



Potential conflict

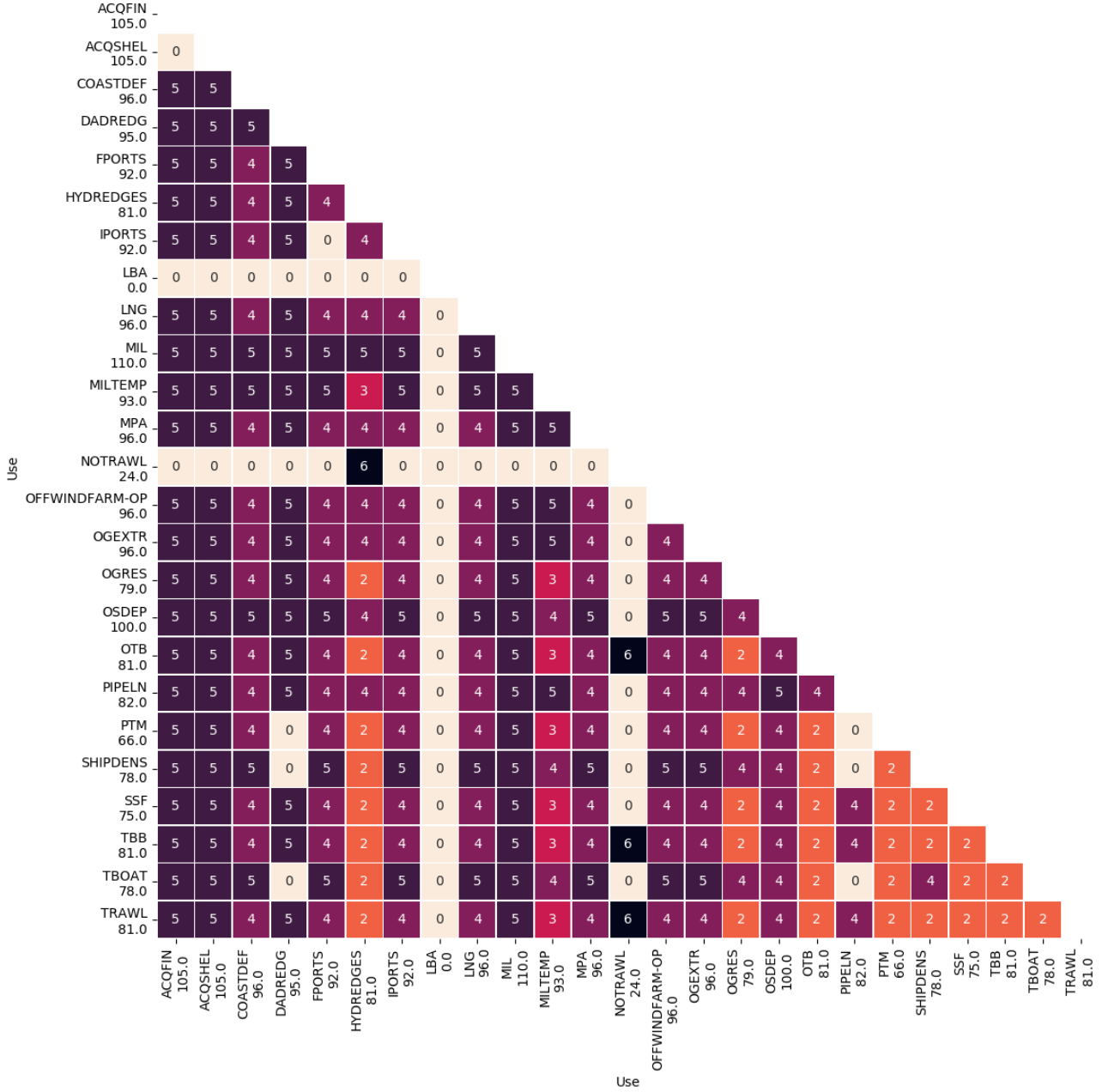


Figure 25 - potential conflict score between use-use combination.



The default Case Study is directly available through the GAIR:

- T2.3 Emilia-Romagna Case Study <https://www.portodimare.eu/casestudies/121/>

All datasets have been rasterized in a regular grid with a cell resolution of 250 x 250 m. Differently from the CEA analysis, the MUC model considers only the presence/absence distribution of human uses (it does not support intensity). Hence, a binary classification (0/1) based on discriminant threshold has been applied to intensity-represented use layers (e.g. Maritime transport, Fishery). The following table describes the human uses in the study area, including the references to the layer published through the PORTODIMARE GAIR and the discriminant threshold.

Human use	Description	Unit/Threshold	Source
Aquaculture	Aquaculture (RER - 2020)	P/A	2020 shellfish farms in Emilia-Romagna (IT)
Cables and Pipelines	Submarine pipelines and safety zones around the pipelines	P/A	Pipelines (Emilia-Romagna Region) SAFETY ZONE - around pipelines
Coastal and Maritime Tourism	Bathing waters	P/A	Bathing waters monitoring network
	Marinas - Italy	Nr of berth threshold 40%	Marinas - Italy - Published 2014
Marine Protected Areas	ADRI-BLU TECNOREEF and wreck of Paguro platform	P/A	Protected marine habitat (Emilia-Romagna Region)
Maritime Transport	Adriatic traffic density (July 2014-June 2015)	Ship passages/cell threshold 10%	Adriatic traffic density July 2014 - June 2015
Naval base activities	Cruise Ports data (year 2015)	Nr of cruises threshold 40%	Cruise Ports - Italy 2015
	Main Ports (Total shipped goods, year 2016)	Tons threshold 40%	Main Ports Stats 2015-2016
No trawling areas	Trawling restrictions in Emilia-Romagna	P/A	No-trawling areas in Emilia-Romagna marine area



Human use	Description	Unit/Threshold	Source
Offshore sand deposits	Offshore sand dredged and offshore sand deposits	P/A	Localisation and volume of dredged sands offshore (Emilia-Romagna Region) Offshore sand deposit (Emilia-Romagna Region)
Oil & Gas extraction	EMODNET Hydrocarbon Extraction - Offshore Installations and safety zones around the platforms	P/A	O&G extraction platforms - Italy Oil and gas marine terminals Emilia-Romagna (IT) Safety zones around platforms
Small scale fishery	Small scale fisheries (e.g. Set gillnets, purse seines, traps, etc.)	Total operations threshold 10%	Small scale fisheries (It RER VEN FVG) GNS - Reti a imbrocco - 2015 (It RER VEN FVG) PS - Circoizione - 2015 (It RER VEN FVG)
Mid-water pelagic trawling	Mid-water pair trawl from AIS data (year 2015)	Swept area (km ²) threshold 10%	PTM - Volanti - 2015
Trawling OTB	Bottom otter trawl from AIS data (year 2015)	Swept area (km ²) threshold 10%	OTB - Bottom otter trawl - 2015
Trawling TBB	Beam trawl from AIS data (year 2015)	Swept area (km ²) threshold 10%	TBB - Rapidi - 2015

Table 5 - Human uses included in the MUC analysis.

The main outputs of the Tools MUC module are:

- the geospatial distribution of conflict score (MUCSCORE). A bidimensional GeoTIFF raster file representing the overall conflict score in each raster grid cell.
- MUC score for each use/use (U-U) combination (HEATUSEMUC). A table/matrix representing the contribution (in percentage) of the single pairwise combinations to the total MUC score (for the whole area of analysis).

7.2.2 Main results

Figure 26 shows the results of the marine use conflict analysis. The analysis highlights how, within the national waters (12 NM), there are the highest MUC scores, especially in the coastal portion of the military area Echo 346 and of the port of Ravenna, while offshore conflicts are mainly linked to trawling fisheries, maritime traffic and extractive activities (both hydrocarbons and sands) and related cables and infrastructures (see Figure 27).

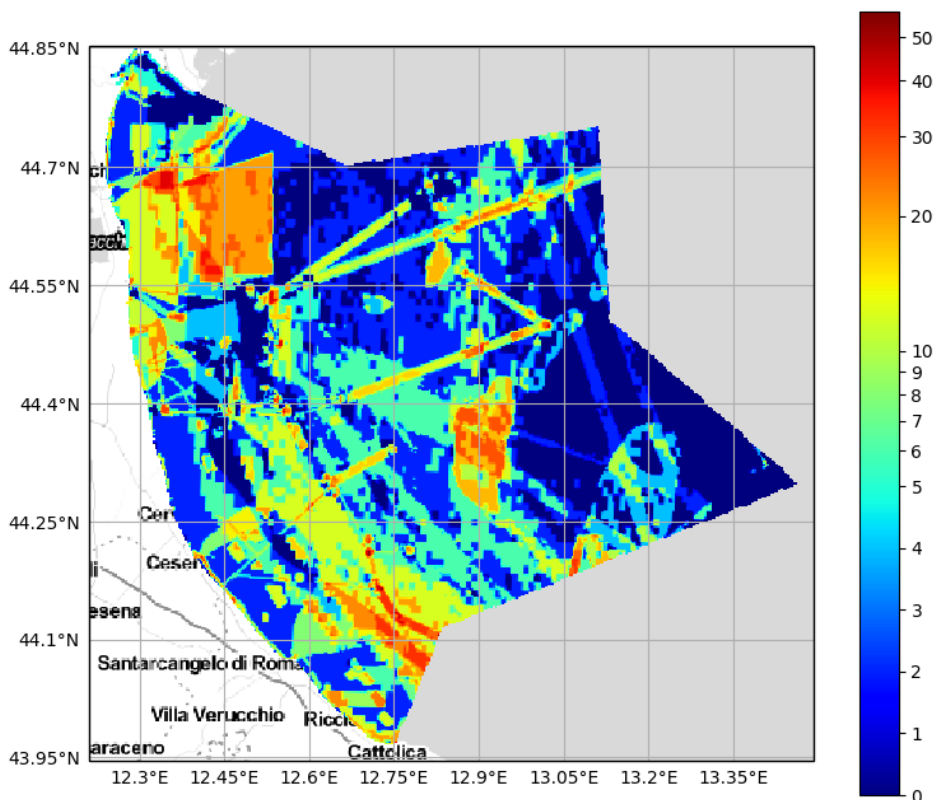


Figure 26 - Spatial distribution of MUC scores.

A detailed analysis of the interactions between uses that generate the MUC scores are shown in Figure 27. The higher scores are linked to the interactions between the extensive no-trawling zones (where the trawling is banned due to other human activities such as military areas and oil and gas extraction and/or environmental protection and fishery management) and trawling fisheries, sand extraction and trawling fisheries, maritime traffic and trawling fisheries and between different trawling fleets (TBB, PTM and OTB). Other relevant potential conflicts are those between small scale fisheries and military areas, coastal and maritime tourism with maritime transport, coastal and maritime tourism with small scale fisheries, and trawling fisheries and small-scale fisheries.

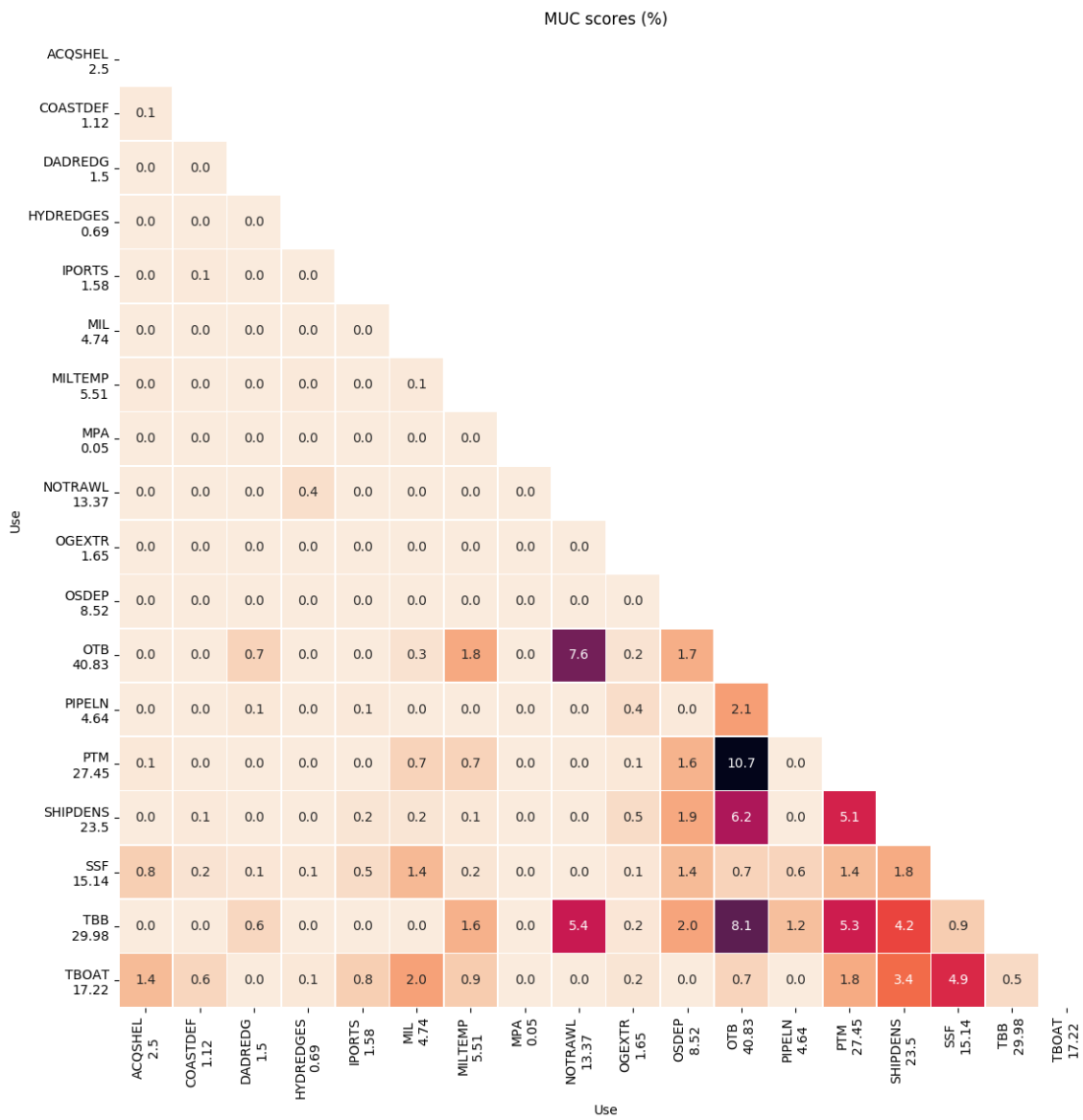


Figure 27 - Matrix representing the contribution (in percentage) of the single pairwise combinations of uses to the total MUC score for the whole area of analysis.



7.3 PARTRAC Module

Objectives: An advection-diffusion modelling tool for Lagrangian particles is proposed as a planning tool tuned to end-users and stakeholders. The particle tracking module (PARTRAC) allows to assess the dispersion of particles released in the Adriatic Sea. Its outputs and derived variables can be customised and analysed basing on the end-user requests. The module has been used to evaluate events of release of floating marine litter (e.g. plastic nets used in mussel farming and growing ropes) from the aquaculture related activities, in both continuous and impulsive dispersion scenarios.

7.3.1 Method and data

The particle-tracking module simulates the trajectory of particles as a function of the hydrodynamic conditions simulated by the state-of-the-art 3D SHYFEM oceanographic model.

SHYFEM solves the primitive equations, vertically integrated over each layer considering tidal, atmospheric and density-driven forces. SHYFEM has been already applied to simulate hydrodynamics in the Mediterranean Sea (Cucco *et al.*, 2012; Ferrarin *et al.*, 2013), in the Adriatic Sea (Bellafiore and Umgiesser 2010; Ferrarin *et al.* 2016, 2017, 2019), in several coastal systems (Umgiesser *et al.*, 2014, and references therein).

The horizontal discretization of the state variables is carried out with the finite element method, with the subdivision of the numerical domain in triangles varying in form and size. Velocities are computed in the centre of the grid element, whereas the water levels are computed at the element vertices (nodes). Vertically the model applies Z layers with varying thickness. Most variables are computed in the centre of each vertical layer, whereas stress terms and vertical velocities are solved at the interfaces between layers.

