CO-EVOLVE

Promoting the co-evolution of human activities and natural systems for the development of sustainable coastal and maritime tourism

Deliverable 3.6.2

Comparative Analysis

Activity 3.6

Threats to co-evolution in touristic areas - Mediterranean scale: Land-Sea uses and land-sea interactions

WP3

University of Thessaly

Authors

Harry Coccossis and **Antonia Koutsopoulou**

University of Thessaly
Department of Planning and Regional Development
Volos 38334, Greece

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1. Introduction and scope of work

The evaluation of current and future conflicts as well as the identification of potential synergies between different land uses and economic activities may prove crucial for spatial policy options, especially in the Mediterranean coastal zone where various competitive and often incompatible activities are developed in the same or neighbouring areas.

However, the combined effects from the simultaneous development of different economic activities and their cumulative impacts on the Mediterranean coastal environment can be better evaluated at a local scale. As highlighted by Torre et al. (2014), conflicts have a localized physical dimension in the context that they emerge in relation to differing land uses and may expand spatially, socially, economically and environmentally.

In this context, the current report builds on the results of Deliverable 3.6.1. and serves a bilateral objective. The first is to identify and evaluate cumulative pressures created by tourism's interaction with other important economic activities located in coastal areas as well as to highlight the related "pressure hotspots" ***at Mediterranean scale***. The second is to provide a specific methodological framework for assessing the interactions and potential impacts between coastal and maritime activities - especially in relation to tourism - ***at local scale***, by reviewing existing approaches in land use conflicts assessment and taking into account spatial, economic and environmental criteria.

2. Cross-cutting analysis on cumulative pressures and identification of potential hotspots at Mediterranean scale

2.1 Interactions of tourism with main coastal and maritime activities

The predominance of tourism sector in Mediterranean coastal areas has often led to overexploitation of coastal and maritime resources. In combination with other competitive economic activities in the area, severe threats are created regarding the balance of the Mediterranean ecosystem (UNEP/MAP, 2012).

Given the estimated upward trend in all coastal and maritime sectors in the future – besides fisheries- the interactions and potential conflicts among different sectors is also expected to grow. Such interactions may vary from positive to negative effects, conflicting or competing interests or even synergies between sectors (Piante and Ody, 2015).

In order to identify the potential cumulative pressures in the Mediterranean basin that undermine the co-evolution of touristic activities and natural systems in coastal areas, it is necessary to specify in more detail the interactions between tourism and other major coastal and maritime activities. In the absence of an official regime tracking the impacts of tourism and other economic activities in coastal areas, it is extremely difficult to specify the exact nature of these interactions at the Mediterranean level. At this point, it is only possible to identify and suggest areas for further study as potential Mediterranean hotspots.

Building on previous analysis and taking into account the high dependence of tourism on a healthy environment, the key areas of conflict regarding the coexistence of touristic activities and other economic sectors are (Piante and Ody, 2015):

- Conflicts concerning the use of space
- Exploitation of the same coastal and marine resources
- Conflicts related to the degradation of natural ecosystems

Taking into account the suggested destination typology reflecting both annual growth in overnight stays and market share of tourism destinations as well as the pressure index of other major economic activities in the Mediterranean basin, the following conclusions are drawn regarding the interactions between tourism and other economic activities.

In the case of tourism interactions with professional fisheries, the main conflicts derive from the often competing interests of the two sectors in exploiting the same marine resources. Since links between the two sectors rarely exist, tourism often develops at the expense of professional fishing activities (i.e. increase in land values around fishing ports). Although strategies implemented by public policies and local stakeholders can facilitate the interactions and strengthen the links for the cooperation of the two sectors, current interactions and weak synergies pose additional pressure on local communities and the environment (Angelini and Lesueur, 2013).

Taking into account the potential fishing pressure along the Mediterranean coast, key areas of interest – related to high pressures - are mostly located in Spain and Italy and to a much lesser extent France and Greece (Figure 1). By correlating these high pressure areas with destination types of current (high share) or upcoming (low share-high growth) tourism development, areas for further study are highlighted regarding the cumulative pressures of tourism and fishing activities (Table 1). Areas with higher shares and growth rates in tourism (mature and developing destinations with high dynamic) are more likely to record intense combined effects on the environment. However, given the declining trends of fishing activities in the future, cumulative pressures from the development of both activities is also likely to decrease in the future.

Table 1: Identification of hotspots from cumulative pressures of tourism and fishing activities

Type of destination	Future trend in tourism	Future trend in fishing	Hotspots (Cumulative pressures/NUTS3 units)
High share-High Growth	↑	↓	Malaga(SP), Granada(SP), Tarragona(SP), Istria(HR), Attiki(GR), Chalkidiki(GR)
High share- Medium Growth	↑	↓	Valencia(SP), Barcelona(SP), Girona(SP), Hérault(FR), Genova(IT), Palermo(IT), Venezia(IT), Padova(IT), Livorno(IT)
High share-Low Growth	↓	↓	Roma(IT), Lucca(IT), Ravenna(IT), Forli-Cesena(IT)
Low share-High Growth	↑	↓	Sassari(IT), Calabria(IT), Siracusa(IT)

Source: Own elaboration

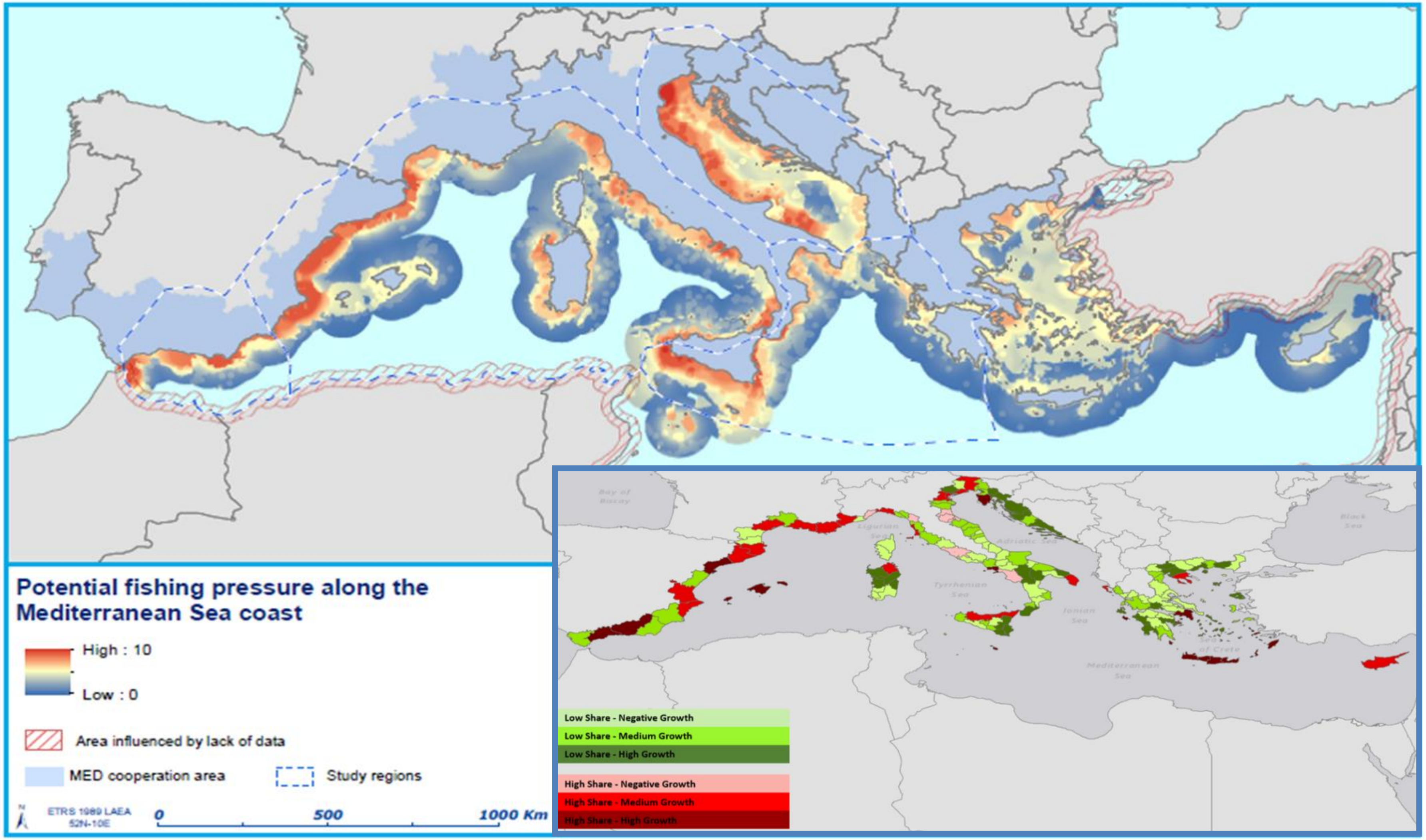


Figure 1: Correlation between potential fishing pressure areas and current or upcoming tourism destinations

Source: Med-IAMER project (2015) and own elaboration

As for the interactions between tourism and aquaculture, both activities have competing interests regarding the use of coastal space for physical developments such as hotels, recreational ports and sea cages deployment. The two activities are often conflicting since aquaculture facilities significantly alter the aesthetics of the coastal landscape with large structures visible from tourism resorts and beaches. Given the undeniable economic force of tourism industry, aquaculture is in many cases excluded from coastal regions in favor of uninterrupted seascapes. Moreover, although tourism and aquaculture