The model uses a semi-implicit algorithm for integration over time, which has the advantage of being unconditionally stable with respect to gravity waves, bottom friction and Coriolis terms, and allows transport variables to be solved explicitly. The Coriolis term and pressure gradient in the momentum equation, and the divergence terms in the continuity equation are treated semi-implicitly. Bottom friction and vertical eddy viscosity are treated fully implicitly for stability reasons, while the remaining terms (advective and horizontal diffusion terms in the momentum equation) are treated explicitly. A more detailed description of the model equations and of the discretization method is given in Umgiesser *et al.* (2004) and Ferrarin *et al.* (2017).

In SHYFEM a 3D lagrangian particle-tracking model coupled with the hydrodynamic code. The numerical computation is performed on a spatial domain that represents the whole Adriatic Sea by means of the unstructured grid. To adequately resolve the river-sea continuum, the unstructured grid also includes the lower part of the other major rivers flowing into the Adriatic Sea. The use of elements of variable sizes, typical of finite element methods, is fully exploited, in order to suit the complicated geometry of the basin, the rapidly varying topographic features. The numerical grid of the Adriatic Sea consists in approximately 110,000 triangular elements with a resolution that varies from 5 km in the open sea to few hundred meters along the coast.

PARTRAC is based on a case-study driven approach. A case-study is defined as pre-configured set of specific characteristics of the Adriatic Sea circulation and characteristics of the particles to be simulated. The user can easily select the deployment locations of the Lagrangian particles by defining polygons through the web-based particle tracking interface.

The module could simulate particles released on the surface or through the whole water column.

In the Case Study, the PARTRAC module was used to simulate the trajectories of the floating marine litter (e.g. mussel farming plastic nets and growing ropes) possibly released during aquaculture

(https://www.portodimare.eu/layers_ext/geonode:2019_shellfish_farms_in_eztyo/) in both continuous and impulsive dispersion scenarios over a maximum period of 10 days.

The PARTRAC module produces outputs in terms of the positions of the released particles at daily time intervals. In this way, the user can follow the particles concentration at daily frequency, computed on a regular grid of 500 m².

7.3.2 Main results

PARTRAC outputs are shown in Figures 28 and 29.

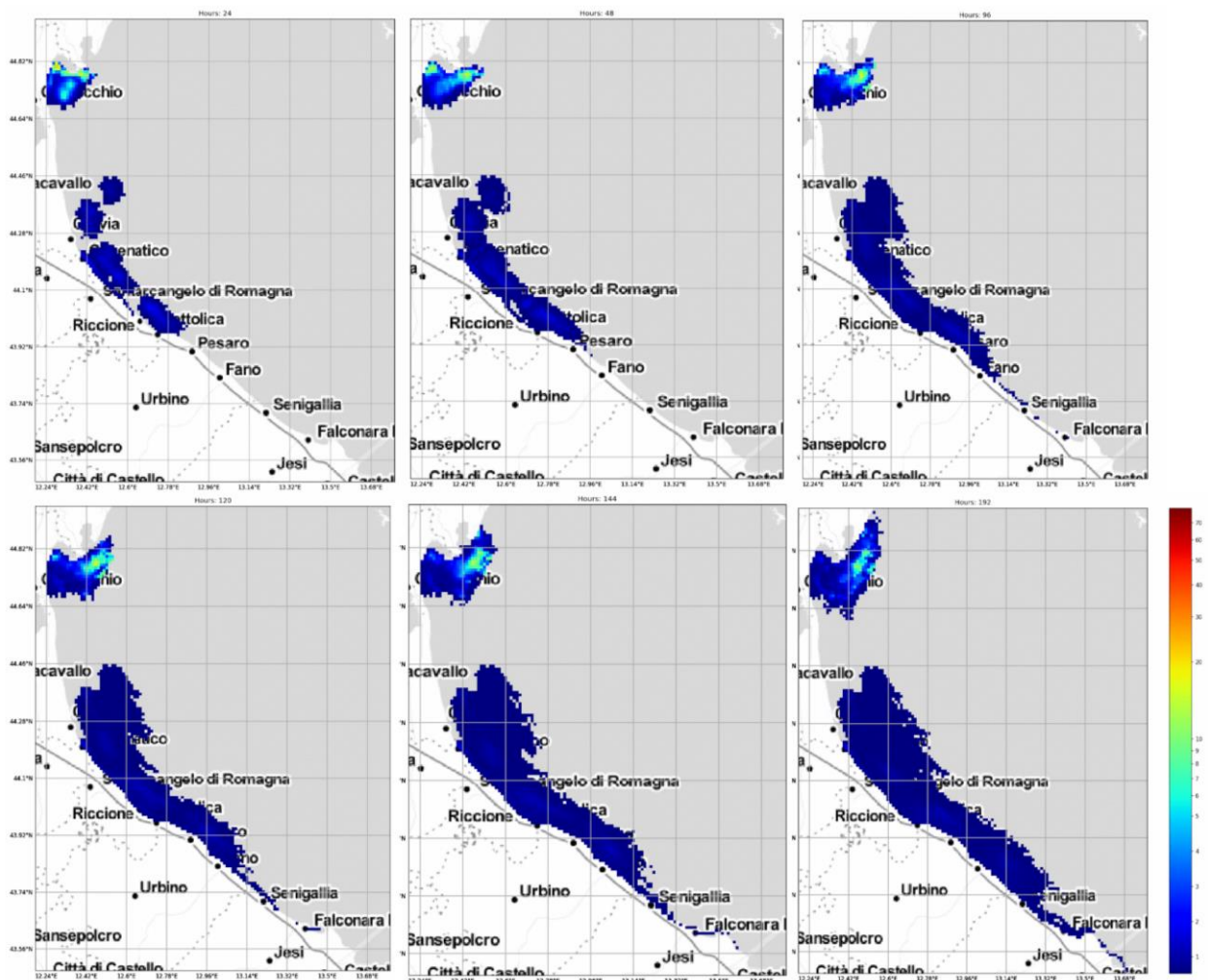


Figure 28 - Particles concentration at daily frequency considering an impulsive release from farms

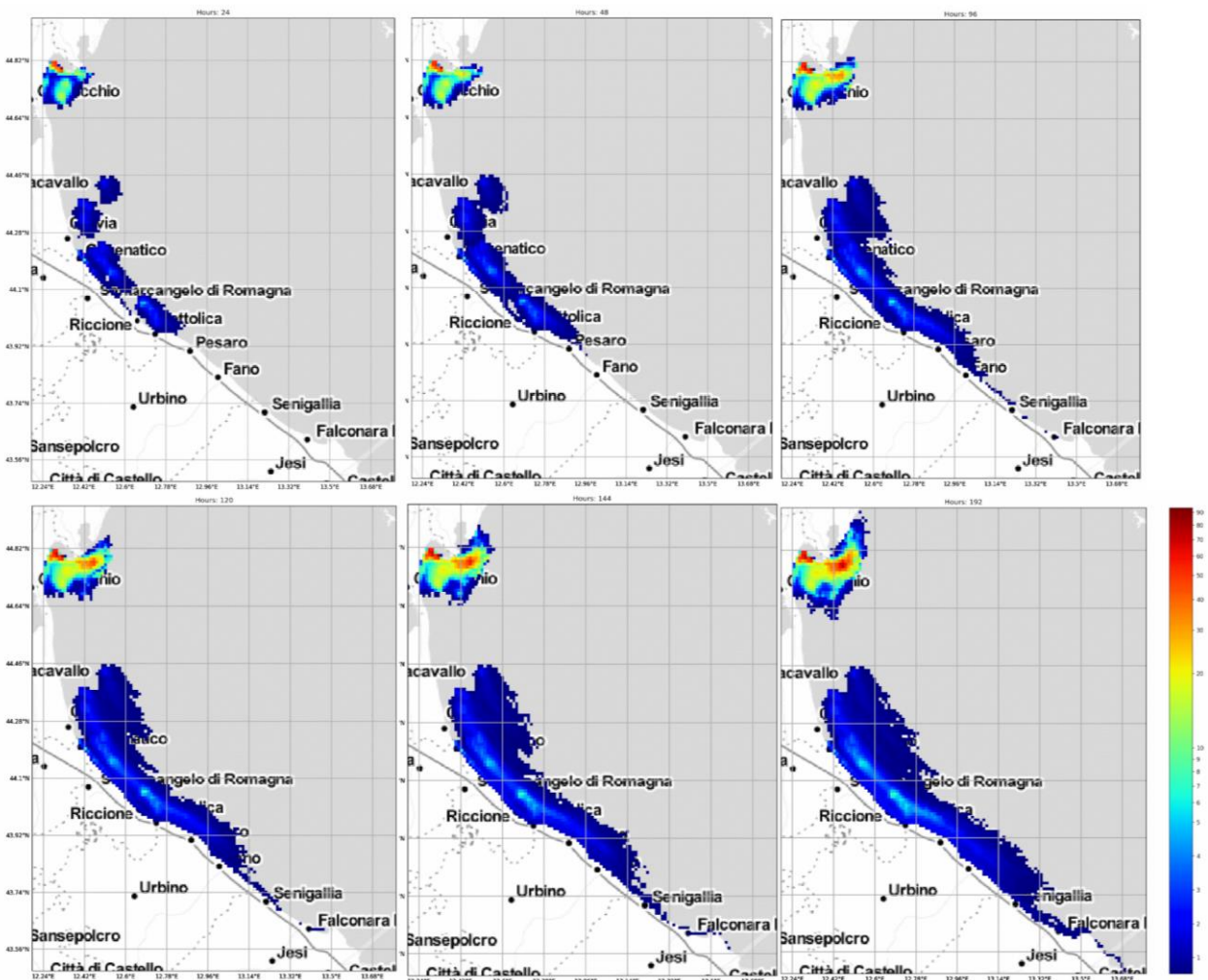


Figure 29 - Particles concentration at daily frequency considering a continuous release from farms.

In both scenarios, the relevant effect of the potential loss/release of floating litter from mussel farms is evident after few days from the hypothetical sporadic and/or frequent events, as most of the Emilia-Romagna coast would be subject to the potential stranding of the plastic garbage (e.g. mussel farming plastic nets and growing ropes). This could have relevant effects on the good environmental status of the coastal habitats and generate potential damage to other priority uses insisting on the regional coast (e.g. bathing tourism).

This scenario highlights the need for the adoption of good practices and new technologies (e.g. non-plastic and degradable mussel nets and ropes) to avoid accidental releases at sea.

7.4 AZA Module

Objectives: to promote the sustainable development of aquaculture activities in synergy with the other uses, by researching new areas for aquaculture development.

7.4.1 Method and data

The AZA (Allocated Zones for Aquaculture) module implemented a spatially explicit Multi-Criteria methodology, namely SMCE (Spatial Multi-Criteria Evaluation) aimed at identifying Allocated Zones for Aquaculture (AZAs), i.e. marine areas where the development of aquaculture is prior to other uses.

The AZA module was developed and tested in the Emilia-Romagna Case Study for the most important marine aquaculture typology for the Region: the mussel farming (*Mytilus galloprovincialis*).

The SMCE applied for the AZA module was conducted by following the framework developed in Brigolin *et al.* (2017), throughout three steps:

- 1) criteria normalization
- 2) weight assignment to each criterion
- 3) suitability index calculation.

The Suitability Index (SI) was calculated by applying the weighted linear combination, using the following equation:

$$SI = \sum w_i x_i$$

where

w_i = weight of the assigned to factor i

x_i = criterion score of factor i

SI values ranged from 0 to 1, where values close to 1 indicate the highest suitability. In this application four criteria were used: (i) optimal growth, (ii) significant wave height, (iii) potential environmental impact and (iv) distance to harbour.

The optimal growth indicator was estimated applying individual-based mathematical models (i.e. Scope for Growth) for the selected species. The equations implemented and the parameters used are described in detail in Brigolin *et al.* (2009). These models allow to explicitly consider the influence of water temperature and food availability on individual growth and metabolism. In this respect, environmental forcing factors required in input are chlorophyll-a concentration and sea water temperature. These data were obtained from the Earth Observation, enabling to map the optimal growth criterion expressed in “time required to reach the commercial size” for the species considered. In particular, SST and Chlorophyll-a datasets at 1 km² spatial resolution for the years 2017 and 2018 were selected. The optimal growth indicator (i.e. “time required to reach the commercial size”) was estimated for two market lengths for shellfish: 5 cm and 7 cm.

The Significant Wave Height (90th percentile) was calculated by means of the SWAN model run operationally by the Hydro-Meteorological Service of the Regional Environment Protection Agency of Emilia-Romagna, and mapped in order to be used as criterion within the Spatial Multi-Criteria Evaluation process for the aquaculture suitability evaluation

(https://www.portodimare.eu/layers_ext/geonode:SWH_90percentile_ER).



For the Emilia-Romagna test area, the environmental impact of a potential shellfish farm was estimated. The mapping of this criterion required the estimation of the organic enrichment of surface sediment because of the presence of a shellfish farm. Therefore, the transport and deposition on the seabed of the organic matter released by shellfish was simulated by using the Fish Cage Integrated Model (FiCIM), described by Brigolin *et al.* (2014). Details about the deposition model used were reported in Brigolin *et al.* (2017).

The distance from ports was estimated in kilometers (km) and mapped in order to be used as criterion within the Spatial Multi-Criteria Evaluation process for the aquaculture suitability evaluation. The grid was extracted from the pixel centroid of the satellite Sea Surface Temperature (SST) data at a spatial resolution of 1 km² (CMEMS) (https://www.portodimare.eu/layers_ext/geonode:Distance_node_from_ports_ER#/)

The AZA module was applied in the Case Study area and the suitability to farming activities was estimated.

The AZA module then applied to the estimated Aquaculture Suitability Index for shellfish farms a set of spatial constraints given by all the areas that do not allow the possible installation of new farms, including (https://www.portodimare.eu/layers_ext/geonode:Constraints_ER#/):

- protected areas
- oil and gas platforms, cables, facilities and safety areas
- harbour, safety and mooring areas
- military areas
- already existing mussel farms.

7.4.2 Main results

The application of the four criteria (optimal growth, significant wave height, environmental impact, distance to harbour) in the CS area (see Figure 30 to 33) shows how the coastal areas are those able to ensure a faster mussel growth, especially in the central and northern part of the Region, in presence of less intense and potentially hazardous waves and, clearly, closer to ports.

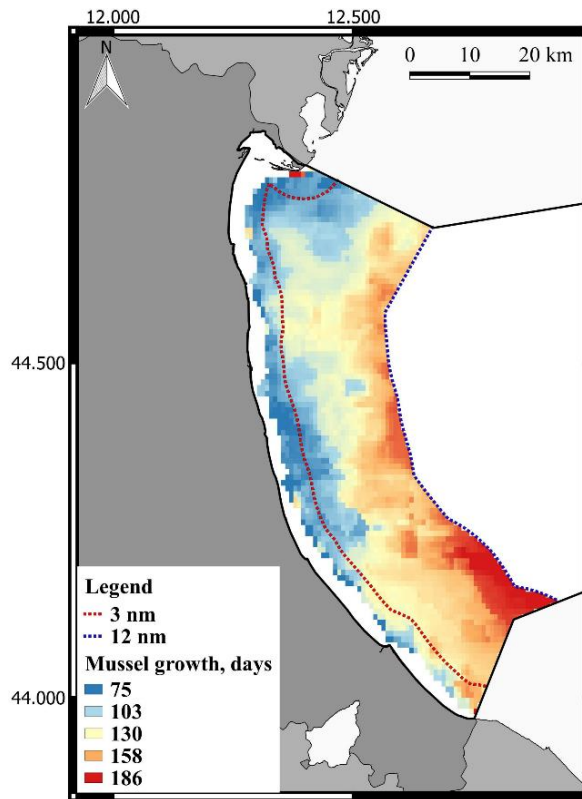


Figure 30 - Mussel growth criterion (days for optimal mussel growth).