compete in order to obtain access to high quality marine environment, both activities have severe impacts such as sewage disposal and fish farm wastes. These impacts, especially when combined, may lead to increased nutrient and pollution levels and create important threats for the sustainability of coastal and marine environment in the long term (i.e. eutrophication, introduction of non-indigenous species etc.) (Dempster and Sanchez-Jerez, 2007).

As a consequence to their predominance in aquaculture production (in tonnes), Greece and Italy have by far the most extensive areas of high pressures recorded from aquaculture activities at Mediterranean level (Figure 2). The results from the correlation of these areas with mature (high share) and developing destinations with high dynamic (low share-high growth) are depicted in Table 2. Taking into account the upward trends of tourism and aquaculture sector in the Mediterranean basin, the combined impacts from both activities can also be expected to grow in the future.

Table 2: Identification of hotspots from cumulative pressures of tourism and aquaculture activities

Type of destination	Future trend in tourism	Future trend in aquaculture	Hotspots (Cumulative pressures/NUTS3 units)
High share-High Growth	↑	↑	Napoli(IT), Dodekanisa(GR)
High share- Medium Growth	↑	↑	Venezia(IT), Padova(IT), Kerkyra(GR)
High share-Low Growth	↓	↑	-
Low share-High Growth	↑	↑	Argolida(GR)

Source: Own elaboration

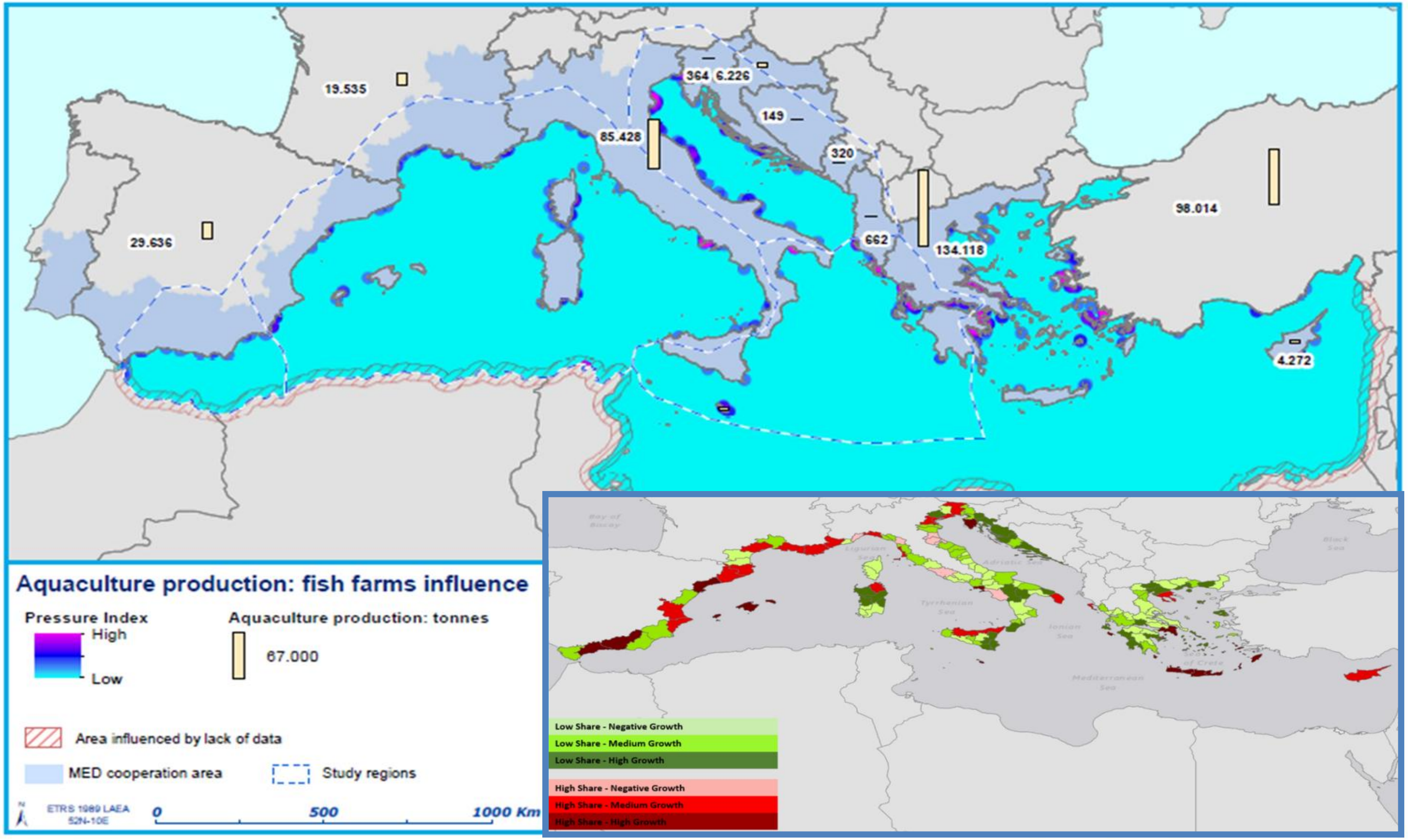


Figure 2: Correlation between potential aquaculture pressure areas and current or upcoming tourism destinations

Source: Med-IAMER project (2015) and own elaboration

Energy extraction requires major spatial on-and offshore areas for production plants and storage facilities but also poses barriers for the development of other coastal and maritime activities in their vicinity due to irreversible alteration of land-and seascape. Conflicts with tourism activities may arise not only in terms of use of space and landscape alterations but also in terms of operational impacts from energy extraction facilities, including disposal of fly ash, particulate and gas emissions, noise and accidental oil spills (MITOMED Project, 2015). Environmental impacts from energy extraction, both operational and accidental, can pose significant barriers for the development of tourism activities that rely on healthy and pristine environments. Especially in the case of accidental oil leaks and spills, the impacts on the environment and local economy would be long-term and most likely irreversible. Specifically along the Mediterranean basin, the frequency and intensity of seismic events must be taken into account when estimating risks in future development of the energy extraction sector (European Union, 2015· Piante and Ody, 2015).

Taking into account the density of the existing energy infrastructure and its influence as well as the extent of exploration and possible development zones, key areas for further study in terms of potential pressures are mostly located in Italy and to a much lesser extent Spain, France and Croatia (Figures 3 and 4). The results from the correlation of these areas with mature (high share) and developing destinations with high dynamic (low share-high growth) are depicted in Table 3. Conflicts between the two sectors are likely to intensify in the future, especially in new extraction areas where traditional activities have already been established over the past years.