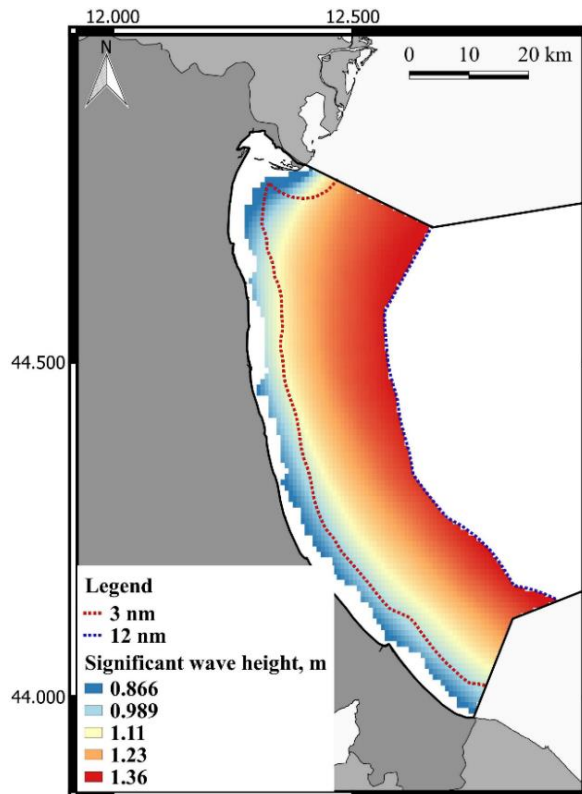


Figure 31 - Significant wave height criterion.

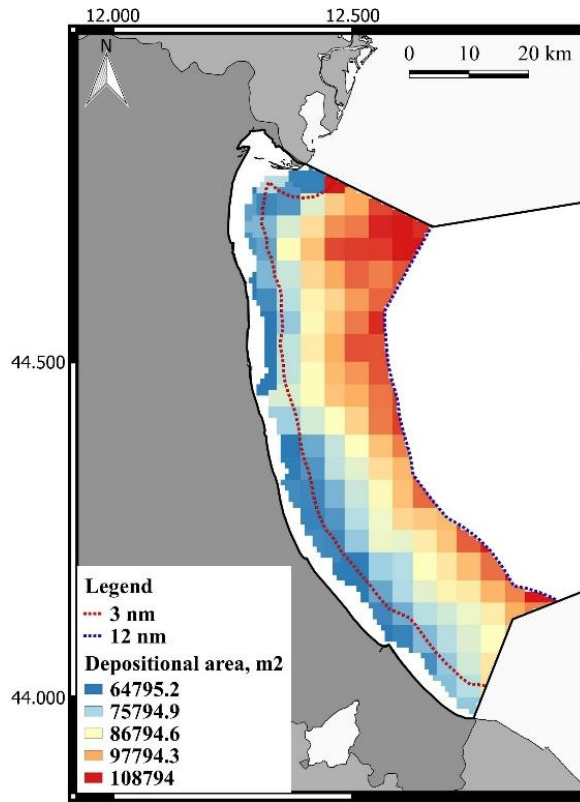


Figure 32 - Environmental impact criterion.

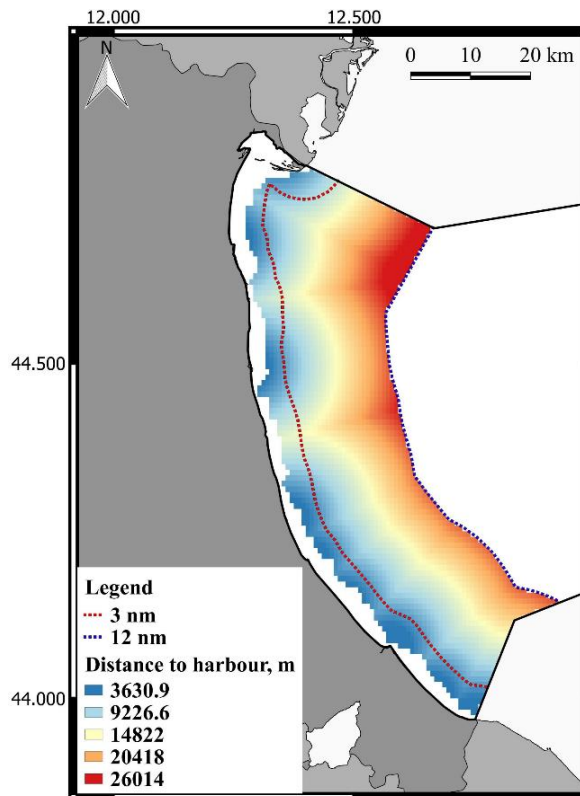


Figure 33 - Distance to harbour criterion.

Figure 34 shows the Aquaculture Suitability Index for shellfish farm estimated by applying the SMCE Methodology.

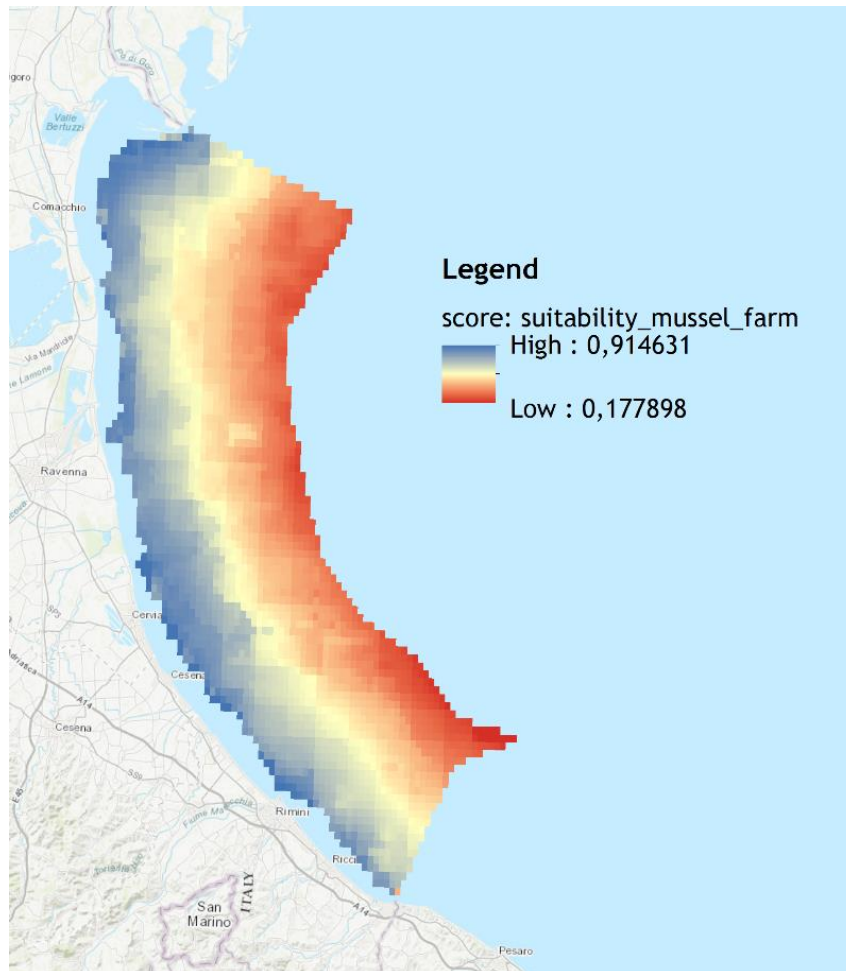


Figure 34 - spatial distribution of the Aquaculture Suitability Index scores for mussel farming (from blue: high suitability to red: low suitability).

The SI index highlights how the extensive coastal areas within the 3 NM offshore may ensure the proper and most suitable location for mussel farming development. However, for a proper use of the module outputs as a provider of possible planning options, it would be necessary to apply the constraints, in order to avoid those areas where mussel farming is not possible: this could allow a better and more realistic individuation of new potential areas.

In Figure 35, such constraints have been overlapped to the SI index, together with the proposed planning units. It is evident how the planning units where ‘aquaculture priority’ had been assigned, actually fit with the higher SI values.

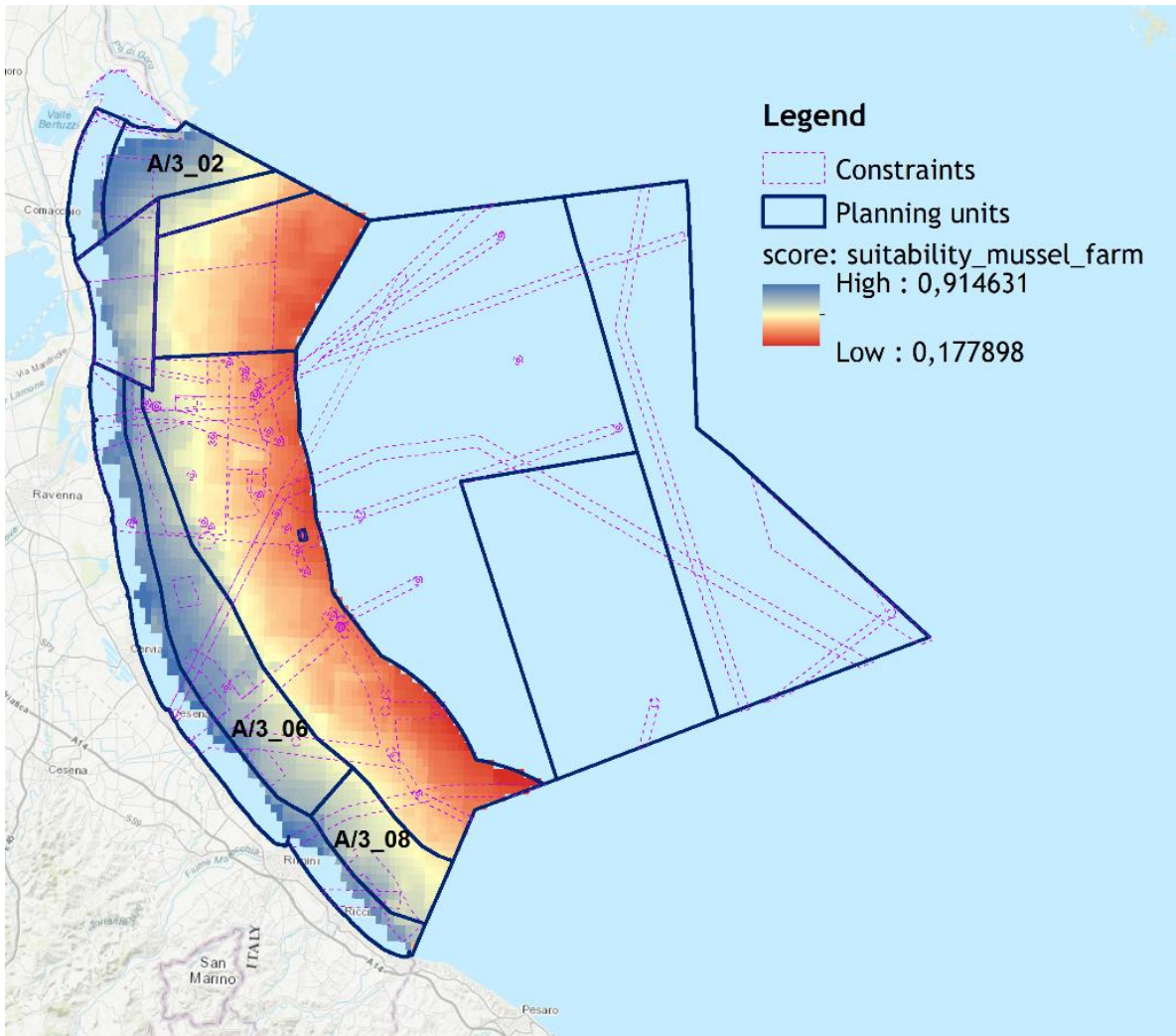


Figure 35 - Possible constrains and planning units over spatial distribution of the Aquaculture Suitability Index scores for mussel farming (from blue: high suitability to red: low suitability).



8 SETTING UP OF THE PLANNING PROCESS (ACCORDING TO THE NTC): STEP 3

8.1 Methodology

The planning process here presented, to which the GAIR and its Tools for MSP (modules) are contributing, has a long history. It started from the capitalisation of those activities carried out in the area during the last two decades aimed at elaborating ICZM strategies and plans. As above mentioned, this process has an important milestone in the approval of the Regional ICZM Guidelines in 2005⁵.

The European projects SHAPE funded by IPA Adriatic CBC (Regione Emilia-Romagna, 2014) and ADRIPLAN funded by DG Mare (Barbanti *et al.*, 2015) represent two other important milestones, because they focused on the assessing of maritime and coastal uses and impacts, on identifying key MSP-ICZM issues in the area and also addressed some planning solutions at a strategic level.

Furthermore, a specific Research Line of RITMARE (a National flagship Project on marine and maritime research topics coordinated by CNR), titled "ICM-MSP in the Adriatic Ionian Region", had the objective to develop a concrete exercise of MSP on the Emilia-Romagna coast and its marine area, by defining a vision, the objectives and a portfolio of coherent planning measures (Barbanti & Perini, 2018; Barbanti *et al.*, 2017a, b). Such activity has been carried out by CNR-ISMAR in collaboration with the Emilia Romagna Region (Land and Environmental Directorate General), as part of an Institutional Collaboration Agreement for study and research activities aimed at supporting the planning and management of the coastal zone of the Emilia-Romagna Region and its marine waters (DG 2274/2016). During both ADRIPLAN and RITMARE the modules MUC and CEA, although at a less developed stage, have been used to support the analysis and the planning phases.

By capitalising on these past activities, and using the new data and tools now made available and more accessible, it is possible to produce an updated proposal of spatial planning in the Case Study area, which takes into account:

- The existing coastal and sea uses;
- Their coexistence, with actual and potential conflicts and synergies;
- Recent and expected trends in the uses;
- Present and future expected effects and impacts on environmental components;
- The existing regulatory, planning and governance framework.

The planning methodology to be used is derived directly from the one applied in the ongoing process to prepare the national maritime spatial plans. Such methodology aims at producing a strategic plan, which has the role of providing guidance on how the sea should be used.

⁵ (Regione Emilia-Romagna, 2005. Linee Guida per la Gestione Integrata Zone Costiere. Delibera C.R. 20 gennaio 2005, n.645)



The methodology phases and main contents are the following:

Phase 1 - Initial assessment and current / expected trends

Phase 2 - Analysis of interactions (conflicts and synergies) among uses and impacts on environmental components

Phase 3 - Vision and strategic objectives

Phase 4 - Planning: vocations, specific objectives, specific measures (by areas and by sectors)

Phase 5 - Methodology and indicators for monitoring and adapting the Plan

Phase 6 - Activities for the consolidation, implementation and updating of the Plan.

The Adriatic Sea maritime area (as defined in Art. 4 of Directive 2008/56/EC) is divided into sub-areas (see Figure 36); in each sub-area, a medium-long term vision is defined, and specific planning objectives have been settled. Within the sub-areas, the actual "Planning Units" are then identified, to which the vocations are attributed and for which measures, prescriptions and recommendations are defined. By identifying the Planning Units and related vocations, the planning is implemented at the sub-area level, as indicated in the National Guidelines (Italian Prime Ministerial Decree 1/12/2017).

The methodology allows then to express operationally the general objective given, that is to produce a strategic plan, by making available to the planner the flexibility necessary to take into account the different complexity of the areas, the level of definition and the diversity of the strategic and specific objectives of the plan, the overall framework of the information available, the structure and complexity of the requests of the stakeholders involved. The division into sub-areas has an operational relevance for the definition and management/implementation and future updating of the Plan. On the other hand, it does not have any relevance on jurisdiction and/or competences, which remain defined by the current regulatory framework, or by specific measures that the Plan will be able to identify and adopt.

The criteria and elements to be considered for the definition of the sub-areas, through their optimal combination and expert judgment, are as follows:

- national and international legal and administrative limits.
- zoning already existing and used for sectoral planning and management activities.
- Marine Reporting Unit MSFD.
- morphological and oceanographic characteristics.
- existing peculiar or prevalent uses of the sea.