Table 3: Identification of hotspots from cumulative pressures of tourism and energy extraction activities

Type of destination	Future trend in tourism	Future trend in energy extraction	Hotspots (Cumulative pressures/NUTS3 units)
High share-High Growth	↑	↑	Tarragona(SP), Istria(HR)
High share- Medium Growth	↑	↑	Barcelona(SP), Bouches-du-Rhône(FR), Lecce(IT)
High share-Low Growth	↓	↑	Savona(IT), Roma(IT), Ravenna(IT), Forli-Cesena(IT)
Low share-High Growth	↑	↑	Siracusa(IT)

Source: Own elaboration

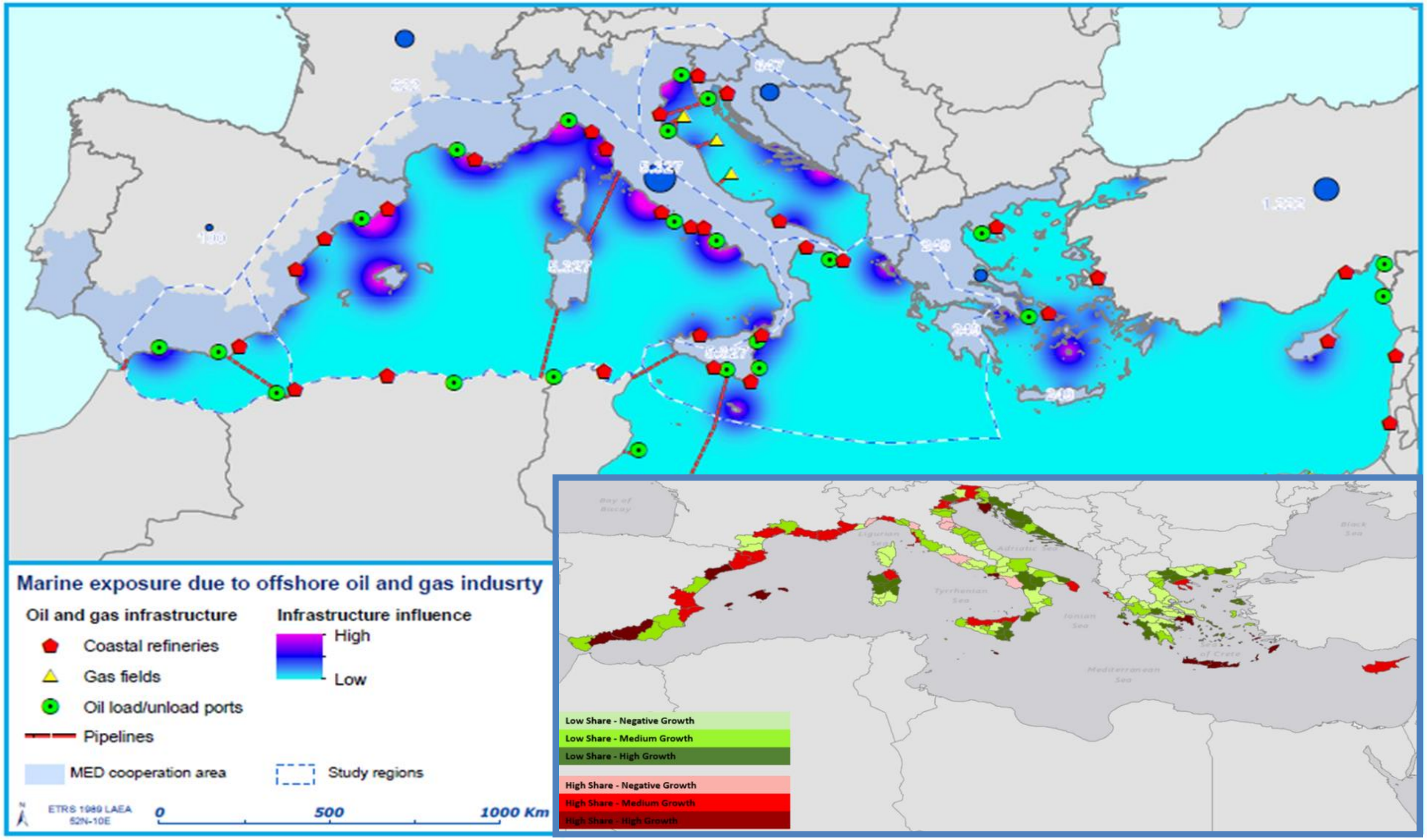


Figure 3: Correlation between potential energy extraction pressure areas and current or upcoming tourism destinations

Source: Med-IAMER project (2015) and own elaboration

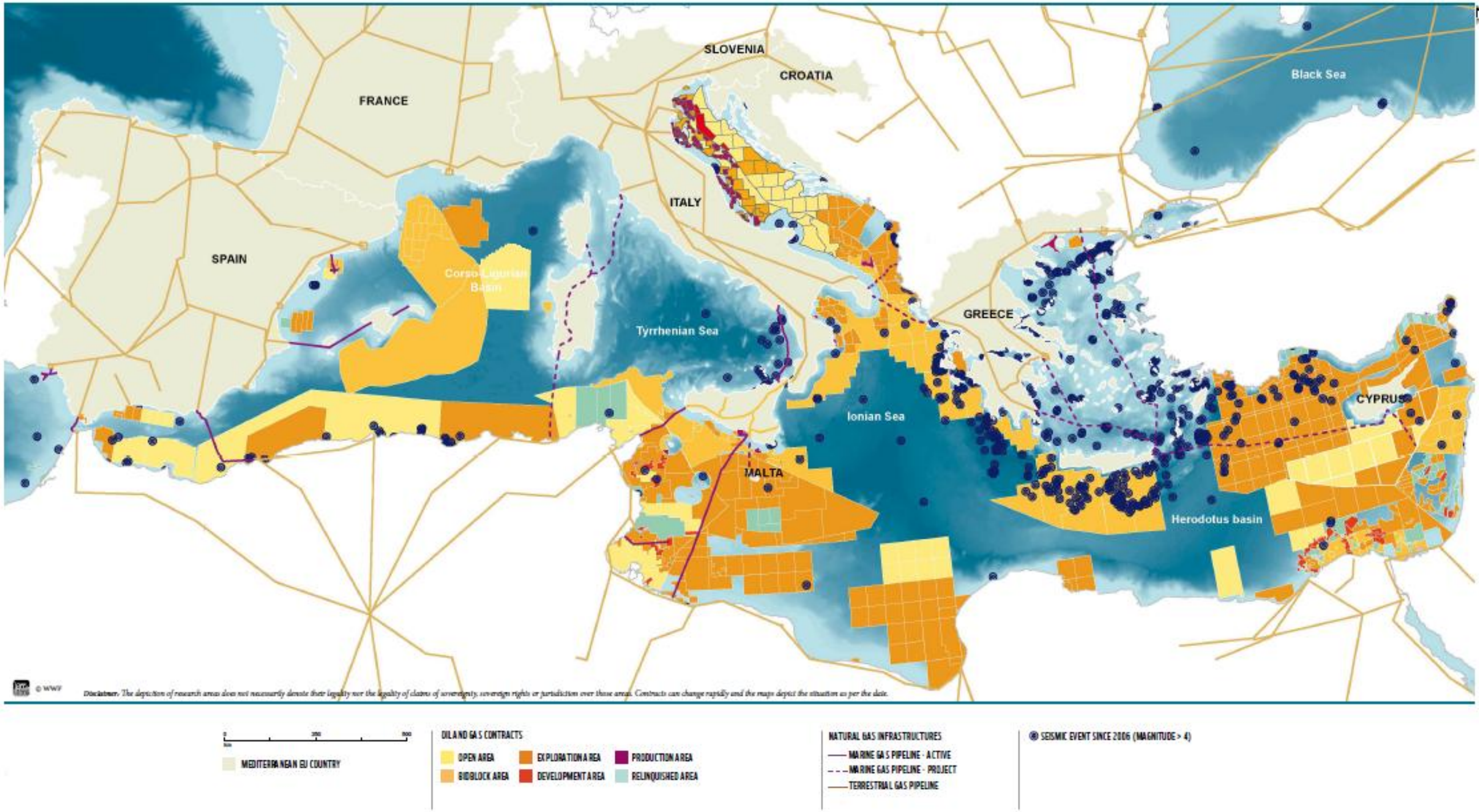


Figure 4: Overlap between oil and gas contracts and seismic events of magnitude > 4

Source: Piante and Ody (2015) and own elaboration

Conflicts between tourism and agriculture over land use, coastal and marine resources and especially water have been pressuring the Mediterranean ecosystems for years. Coastal tourism causes significant reduction of natural sites and open spaces as well as substantial alteration of coastal landscapes whereas agriculture practices are known to alter the ecosystems' dynamics through nutrient surplus, contamination of aquifers and soil erosion phenomena (European Environment Agency, 1999· Roson and Sartori, 2012).