The limits of the sub-areas must be considered as permeable limits, from the point of view of uses, from the point of view of the environment/ecosystem and from the point of view of the governance system, in order to guarantee the maximum coherence with respect to the planning of a large area and the neighbouring sub-areas.



In the Adriatic Sea maritime area, nine sub-areas have been identified (Figure 36). THE Case Study implemented in PORTODIMARE is considering in its analysis the sub-area A/3 and part of the sub-area A/7, similarly to what was already done in Barbanti & Perini (2018).

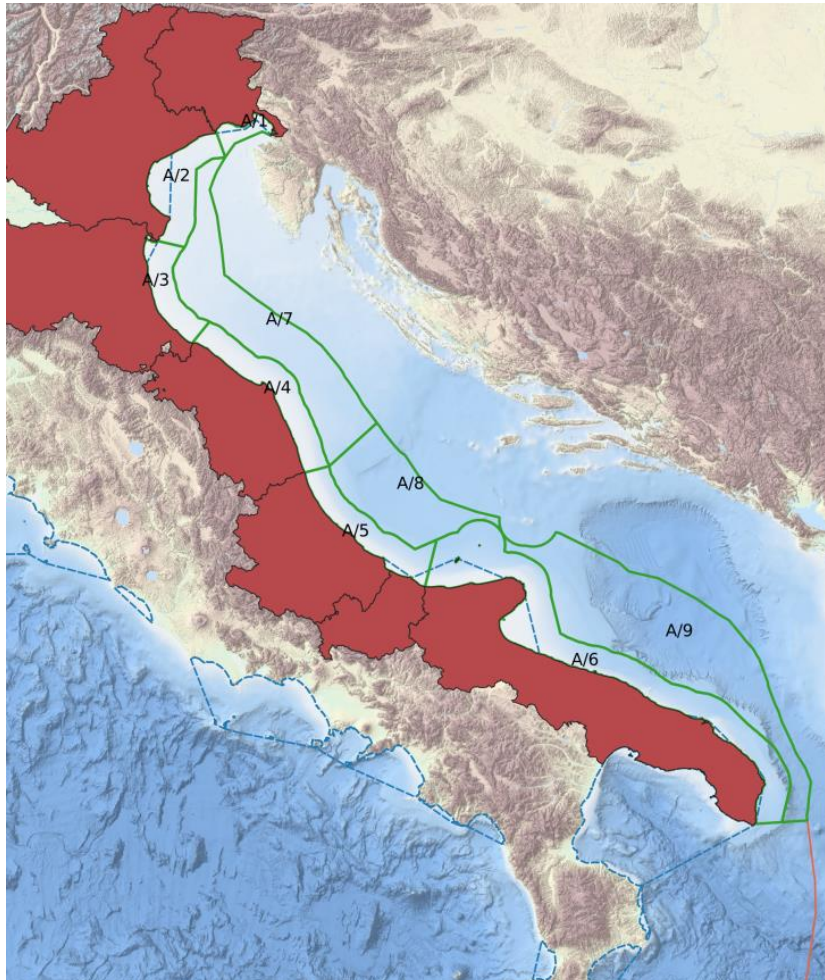


Figure 36 - Sub-areas identified in the Adriatic Sea maritime area. A/1-A/6 in territorial waters; A/7-A/9 on the continental shelf.

In each sub-area the "Planning Units" (PU), or areas to whom specific usage vocations are assigned, are identified with the aim of regulating and directing their use and evolution.

The identification of the Planning Units, as well as the subsequent phase of definition of the planning measures, has to be carried out by taking into account, among other things, the Programme of Measures adopted in accordance to Art. 13 of the Marine Strategy. In fact, the ecosystem-based approach underlies the entire activity of defining the planning units and identifying the vocations of use. In this sense, the elements relevant for the protection and conservation of species and habitats are considered to be transversal and valid for all planning units. Similarly, the needs for the conservation and improvement of the landscape quality and for the protection of the cultural heritage will also be considered as cross-cutting issues and valid for most Planning Units.



A typological attribute is assigned to each PU, according to the coding described below and graphically represented in Figure 37:

- G = Generic Use

Areas where all uses are generally permitted, with specific and mutual regulation mechanisms defined or to be defined in the context of national and international standards or sector plans, in order to guarantee safety, reduce and control environmental impacts and favour coexistence between uses.

- P = Priority Use

Areas for which the Plan provides indications of priority of use and development, also indicating the other uses to be guaranteed or allowed through mutual adjustments and with the identified priority use.

- L = Limited Use

Areas for which a prevalent use is indicated, with other uses that may be present, with or without specific limitations, if and insofar as they are compatible with the prevalent use.

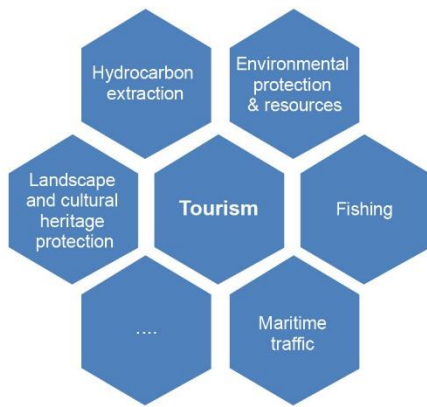
- R = Reserved Use

Areas reserved for a specific use. Other uses are permitted exclusively for the needs of reserved use or except for exceptions and concessions by the person responsible or manager of the reserved use.

This coding, as it is or with any adjustments, may also be suitable for the use at basin scale (e.g., Western Mediterranean, Eastern Mediterranean, Adriatic-Ionian Region), for a harmonized representation of the Plans elaborated by the different States (see in this regard the example offered by the Baltic Sea through the HELCOM Secretariat).

The definition of the PUs in each sub-area by expert judgment considers a series of criteria listed below:

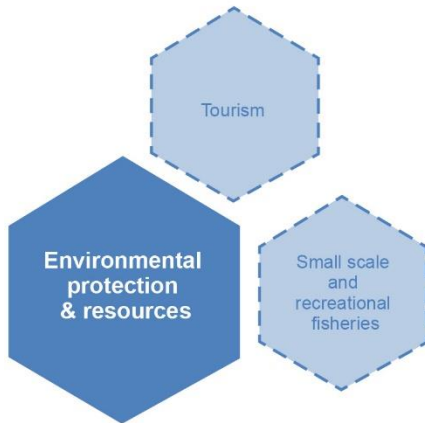
- Current status of uses and environmental components;
- Current trend, both of the physical and environmental system and of the use system;
- Developments of the system of uses to be promoted, based on the vision and objectives stated in the Plan;
- Requirements for conservation and improvement of environmental conditions, as also defined in the Plan objectives;
- Competence framework and governance system;
- Marine Reporting Unit MSFD;
- Standards and plans in place, with particular reference to environmental, landscape and cultural heritage standards.



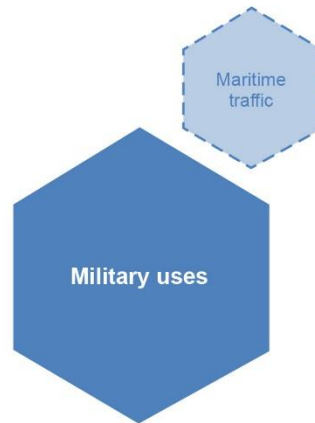
G - Generic use



P - Priority Use



L – Limited Use



R – Reserved Use

Figure 37 - Graphical representation of the four typologies to be attributed to Planning Units.

This methodology allows to express operationally the general objective given, that is to produce a strategic plan, and it does so by providing the planner with the flexibility necessary to take into account the different complexity of the areas, the level of definition and the diversity of strategic and specific objectives of the plan, of the overall picture of the information available, of the requests of the stakeholders involved.



8.2 Vision, planning objective and planning proposal

After the update of the knowledge framework available on the area (conducted in Step 1, both on sea uses and environmental components) carried out with the support of the GAIR, it was possible to perform an analysis of current trends and an update on the relevant EU, national and regional system of policy documents, strategies, plans and legislation, and an analysis of present conditions supported by MSP modules (e.g. selected GAIR tools). Such analysis (Step 2) made it possible to update and basically confirm a **vision for the area** already expressed in Barbanti & Perini, (2018) that can be summarised as follows:

- Coastal and maritime tourism, and its related value chain, is the pivotal use for the area.
- Tourism infrastructures and activities shall respect natural coastal dynamics and the needs of other uses, for a balanced and long-term co-evolution.
- Coexisting uses shall not compromise the resources (e.g. ecosystems, water quality, landscape) on which tourism is based, but shall look for all possible synergies.

A number of **specific planning objectives** (SO) derive from this vision and, in turn, help to define the vision proposal itself. They also consider in an integrated way the system of existing uses and their current trends together with the environmental characteristics and problems of the study area. Such objectives are summarized in Table 6 and mainly concern, in single or combined way, six sectors and uses of the sea/coast:

- Tourism
- Energy
- Fishing and aquaculture
- Environmental Protection
- Coastal defence
- Landscape and cultural heritage protection
- Military uses.

Based on these specific planning objectives (SO), ten PUs were identified in the sub-area A/3 (territorial waters) and three PUs in the part of sub-area A/7 (continental shelf) considered (**Errore. L'origine riferimento non è stata trovata.**³⁸). The PUs identified are thoroughly described in Table 7. They belong mainly to the "Priority Use" (P) type (9 out of 13), although from the point of view of extension, also the "General Use" areas (G) are quantitatively significant.

It is useful to point out the presence of a "Reserved Use" (R) type area, which corresponds to the permanent area of the Foce Reno military range, and of a "Limited Use" type area (L), located in correspondence of the Natura 2000 Site SIC IT4070026 "Wreck of the Paguro platform".

In the following chapters the application of some MSP tools to analyse the planning demands in the area will be presented (Step 4), by highlighting how they can support this planning scenario and thus advise about which aspects must be considered with greater attention in the refinement of the plan and in the subsequent definition of the portfolio of measures for the various sectors.

The framework of 'vision', 'objectives', 'vocations' shown here for the study area is a "work in progress", since it is being further refined and discussed in the context of the drafting of the national plan.



In this sense, PORTODIMARE is on one hand in a position to use the official national methodology for its testing and strategies and on the other hand is able to provide, through the use of GAIR and its Tools for MSP, information and analyses directly usable for the consolidation of the proposed plan.

Sectors	Specific Objectives (SO)
Coastal tourism - Coastal defense	SO.1 - Safeguarding the tourist use of the coasts (seaside tourism) by defending against flooding and counteracting erosion.
Energy - Tourism - Aquaculture - Environmental protection	SO.2 - Allowing the exploitation over time of the methane deposits already authorized in a safe way for humans and the environment, reducing conflicts and increasing synergies with other sectors of sea economy.
	SO.3 - Promoting the exploitation of marine renewable energies, with particular reference to wind power.
Fisheries	SO.4 - Promoting the sustainable and regulated expansion of small-scale fisheries;
	SO.5 - Reviewing the regulation of bottom trawling, also considering the effects on the seabed and on areas with EFHs and the sustainability of stocks exploitation.
Aquaculture	SO.6 - Promoting the sustainable development of aquaculture activities in synergy with the other uses in the area.
Environmental protection - Tourism	SO.7 - Consolidating the system of protected areas and existing conservation measures, within a framework of overall ecological coherence and in synergy with other present uses.
	SO.8 - Maintain/achieve the environmental objectives of WFD, MSFD and H&BD.
Military uses - Traffic - Fisheries and Aquaculture	SO.9 - Allow the maintenance of the military uses of some areas, reducing their conflicts with other existing uses.

Table 6: Specific planning objectives for the study area - Emilia-Romagna T.2.3

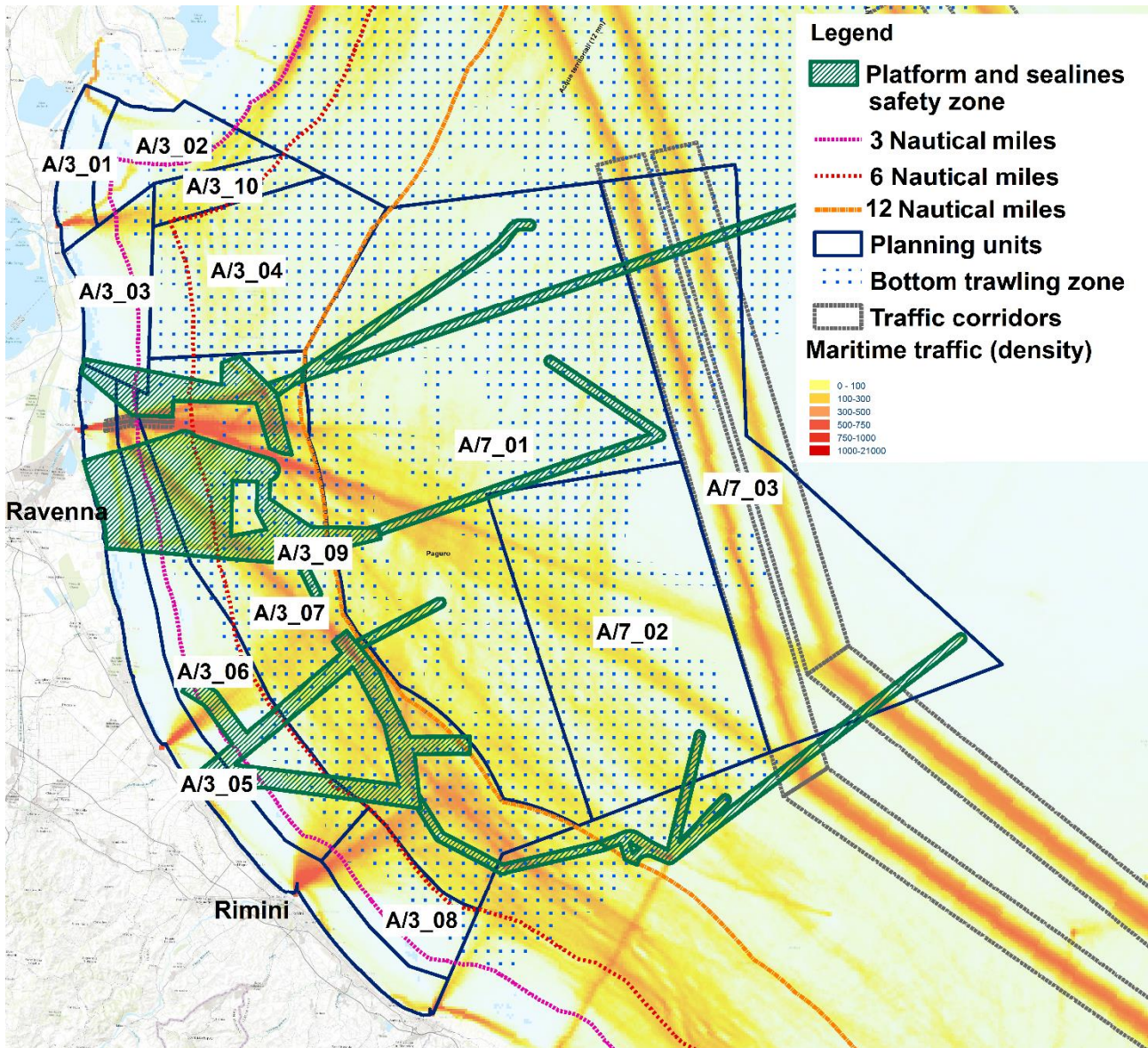


Figure 38 - Planning Units identified in the area and their vocation.