On the bright side, the reduction in agriculture production and the reallocation of water resources towards tourism industry over the past years have resulted in positive water savings in most Mediterranean countries. Although such a case would normally imply improvements towards the symbiotic relationship of the two sectors, future estimates predict an escalation in their combined impacts. Environmental pressure from intensive irrigated agriculture and tourism's expansive trends are expected to aggravate in view of climate change impacts (European Environment Agency, 1999· Roson and Sartori, 2012).

Taking into account the index of coast occupation (Figure 5) regarding the percentage of land occupied by agriculture activities within 500m of coast, most key areas for further study in terms of potential pressures seem to be located in Italy and Greece (with at least 25% of coastal land occupied by agricultural activities). Table 4 presents the results from the correlation of these areas with mature (high share) and developing destinations with high dynamic (low share-high growth).

Table 4: Identification of hotspots from cumulative pressures of tourism and agriculture

Type of destination	Future trend in tourism	Future trend in agriculture	Hotspots (Cumulative pressures/NUTS3 units)
High share-High Growth	↑	↑	Granada(SP), Tarragona(SP), Kerkyra(GR), Zakynthos(GR), Rethymno(GR),Irakleio(GR), Lasithi(GR)
High share-Medium Growth	↑	↑	Valencia(SP), Palermo(SP), Messina(IT), Lecce(IT), Padova(IT), Udine(IT), Cyprus
High share-Low Growth	↓	↑	Roma(IT), Salerno(IT)
Low share-High Growth	↑	↑	Ragusa(IT), Reggio di Calabria(IT), Brindisi(IT), Ogliastra(IT), Kefallinia(GR), Ileia(GR), Messinia(GR), Lesvos(GR), Kavala(GR), Rodopi(GR)