PU CODE	Typology	Generic (G), Priority (P), Limited (L), Reserved (R)	Reason for typology	Other uses	Particular consideration
A/3_01	P(t)	Priority Use (P): tourism (t)	<p>Area with a high tourism vocation (bathing, leisure boating).</p> <p>Attention to landscape aspects is particularly important.</p> <p>Potential development of experiential and eco-tourism due to the presence of coastal Natura 2000 sites and the Po Delta Park.</p>	<ul style="list-style-type: none"> • Aquaculture • Fisheries • Maritime transport • Environmental protection 	<p>Potential for aquaculture and harvesting of bivalve molluscs from natural schools (A.T.B. Sacca di Goro).</p> <p>Harvesting of molluscs with hydraulic dredger according to current legislation.</p>
A/3_02	P(a)	Priority Use (P): aquaculture (a)	Area with a high vocation for mussel farming. Presence of concession areas for mussel farming and harvesting of bivalve molluscs from natural schools (A.T.B. Sacca di Goro).	<ul style="list-style-type: none"> • Fisheries • Maritime transport • Environmental protection • Tourism 	Fishing activities with gears and towed gears allowed in compliance with current legislation outside the areas intended for priority use.
A/3_03	R(d)	Reserved Use (R): defense (d)	Reserved use for national defence (Military training area Echo 346)		Transit allowed according to specific provisions and ordinances.
A/3_04	P(n,d)	Priority Use (P): - nature (n) - defense (d)	<p>Priority on environmental protection for high naturalistic value. Proposal under finalization for the creation of a SCI (Habitat Directive) site for the protection of species of high naturalistic value (<i>Caretta caretta</i> and <i>Tursiops truncatus</i>).</p> <p>Area of interest for national defence (Echo 346 military exercise area) according to ordinances and temporary provisions.</p>	<ul style="list-style-type: none"> • Fisheries • Maritime transport • Tourism 	<p>Fishing activities allowed in compliance with current legislation and according to the requirements determined by the priority uses.</p> <p>Tourism / recreational activities with naturalistic orientation (according to the established measures).</p>



PU CODE	Typology	Generic (G), Priority (P), Limited (L), Reserved (R)	Reason for typology	• Other uses	Particular consideration
A/3_05	P(t)	Priority Use (P): - tourism (t)	Area with a high tourism vocation (bathing, leisure boating). Attention to landscape aspects is particularly important. Presence of artificial reefs with potential for underwater and eco-tourism development.	<ul style="list-style-type: none"> • Aquaculture • Fisheries • Maritime transport • Environmental protection • Oil & Gas exploitation 	<p>Presence of concession areas for mussel farming with potential development of the sector.</p> <p>Small scale fisheries allowed according to current legislation.</p> <p>Harvesting of molluscs with hydraulic dredger according to current legislation.</p> <p>Commercial / passenger maritime traffic (Port of Ravenna) and intense leisure boating.</p> <p>High ecological value: area of reproduction and growth of commercial fishery species.</p> <p>Presence of Oil & Gas concessions and Oil & Gas activities with potential for the reuse of decommissioned platforms.</p>
A/3_06	P(a)	Priority Use (P): - aquaculture (a)	Area with a high vocation for mussel farming. Presence of concession areas for mussel farming with potential development of the sector.	<ul style="list-style-type: none"> • Fisheries • Maritime transport • Environmental protection • Oil & Gas exploitation 	<p>Commercial / passenger maritime traffic (Port of Ravenna) and intense leisure boating.</p> <p>Fishing activities with gears and towed gears allowed in compliance with current legislation outside the areas intended for priority use.</p> <p>Presence of Oil & Gas concessions, Oil & Gas activities, marine terminals and infrastructures operating according to current legislation, with potential for the reuse of platforms that are soon to be decommissioned.</p>



PU CODE	Typology	Generic (G), Priority (P), Limited (L), Reserved (R)	Reason for typology	• Other uses	Particular consideration
A/3_07	P(e)	Priority Use (P): - energy (e)	High presence of hydrocarbon extraction platforms, support structures, subsea pipelines and marine terminals operating according to current legislation. Potential for the reuse of decommissioned platforms. Within the area, areas of interest for possible wind farms and other renewable sources (solar, wave motion) have been identified. Need to consider the effects of the possible installation of these infrastructures on the coastal landscape.	<ul style="list-style-type: none"> • Aquaculture • Fisheries • Maritime transport • Environmental protection 	<p>High ecological value: area of reproduction and growth of fish species of commercial interest (Presence of the Biological Protection Area "Outside Ravenna", Tecnoreef ADRI.BLU Area).</p> <p>Fishing activities with gears and towed gears allowed in compliance with current legislation outside the areas intended for priority use.</p> <p>Commercial / passenger maritime traffic (Port of Ravenna) and intense leisure boating.</p> <p>Limited presence of concession areas for mussel farming with potential development of the sector.</p>
A/3_08	P(a, t, n)	Priority Use (P): - aquaculture (a) - tourism (t) - nature (n)	Area ad elevata vocazione per la mitilicoltura. Presenza di aree in concessione per la mitilicoltura con potenziale sviluppo del settore. Area ad elevata vocazione turistica (nautica da diporto, presenza di reef artificiali, eventualmente ampliabili, con potenziale sviluppo turismo subacqueo e naturalistico). Elevata valenza naturalistica: area di riproduzione e accrescimento specie alieutiche di interesse commerciale (potenziale istituzione nuova Z.T.B.).	<ul style="list-style-type: none"> • Fisheries • Maritime transport 	<p>Fishing activities with gears and towed gears allowed in compliance with current legislation outside the areas intended for priority uses.</p> <p>Heavy maritime traffic.</p> <p>Collection of molluscs with hydraulic dredger according to current legislation.</p>
A/3_09	L(n)	Limited Use (L): - nature (n)	High ecological value with presence of SAC - Wreck of the Paguro platform (IT4070026).	<ul style="list-style-type: none"> • Tourism 	<p>Area with a high vocation for underwater and eco-tourism.</p> <p>Leisure boating traffic regulated by a management plan.</p>



PU CODE	Typology	Generic (G), Priority (P), Limited (L), Reserved (R)	Reason for typology	• Other uses	Particular consideration
A/3_10	G	Generic Use (G)	Various uses that share the same space in compliance with the specific rules of each use and rules of coexistence between uses.	<ul style="list-style-type: none"> • -Aquaculture • -Fisheries • -Maritime transport • - Environmental protection 	<p>Potential for aquaculture and bivalve shellfish harvesting.</p> <p>Fishing activities with gears and towed gears allowed in compliance with current legislation.</p> <p>High ecological value: presence of protected species (Annex II Habitat Directive - <i>Caretta caretta</i> and <i>Tursiops truncatus</i>).</p>
A/7_01	G	Generic Use (G)	Various uses that share the same space in compliance with the specific rules of each use and rules of coexistence between uses.	<ul style="list-style-type: none"> • Fisheries • Maritime transport • Environmental protection • Oil & Gas exploitation • Renewable energies • Relict sands extraction 	<p>Fishing activities with gears and towed gears allowed in compliance with current legislation, with potential closure to towing gears within the area called "Sanctuary of the sole".</p> <p>Oil & Gas concessions and Oil & Gas activities.</p> <p>Presence of submarine deposits of relict sands.</p> <p>High ecological value: presence of protected species (Annex II Habitat Directive - <i>Caretta caretta</i> and <i>Tursiops truncatus</i>), in particular in the northern part of the Planning Unit.</p>



PU CODE	Typology	Generic (G), Priority (P), Limited (L), Reserved (R)	Reason for typology	• Other uses	Particular consideration
A/7_02	P(n, sa)	Priority Use (P): - Relict sand extraction (sa)	High ecological value: area of reproduction and growth of commercial fish species. A small portion of the area falls within the proposed "Sole sanctuary" (Fishery Restricted Area -FRA), an action that would also help to reduce the impacts of fishing (e.g. accidental catches) on cetaceans and turtles. Presence of significant deposits of relict sands (ancient coastal deposits), which are source for beach nourishment	<ul style="list-style-type: none"> • Fisheries • Maritime transport • Oil & Gas exploitation 	<p>Fishing activities with fixed and towed gears allowed in compliance with current legislation, with possible further restrictions due to the possible institution of the FRA.</p> <p>Oil & Gas concessions and Oil & Gas activities should avoid infrastructures above the 'relict sand deposits.</p>
A/7_03	P(tm)	Priority Use (P): - maritime transport (tm) - nature (n)	Area with high density of maritime traffic, transit corridors and IMO maritime traffic separation schemes. A significant portion of the area falls within the proposed "Sole sanctuary" (Fishery Restricted Area -FRA), an action that would also help to reduce the impacts of fishing (e.g. accidental catches) on cetaceans and turtles.	<ul style="list-style-type: none"> • Fisheries • Relict sands extraction 	<p>Fishing activities with fixed and towed gears allowed in compliance with current legislation, with possible further restrictions due to the possible institution of the FRA.</p> <p>Presence of submarine deposits of relict sands, with exploitation methods to be agreed to limit conflicts with navigation and guarantee safety.</p>

Table 7: Planning Units and their main characteristics.



9 TESTING OF A MANAGED SCENARIO THROUGH TOOLS FOR MSP: STEP 4

9.1 CEA module

Objectives and scenario tested (cfr. Step 3), chapter 8): the Cumulative Effects Assessment analysis has been performed in order to inform the planning process on the possible effects of proposed management measures on the propagation of pressures and on the spatial distribution of impacts exerted by one or multiple pressures on one or multiple environmental receptors.

9.1.1 Data

The CEA Case Study incorporating the managed scenario proposals is available at the following link:

- <https://www.portodimare.eu/casestudies/128/>

Comparing to the CEA Analysis of the current situation (Chapter 7), the spatial distributions of six human uses have been modified to consider: scenarios of expansion (Aquaculture), the introduction of bans/regulations (Small Scale Fishery, Mid-water pelagic trawling, Trawling OTB and Trawling TBB) and the increase of sand extraction from offshore sand deposits.

In addition, two new uses have been introduced:

- Offshore Wind Farm: to reflect the growing interest in wind farm development
- Trawling OTB-BRD: to identify/characterize the Trawling OTB with selective devices (BRD - bycatch reduction device). Different values of pressure weights have been assigned to OTB-BRD in respect to standard OTB.

Table 8 reports all the reviews introduced in human uses spatial distributions to incorporate the managed scenario proposals.

Differently, we assumed that the spatial distribution of environmental receptors will not change in respect to the current scenario (see Table 3).

Human use	Criteria type	Criteria for reviewing spatial distribution	Additional sources
Aquaculture	Use expansion	Add of 100 km ² of new shellfish farms assuming it will be uniformly distributed on areas with a high level of suitability (suitability ≥ 0.75 ; cfr. cap7.d) and overlapping the areas with a high vocation for mussel farming (A/3_02, A/3_06 and A/3_08)	suitability_constraints
Small scale fishery	Regulation	25% uniformly reduction of set gillnet fishing pressure over the planning area "A/7_03" due to the proposed seasonal ban (December-February). 40% uniformly reduction of set gillnet fishing pressure over the coastal area (within 3 NM) due to the proposed regulation in minimum mesh size.	RER - MSP planning units



Human use	Criteria type	Criteria for reviewing spatial distribution	Additional sources
Mid-water pelagic trawling	Ban	Total ban within the proposed Biological Protection Zone (BPZ) in overlap with the planning unit “A/3_08”. Total ban within the “Sola sanctuary” in overlap with the planning unit “A/7_03”.	Ritmare_RER_Measure 9_ZTB_RN RER - MSP planning units Sole sanctuary
Trawling OTB	Ban	Total ban within the proposed Biological Protection Zone (BPZ) in overlap with the planning unit “A/3_08”. Total ban within the “Sola sanctuary” in overlap with the planning unit “A/7_03”.	Ritmare_RER_Measure 9_ZTB_RN RER - MSP planning units Sole sanctuary
Trawling OTB-BRD	New use type, Regulation	OTB activity within the proposed Site of Community Importance (SCI) (planning unit “A/3_04”) has been reclassified as OTB-BRD, considering the application of Bycatch Exclusion Devices (BRDs) on trawling nets to reduce the mortality of marine turtles when accidentally caught within the trawling nets, with an estimated reduction of the 30% of the OTB weight in generating the pressure “selective extraction of species, including incidental non-target catches”.	RER - MSP planning units
Trawling TBB	Ban	Total ban within the proposed Zone of Biological Protection (BPZ) in overlap with the planning unit “A/3_08”. Total ban within the “Sola sanctuary” in overlap with the planning unit “A/7_03”.	Ritmare_RER_Measure 9_ZTB_RN RER - MSP planning units Sole sanctuary
Offshore Wind Farm	New use type	Add of the two areas of interest for wind farm development located in the offshore Ravenna and Rimini. Use intensity for both areas has been reduced to 30%, assuming that the new wind farms will partially cover the entire area.	WF_OffS_Rimini Ritmare_RER_Measure 4_WF1
Offshore sand deposits	Use expansion	Uniform extraction from the Emilia-Romagna offshore sand deposits, assuming the extraction of 650000 m ³ /year for 10 years and 0.5 m of digging depth.	Offshore sand deposit (Emilia-Romagna Region)
Mobile uses: OTB, TBB, PTM, Small Scale Fisheries, Maritime transport, Hydraulic dredges	Use replacement	Reduce intensity for areas overlapping the new proposed aquaculture areas (High aquaculture suitability on PU A/3_02, A/3_06 and A/3_08).	

Table 8: list of the reviews in human uses spatial distributions to incorporate managed scenario proposal.

9.1.2 Main results

In Figure 39 the spatial distribution of new scores from CEA application in the managed scenario are presented.

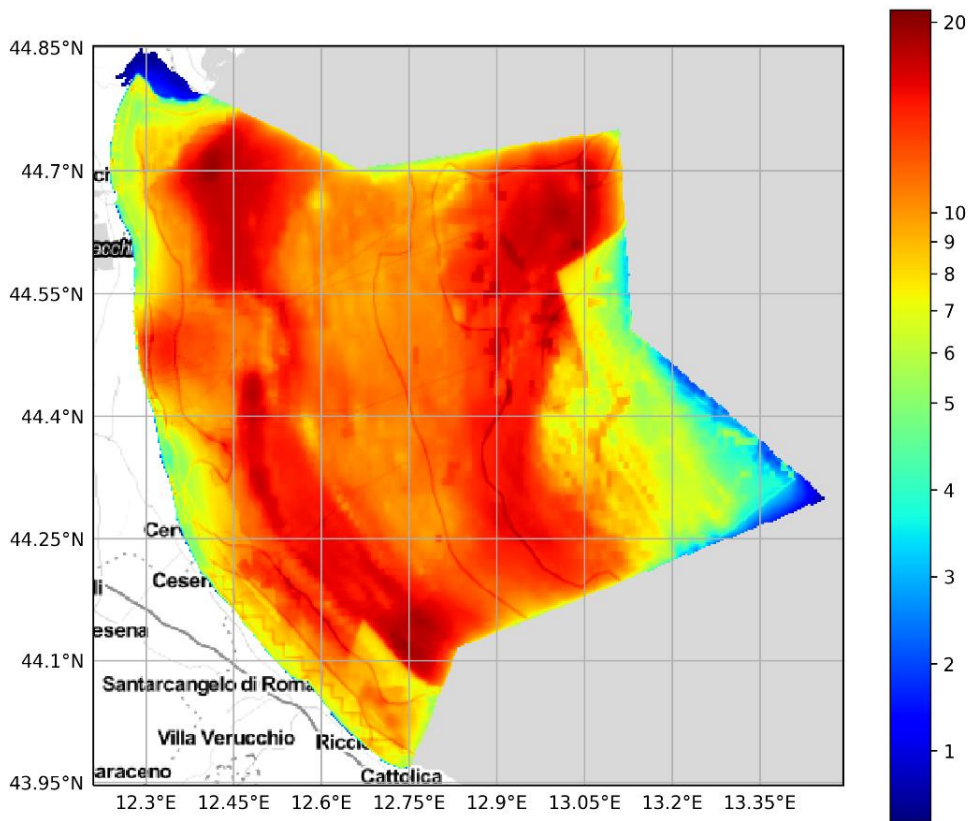


Figure 39 - Spatial distribution of CEA scores in the managed scenario.

The CEA scores confirm a pattern linked to high traffic densities and trawling related pressures, with the highest scores (14-21) still located in the whole CS area between 3 and 12 NM offshore, in a wide area belonging to International waters (approximately 20 NM offshore) and in proximity of the port of Ravenna. Medium-high scores (7-14) remain the more representatives along the entire region (Figure 39), while lower CEA scores (<7) are located mainly within the 3 NM.

The differences between CEA scores after the application of the measures (Figure 39) and before (Figure 17) highlight the important role of a possible BPZ in limiting all the trawling fisheries pressures on the seabed and on the Essential Fish Habitats, and also the effects of the proposed “Sole sanctuary” implementation in reducing the impacts over the Essential Fish Habitats, the Mammals and the Turtles. On the other hand, the managed scenario evidences the potential increase of the impacts caused by the new infrastructures (i.e. offshore wind farms) and the new aquaculture facilities (Figure 40).

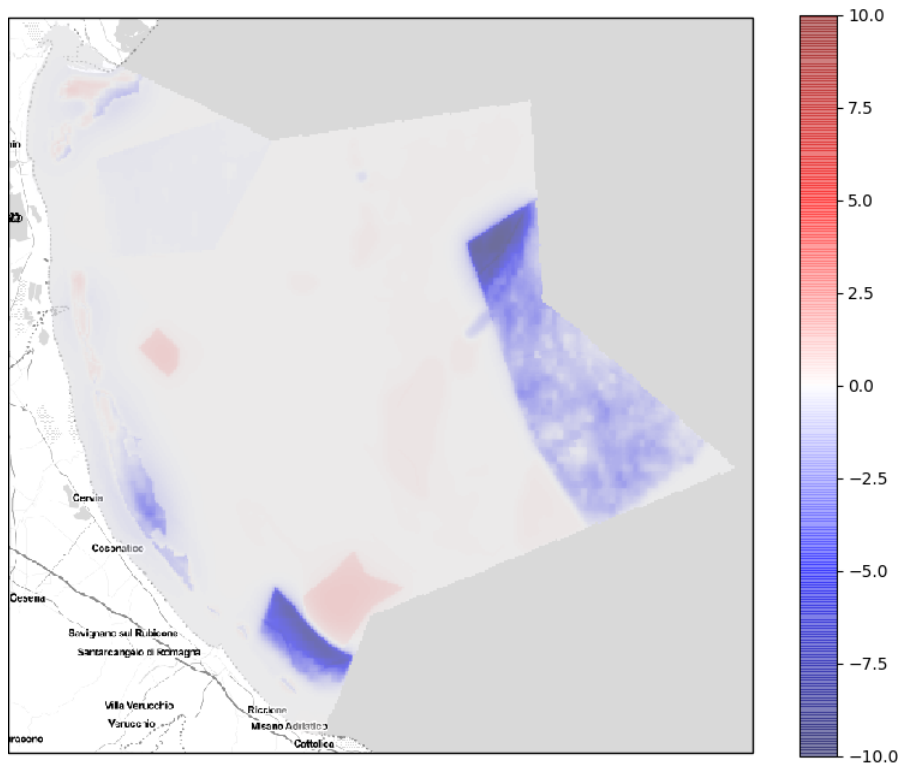


Figure 40 - Spatial explicit differences between the managed scenario and the present condition CEA scores.

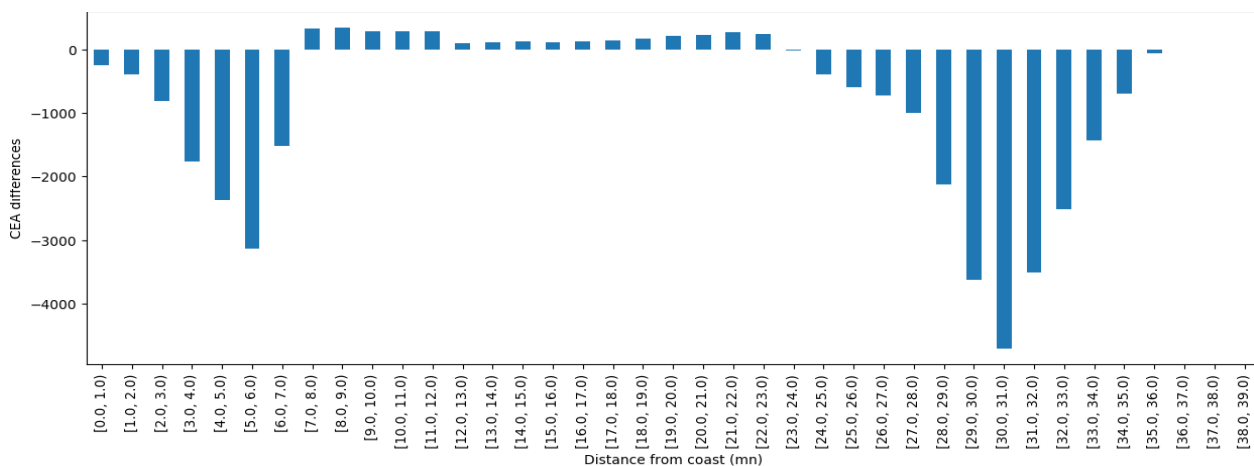


Figure 41 - Histogram representing the distribution of CEA scores' differences by the distance from the coast in nautical miles (NM).

The full set of trawling activities reaches a total CEA score which is higher in respect to the one generated by the maritime transport: bottom otter trawlers (OTB), mid-water pelagic (PTM) and “rapido” beam trawlers (TBB) impact the area mainly by generating abrasion, change in siltation, smothering and selective extraction of species.

An important reduction in CEA scores is evident in the areas A/3_08 and A/7_03, due the total trawling ban applied within, respectively, the proposed Zone of Biological Protection (BPZ) and the “Sole sanctuary”. The latter is a spatial measure suggested within the Dory Project (final report 2019), assuming the results of previous research, also published into the report STECF 2019, in the section on the ‘Multi-Annual Plans



for the fisheries exploiting demersal stocks in the Adriatic Sea’. Moreover, the same measures have been considered into the SUPREME project - Adriatic CS, after the discussion within the GFCM (General Fisheries Commission for the Mediterranean).

The proposed Natura 2000 SCI for the protection of *Caretta caretta* and *Tursiop truncatus* in the marine waters facing the Po Delta (A/3_04) could foresee, among management measures, the application of Bycatch Exclusion Devices (BRDs) on trawling nets. The BRDs are widely used in order to reduce the mortality of marine turtles when accidentally caught within the trawling nets, together with other good practices (e.g. the increase in nets stability with technological improvements). The hypothesized effect of these measures is the reduction of the OTB pressure on *C. caretta*, by reducing of the 30% the specific weight in generating the pressure "selective extraction of species, including incidental non-target catches", with a substantial reduction of the overall CEA score in the area and an evident effect on the influenced environmental components (especially marine turtles; see Figure 43).

Important increases in human-related pressures are evident locally where the new wind farms are planned, mainly due to physical pressures (e.g. sealing; see Figure 42). Differently, the additional impact exerted by the new aquaculture installation is partially balanced by the consequent reduction of other activities (e.g. trawling, shipping).

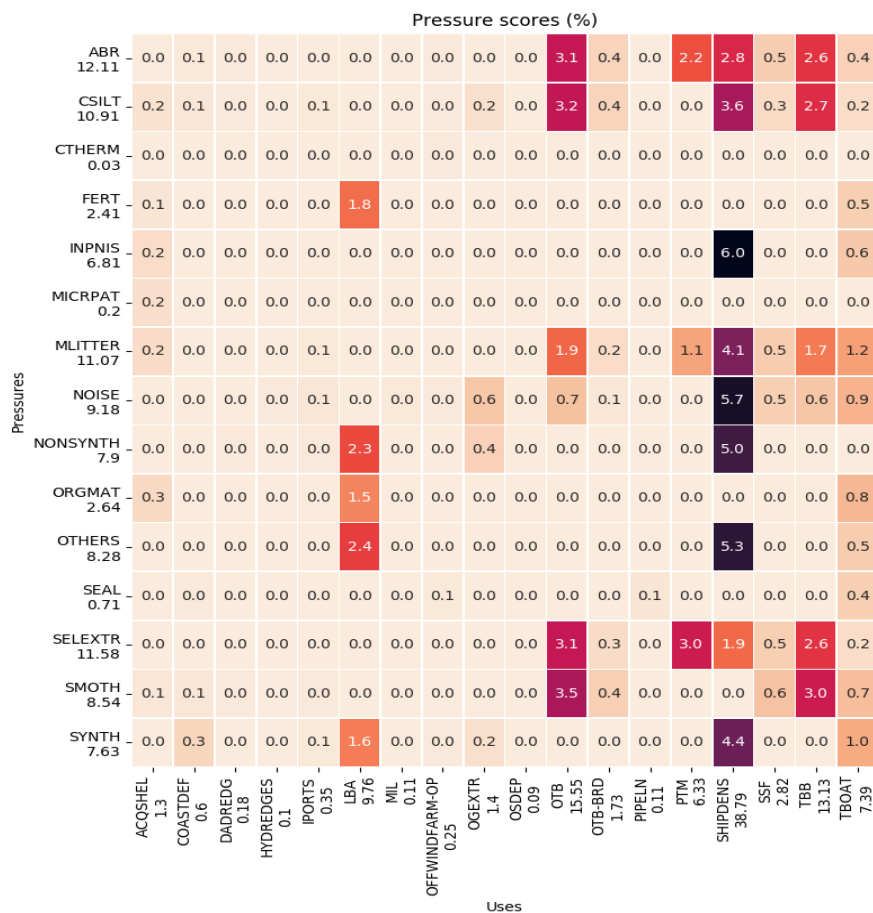


Figure 42 - Matrix representing the contribution (in %) of the single pairwise combination of human use (U) and pressure (P) to the total CEA score for the whole area of analysis (managed scenario).



The application of specific bans and measures for trawling fisheries could allow a substantial reduction of the pressures on habitats and species. Key nursery and spawning areas of species of commercial interest for fisheries (EFHs) and seabed habitats are still the components more exposed to anthropogenic pressures (e.g. abrasion, pollution, marine litter), even if with evident reductions where trawling bans are applied.

Marine mammals and turtles also benefit of the increased sustainability of fisheries, even if only in the areas where management measures are proposed.

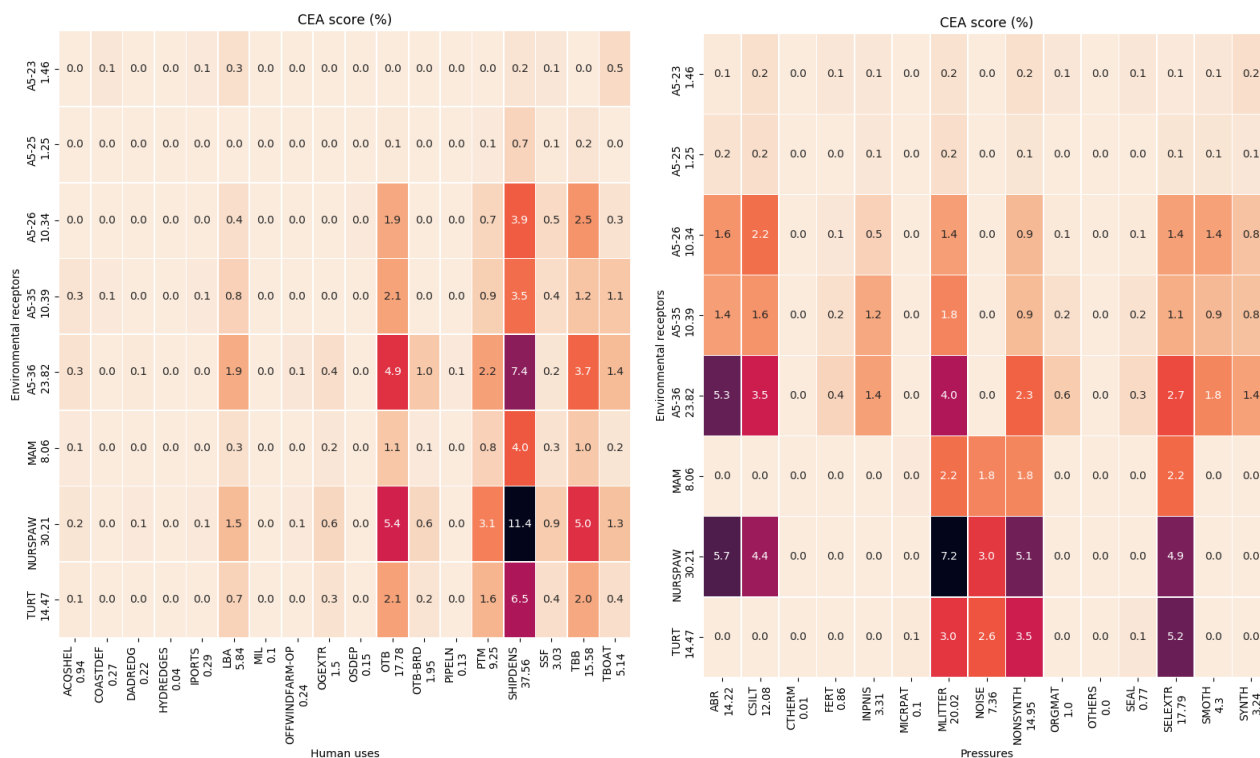


Figure 43 - Matrixes representing the contribution (in %) of the single pairwise combination of human use/environmental receptor (left) and of pressure/environmental receptor to the total CEA score for the whole area of analysis (managed scenario).

Substances, litter and energy pressures remain those with the higher scores in the CS area, with an important hot-spot close to the port of Ravenna (see Figure 44) and increased values close to new aquaculture farms.

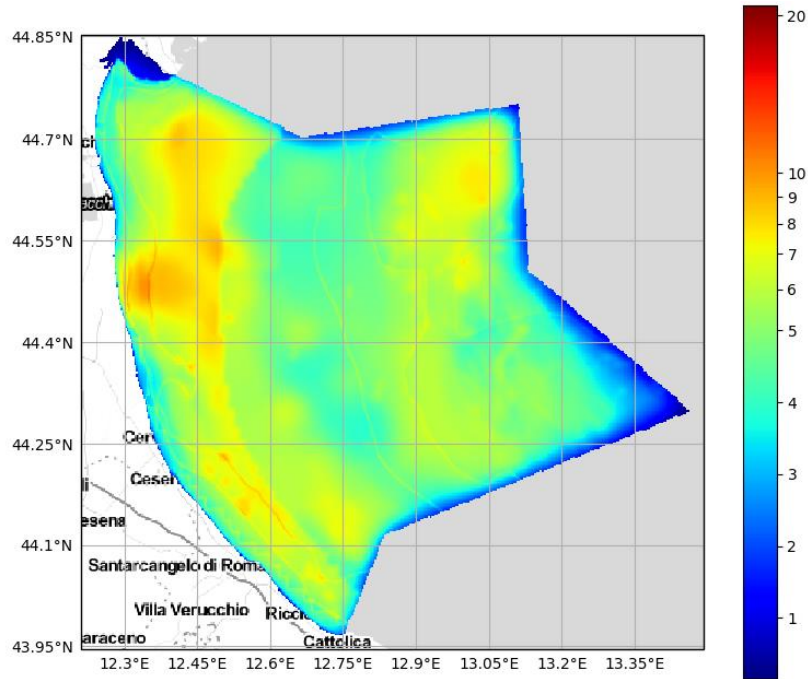


Figure 44 - Spatial distribution of CEA scores exerted by MSFD substances, litter and energy pressures (MAPCEA-MSFDSUB): inputs of fertilisers and other nitrogen and phosphorus-rich substances, inputs of organic matter, introduction of non-synthetic substances and compounds, introduction of other substances, introduction of radio-nuclides, introduction of synthetic compounds, marine litter, underwater noise. Managed scenario.

Biological pressures and physical pressures still show lower scores. Physical pressures are heavily influenced by the proposed measures, with strong reductions where trawling fisheries are limited (especially due to the absence of trawling related mechanical damages) and higher sealing scores where new wind farms are foreseen. The biological pressure “Selective extraction of species, including incidental non-target catches” related scores are also reduced by the trawling fisheries bans/limitations.

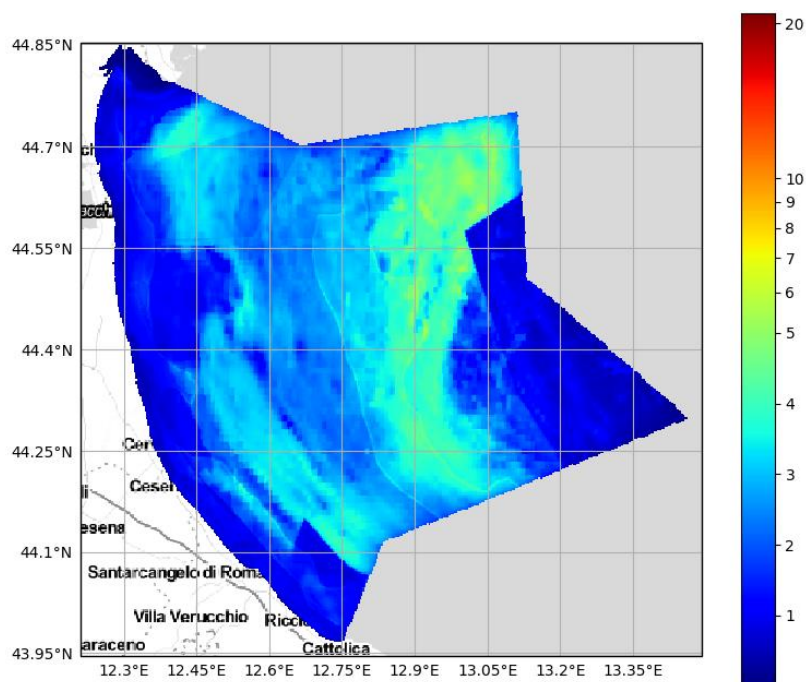


Figure 45 - Spatial distribution of CEA scores exerted by MSFD Biological pressures (MAPCEA-MSFDBIO): food availability, introduction of microbial pathogens, introduction of non-indigenous species and translocations, selective extraction of species, including incidental non-target catches. Managed scenario.

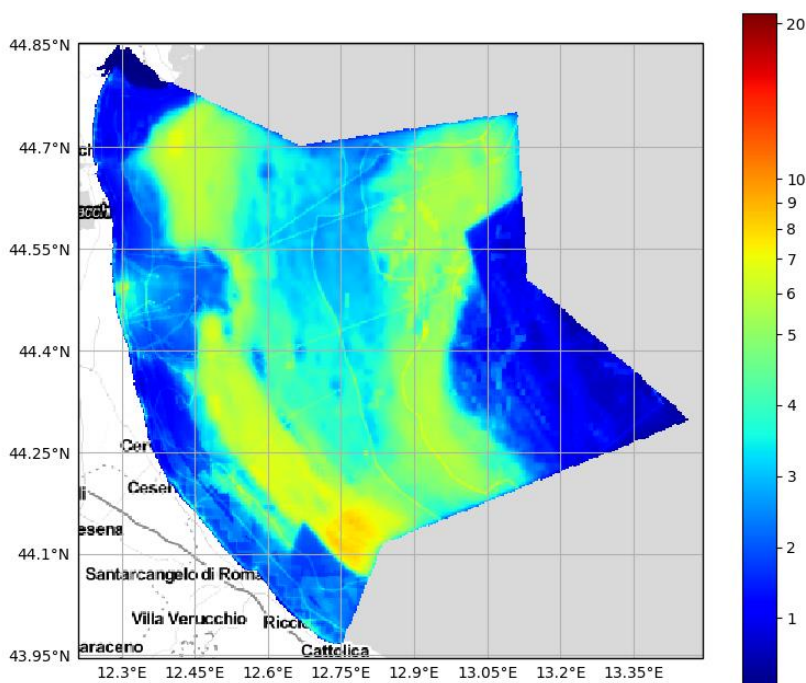


Figure 46 - Spatial distribution of CEA scores exerted by MSFD Physical pressures (MAPCEA-MSFDPHY): abrasion (surface, light, heavy), changes in siltation, removal of substratum (extraction), sealing, significant changes in salinity regime, significant changes in in thermal regime, smothering. Managed scenario.



The contribution of each pressure to the overall CEA score is represented in Figure 47.

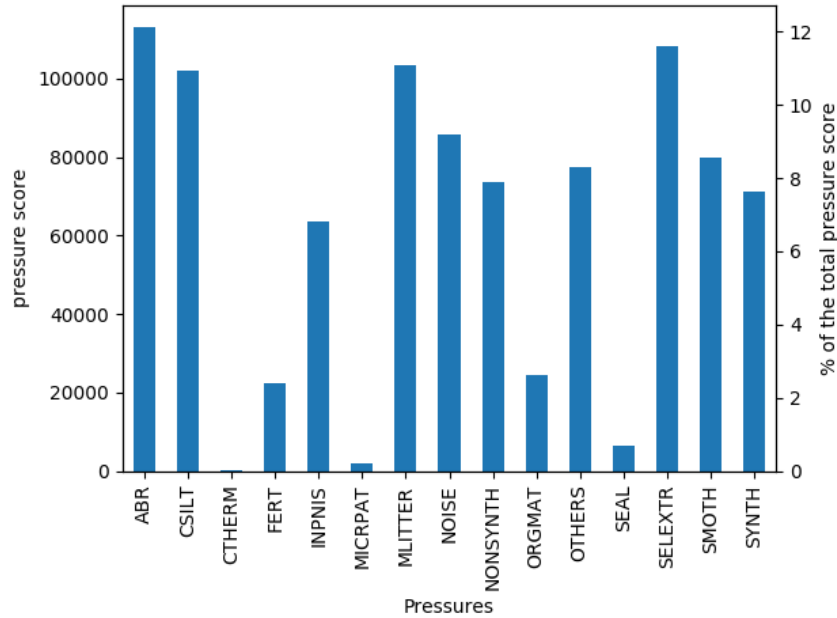


Figure 47 - Barplot representing the ranking of exerted pressures over the entire study area (managed scenario). Results are represented in pressure scores (left axis) and in percentage (right axis. ABR: abrasion; CSILT: Changes in siltation; FERT: Inputs of fertilisers and other nitrogen and phosphorus-rich substances; INPNIS: Introduction of non-indigenous species; MICRPAT: Introduction of microbial pathogens; MLITTER: Marine litter; NOISE: Underwater noise; NONSYNTH: Introduction of non-synthetic substances and compounds; ORGMAT: Inputs of organic matter; SEAL: Sealing ; SELEXTR: Selective extraction of species, including incidental non-target catches; SMOTH: Smothering; SYNTH: Introduction of synthetic compounds.

9.2 MUC module

Objectives and scenario tested: (cfr. Step 3), chapter 8): the Maritime Use Conflict analysis (MUC) has been performed in order to inform the planning process on the possible effects of proposed management measures investigating how the proposed allocation of new human activities (aquaculture, offshore wind farm installations) and new areas of environmental protection (BPZ and Sole sanctuary) overlap/conflict with activities currently present in the area.

9.2.1 Data

The MUC Case Study incorporating the managed scenario proposals is available at the following link:

- <https://www.portodimare.eu/casestudies/129>

Compared to MUC Analysis of present conflicts (Chapter 7), the spatial distribution of human uses was modified to incorporate new aquaculture areas and new offshore wind farm installations. In addition, the proposed new environmental protection areas (where trawling activities are banned) were directly incorporated into the “No-trawling area” layer (see Table 9).

Human use	Criteria type	Criteria for reviewing spatial distribution	Additional sources
Aquaculture	Use expansion	Add new shellfish farms, assuming they will be distributed on areas with a high level of suitability (suitability ≥ 0.75 ; cfr. cap7.d) and overlapping the areas with a high vocation for mussel farming (A/3_02, A/3_06 and A/3_08)	suitability constraints
Offshore Wind Farm	New use type	Add of the two areas of interest for wind farm development located in the offshore Ravenna and Rimini.	WF OffS Rimini Ritmare_RER_Measure 4_WF1
No-trawling areas	Use expansion	Extend no-trawling areas layer to incorporate BPZ in overlap with PU A/3_08 and the Sole sanctuary in overlap with PU A/7_03	Ritmare_RER_Measure 9_ZTB_RN RER - MSP planning units Sole sanctuary

Table 9: list of the reviews in human uses spatial distributions to incorporate managed scenario proposal.



9.2.2 Main results

In Figure 48 the results from marine use conflict analysis incorporating the managed scenario proposal.

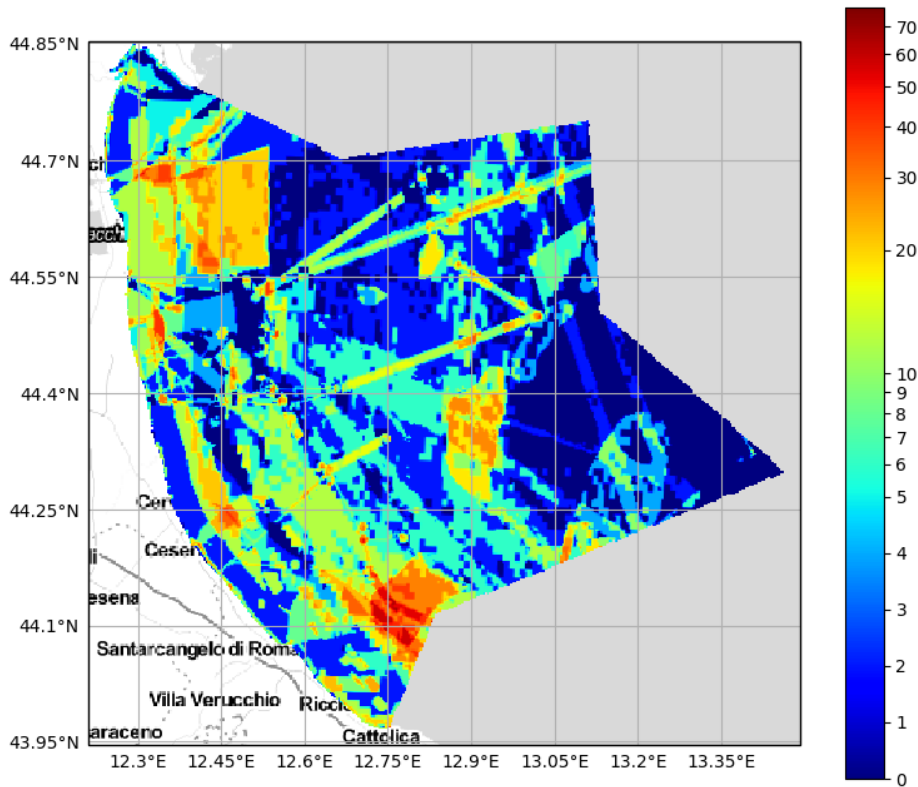


Figure 48 - Spatial distribution of MUC scores (managed scenario).

In Figure 49 the differences between the managed scenario and the present conditions are presented. The map shows the evidence of the increase in the conflicts derived from the proposed institution of a new managed area as the BPZ (4 to 6 NM), from the possible expansion of aquaculture (mainly with SSF) and for the presence of the new offshore wind farms, with both trawling fisheries and maritime traffic, within 7 to 12 NM (see Figures 50 and 51). In addition, an increase in MUC scores is also evident within PU “A/7_03” (overlapping with “Sola sanctuary”) where a ban for trawling activities has been proposed.

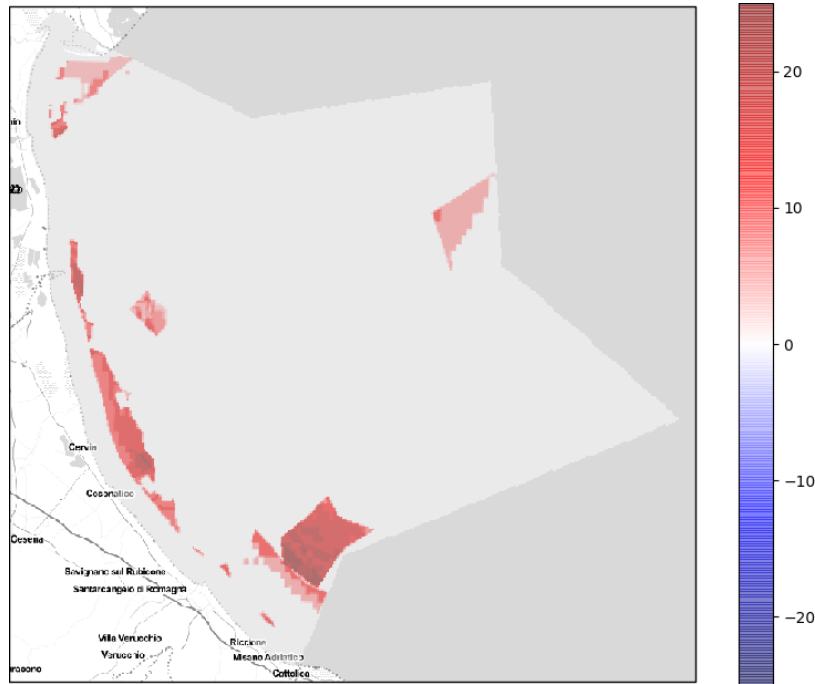


Figure 49 - Spatial explicit differences between managed scenario and present condition MUC scores.

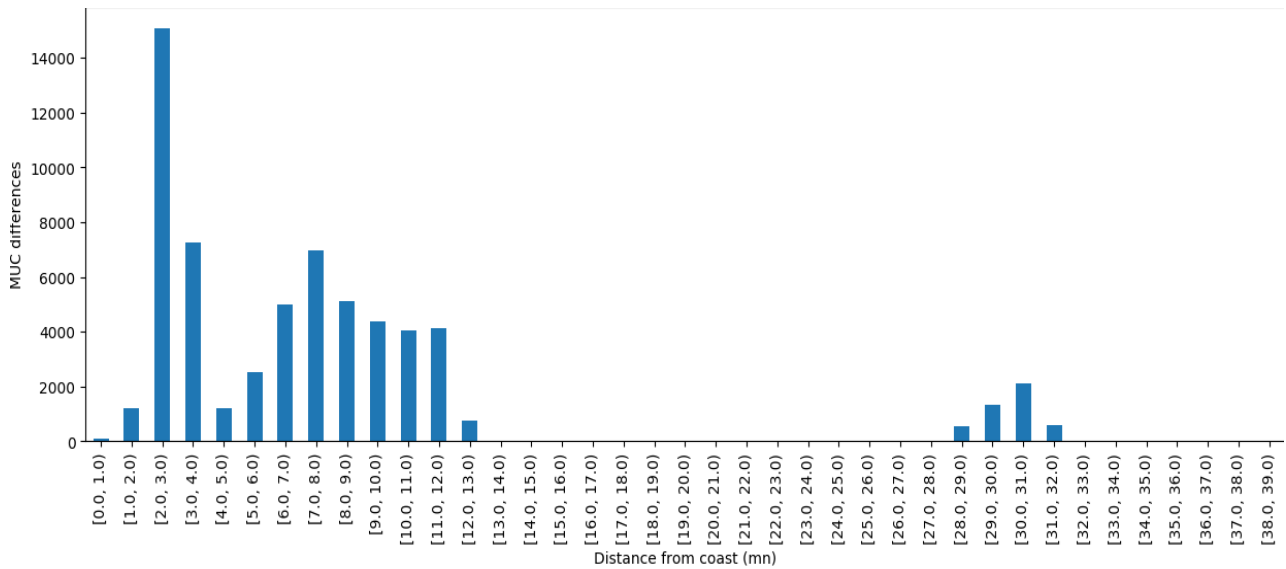


Figure 50 - Histogram representing the distribution of MUC scores' differences by the distance from the coast in nautical miles.

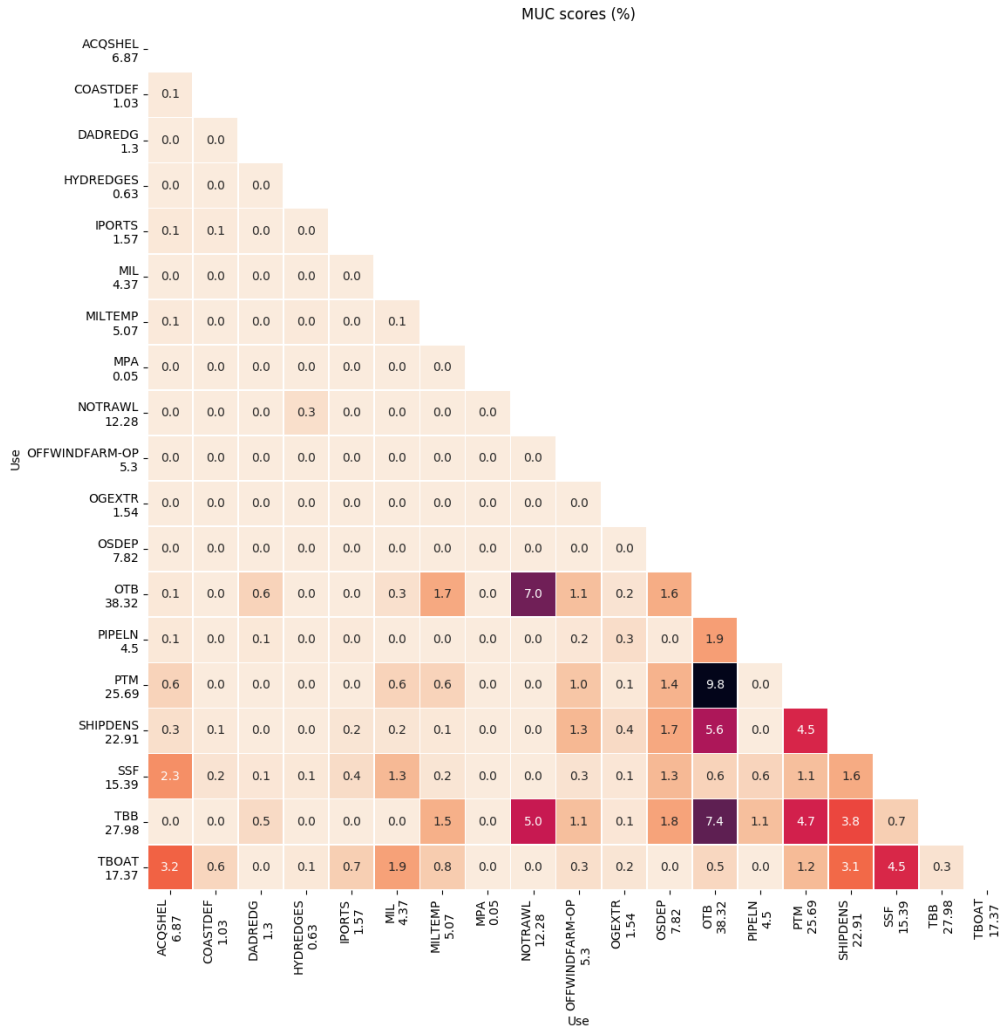


Figure 51 - Matrix representing the contribution (in %) of the single pairwise combinations to the total MUC score for the whole area of analysis (managed scenario).



10 INDICATIONS FOR A MARITIME SPATIAL PLAN IN THE EMILIA-ROMAGNA SEA ZONE: STEP 5

The MSP planning methodology applied within the ongoing Italian MSP process, designed by the scientific pole, and taking into account the National Guidelines approved by Prime Ministerial Decree 1/12/2017, foresees that into the ‘real planning phase’ (phase 4 of NTC methodology) it is necessary to define specific management measures be applied to each Planning Unit (see chapter 8, Figure 38).

The methodology suggested a range of ‘measures typologies’ to be potentially used in the plan, which are:

- Spatial measures
- Temporal measure
- Behavioural measures
- Measures oriented to Technical and Ecological improvements (T&E improv.)
- Knowledge Measures
- Monitoring, control and surveillance measures
- Multi-level governance
- Regulations and administration measures
- Economic and financial measures
- Entrepreneurial development and marketing (Ent. Dev. Mark.)
- Training and engagement of operators and the public

To define most of them it is necessary, however, to have detailed knowledge and to conduct analysis such as the ones produced in the Emilia-Romagna Case Study T2.3.1.

The Tools for MSP outputs, indeed, highlighted specific criticalities that could be solved, mitigated, or managed though dedicated measures. Such measures, moreover, can be modelled by using the tools in a ‘managed scenario mode’ with the aim of analysing, in a quantitative way, their possible benefits. This was partially done during the ‘Step 4’ of the CS T2.3.

A first example of this concerns CEA-module run results, that revealed of a strong pressure related to the fishing trawling over the benthic habitat, the key nursery and the species of conservation interest (i.e. marine turtles and mammals). In those areas it could therefore be useful to promote specific technical measures for fishing oriented to reducing such kind of risks, and to ban trawling activities in the proposed BPZ (zone of biological protection) and in the “Sole sanctuary”.

Another example refers to the results of the MUC module, which evidenced some potential sea use conflicts in areas where it would be truly possible to manage them. One example is the wide military area in front of Reno river mouth, where conflicts with small scale fishery were highlighted. Here, the most suitable measures are spatial and temporal, relating to restrictions to be enforced during the military exercises. A significant increase in conflicts with fisheries may arise from new aquaculture farms and new wind farms. As a whole, this would require mitigation measures such as, for example, reallocating fishing activities, promoting synergies with tourism, limiting as much as possible the subtraction of fishing grounds.



The analysis carried out through the PARTRAC module, although experimental and hypothetical as it simulates the dispersion of waste having as sources the aquaculture sites, made evident the opportunity to better address the activities in those sites. Waves and water currents, indeed, can facilitate the dispersion of materials, which can accumulate in areas ecologically delicate or of interest for other aspects. It is therefore very important to suggest as a measure the use of biodegradable materials for nets.

Finally, the testing of the AZA tool highlighted the opportunity to carry out such specific analyses in order to more appropriately direct the development of the aquaculture industry, which in Emilia-Romagna is one of the largest in the maritime sector.

As a whole, the tested planning scenario does not introduce any radical variation in the use of the maritime space facing the coast of the Region, in line with the proposed vision that substantially repeats and defines a current vocation. However, it proposes a series of important innovations and optimizations in order to:

- Allow the sustainable development of certain uses, i.e. promoting the Blue Growth, solving existing problems and fostering opportunities that are not currently exploited, as well as safeguarding the existing uses (e.g. aquaculture and MRE).
- Manage conflicts and increase synergies among uses.
- Reduce environmental impacts and increase the level of protection of relevant habitats and species (e.g. new TZB near Rimini, use of OTB-BRD, gillnet mesh size).

Even if these measures could be implemented independently, and reflecting specific sectorial needs, they have been conceived and tested by considering mutual connections and explicit elements of synergy, consistently with a general planning and non-sectorial vision.

10.1 Example of planning measures

Thanks to the large knowledge framework made possible by the GAIR and to the results of the Tools for MSP run, it is thus actually possible to prepare a set of measures to be proposed for the plan in the A3 and A7 areas, according the NTC methodological indications.



Measures types	SEA USES						
	tourism	Aquaculture	fishery	Environment protection	traffic	military defence	Oil & gas
spatial measures		Detailed setting of new allocated zone for aquaculture (AZA)	Encourage the progressive movement of trawling out of 4 nautical miles	Encourage measures to reduce impacts on nursery areas and target species;		Limitations to other sea uses during military exercise	Encourage the offshore moving of extraction sites to reduce coastal subsidence
temporal measures			extending the biological lock for tools with high impact on the bottom		reduce speed of vessels in the periods of higher density of protected species (e.g. Tursiops, sea turtles).		
behavior measures		Co-managed measures - to limit loss of tools and waste and reducing environmental impacts (e.g. use of biodegradable materials)		Adoption of right practices for waste management from anthropogenic activities	good practices reducing potential impacts of recreational boating		
T&E improv. measures		Testing new biodegradable materials and highly sustainable and productive mussel farming techniques	use bycatch reduction tools (e.g. UV lamps, acoustic bollards) on fishing nets and mesh increase (72 mm)		New technology aimed at reducing underwater noise and emissions		
Knowledge measures		research of new species to be bred		Identify gaps and promote actions to improve ecological knowledge; identify pressures	R&D aimed at reducing the impact of ports on the surrounding environment (CO2)		Improve studies on decommissioning and re-use
Ent. Dev. Mark	Develop multi-use tests (fishing / tourism) creating clusters of operators from different sectors						
training	for new professionals						



10.2 Further investigations and improvements

The planning proposal here presented is currently under discussion and consolidation within the national process to prepare the maritime spatial plans. The GAIR analysis and the analysis and simulations made with Tools for MSP are demonstrating how PORTODIMARE outputs may, and actually are, concretely contributing to the formal process preparing the plan.

However, several aspects should be, and are being, further investigated and tested, starting from this baseline condition. Some of these investigations can still directly benefit from the GAIR and its modules, while others will require different approaches, data and tools. These approaches, data and tools should all be considered for the future applications and developments of the GAIR in the coming months and in possible future projects.

The following is a non-exhaustive list of items and topics for further investigations and improvements:

- A more precise understanding of the Land-Sea Interactions and a definition of related measures to ensure coherence between terrestrial and marine planning. The studies carried out for Case Study T2.3, indeed, are mainly focusing on the marine area, that is the ‘domain of analysis’ of the Tools for MSP integrated into GAIR. What is still missing are some dedicated modules for the analysis of land-sea interactions (except for CEA, that includes among the anthropogenic pressures the so-called Land Based Activities). This is an extremely complicate matter, due to the large amount of playing factors and to the difficulties of considering land and sea processes altogether. For this reason, PORTODIMARE capitalized on the most relevant factors evaluated into previous projects (e.g. Ritmare and SHAPE project). Their results have been used, indeed, as input for the MSP tools. However, it is probably necessary to deepen other issues, such as the pressure on land of several sea-uses, that in this Case Study have been considered only in a qualitative way. Thanks to the use of the GAIR, nevertheless, it was possible to analyse the main criticalities by overlapping different layers, but no quantitative analysis has been done;
- Future scenarios related to oil and gas exploitation, and to the decommissioning and potential reuse of the related infrastructures in the area;
- Other specific measures for the fisheries (e.g. trawling limitations in space and time, gears limitation, regulation of dredgers harvesting *Chamaelea gallina*, gillnet limitation in the so-called “sole sanctuary”);
- Other nature conservation measures (e.g. specific conservation measures in the new Natura2000 area - under establishment - to protect marine turtles and Tursiops);
- Reduction (permanent and/or after storm events) of pollution loads coming from rivers and wastewater discharges and a deeper study of the area affected by their plumes (through PARTRAC);
- Future expected maritime traffic conditions and intensities (i.e. effects on coastal infrastructures, effects of coastal infrastructures on the coastal area, conflicts with other sea uses, higher environmental pressures);
- Future trends in tourism, including tourism models complementary to the traditional beach tourism (e.g. nautical, cultural, eco-tourism, fish-tourism, diving, ecc.) and synergies with other existing uses;
- Specific and more detailed understanding of the effects and interactions from potential new offshore wind farms;
- Development and testing of new and different integrated alternative scenarios (e.g. “Business as Usual scenario”, “conservation scenario”, “gold-rush scenario”);



- Participatory and stakeholder consultation processes, supported by GAIR data, maps, simulations, with the potential support of new sketching/drawing dynamic features.
- Socio-economic analysis of costs and benefits of planning options and scenarios, including assessment of the economic value of ecosystem services.



11 CONCLUSIONS

The Case Study (CS) T2.3 is focused on the testing of the Geoportal and of the Tools for MSP (modules) dedicated to the analysis of conflicts/synergies among uses and on cumulative impacts, with the aim of evaluating the sea-uses sustainability in the maritime area offshore the Emilia-Romagna coastline. It offered, indeed, the opportunity to develop multiple and valuable information that can be actually transferred to the Maritime Spatial Plan that is being drawn by the National Technical Committee (NTC). Besides, the CS results can also supply information to other sectorial plans that are currently in a phase of updating or in elaboration, both at sea and on the coast (e.i: coastal adaptation plan; aquaculture plan, waters protection plan).

First of all, it is quite evident that the availability of a geoportal specifically dedicated to MSP and ICZM processes, managed by governmental and research institutions, gives access to multiple source of data that, even if developed for very different purposes, all together can help in creating the knowledgeable background essential for the context analysis. In fact, the MSP process itself requires skills and information so wide and various that can hardly be managed without an integrated information system as the GAIR is.

In this framework it is important to underline how, being the Emilia-Romagna Region, lead partner of PORTODIMARE, a member of the NTC, it was decided to perform the project activity T2.3 by directly integrating the planning approach developed at national level and what was foreseen by the project itself, thus making evident how PORTODIMARE deliverables can substantially contribute to a real planning process.

The CS T.2.3, covers the maritime area facing the Emilia-Romagna coastline, belonging to sub-areas A3 and part of sub-area A7 of the Adriatic Sea maritime area (see Figure 38). The activities implemented, organized into several steps, basically concerned data collection, maps processing and the testing of the Tools for MSP integrated into the GAIR. They allowed to test also the proposed managed scenario, thus validating the 'unit planning' suggested by NTC for the sub-areas A3 and A7, and to define a set of suitable planning measures.

Starting from the big amount of data collected and processed into the GAIR, in fact, it was possible to create thematic maps needful to focus on the main critical issues at sea and concerning land-sea interactions. Besides, the high resolution of the most important datasets allowed to set the modules at a very high spatial resolution (250 m), thus reaching very detailed and realistic results about multi-use conflict and cumulative impacts analysis.

What is evident by the analyses carried out in CS T2.3 is the high density of human uses (13 sea uses have been classified) which, in some areas, conflict each other and/or produce a strong pressure on the marine and/or coastal environment. Some issues emerging by the analysis of conflicts among the different uses, highlighted in the results of the MUC tool run (Figure 29), can be actually mitigated through spatial and temporal measures. Some example in the area: the conflict between small scale fishery and the military area Echo 346 in front of Reno river mouth, or the coexistence of sand extraction and trawling fisheries; other conflicts are more complex to manage, such as the Ravenna harbour zone where maritime traffic and oil/gas infrastructures are in conflict with tourism and environment.

Another conflict to address concern the offshore sand deposits, which are located in areas that are also suitable for oil and gas extraction. Future drilling permissions should consider the opportunity of leaving sand stocks free from platforms, by adopting suitable drilling techniques such as directional drilling.



Issues related to environmental impacts are more critical and need a stronger involvement of the political level to be solved. The most significant cumulative impacts are spread in the marine area between 3 and 12 NM, in front of the Ravenna harbour and off-shore the 20 NM (see Figure 17), where the high intensity of maritime traffic and trawling fishery impacts on species of conservation interest (i.e. marine turtles and mammals), on key nursery and on Essential Fish Habitats, representing the environmental components more exposed to the anthropogenic pressures. Measures to reduce those impacts are thus recommended, such as new trawling techniques, to avoid the catch of unexpected species, the gradual reduction or shifting of the trawling activities and the green technologies for maritime transport. Besides, looking to the high benefits related to the institution of a possible ‘biological protected zone’ and of a ‘Sole sanctuary’, a total ban of bottom otter trawlers (OTB) and “rapido” beam trawlers (TBB) should be considered in those areas.

From this extensive use of the GAIR and some of its Tools for MSP in the marine area facing the Emilia-Romagna Region we conclude that:

- the GAIR adequately describes the coast-and sea system according to ICZM-MSP needs. A further upgrade and a continuous update of information are expected and recommended;
- the GAIR allows a flexible, dynamic and interactive exploration and analysis of the available data, while the production of final maps with fine editing is left to more sophisticated GIS tools (e.g. QGIS);
- the GAIR and its tools for MSP proved to be very useful in addressing and informing the planning phase, through a tool-assisted phase of assessment and analysis of interactions among uses and effects/impacts on environmental components;
- the GAIR and its tools for MSP proved to be very useful in testing planning options and proposals, by producing quantitative/semi-quantitative spatially explicit outputs on the interactions and single/cumulative effects/impacts;
- the GAIR and its and its tools for MSP can now be easily used (provided that the user has the proper skills to prepare, run and interpret simulations) to create and test different planning measures and scenarios, and to evaluate their absolute and relative consequences.
- the above listed results and potentialities are now accessible to be used in support of discussions and consultations with stakeholders.



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