Source: Own elaboration

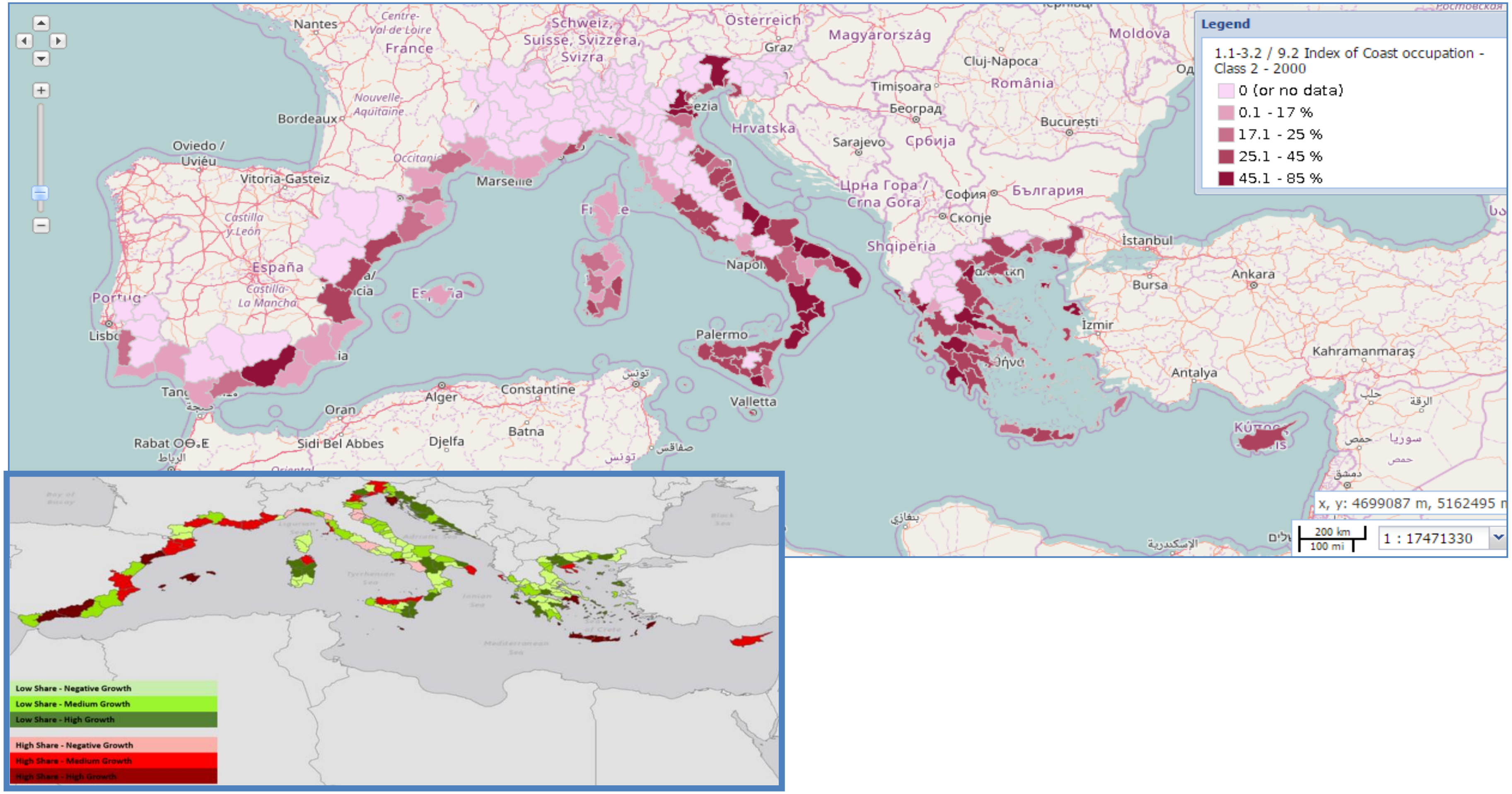


Figure 5: Correlation between potential agriculture pressure areas and current or upcoming tourism destinations

Source: GeoExplorer (2017) and own elaboration

The relationship between tourism and maritime transport is characterized by a wide and complex net of interactions since both activities are deeply connected to the sea and each other (in the case of passenger and goods transport). Maritime connections, intermodal transport and infrastructures are essential for tourism development. However, impacts from maritime transport may pose serious barriers to tourism development, by threatening valuable environmental assets which are essential to the sustainability of tourism industry. Marine pollution (especially oil spills), noise and introduction of invasive species through the discharge of ballast waters are among the main environmental threats posed by maritime transport. Some of the most accident-prone areas in the Mediterranean in terms of intense maritime traffic are the Strait of Gibraltar and Messina, the Sicilian Channel and several ports like Genoa, Livorno, Venice, Trieste, Piraeus and Limassol (European Environmental Agency, 1999· Davenport and Davenport, 2006· ESPON, 2013· Piante and Ody, 2015).

In spite of the conflicts related to the degradation of the environment, there is also competing interest in terms of space and land uses. Maritime infrastructure requires large areas for the development of ports, railways, roads and logistics. It also poses barriers to the development of other activities in their vicinity because of high noise and pollution levels (UNEP/MAP, 2012· ESPON, 2013· Piante and Ody, 2015).

In order to identify the key areas of marine exposure, both passengers and goods transport need to be taken into account. The density and influence of ports infrastructure seems to be intensified in Italy, Greece and Spain compared to the rest of the Mediterranean basin (Figures 6 and 7). In correlation with mature (high share) and developing destinations with high dynamic (low share-high growth), potential areas of cumulative pressure are highlighted for further study (Table 5).

Table 5: Identification of hotspots from cumulative pressures of tourism and maritime transport

Type of destination	Future trend in tourism	Future trend in maritime transport	Hotspots (Cumulative pressures/NUTS3 units)
High share-High Growth	↑	↑	Tarragona(SP), Napoli(IT), Malta, Attiki(GR)
High share-Medium Growth	↑	↑	Valencia(SP), Bouches-du-Rhône (FR), Genova(IT), Livorno(IT), Messina(IT), Venezia(IT)
High share-Low Growth	↓	↑	-
Low share-High Growth	↑	↑	Reggio di Calabria(IT)

Source: Own elaboration

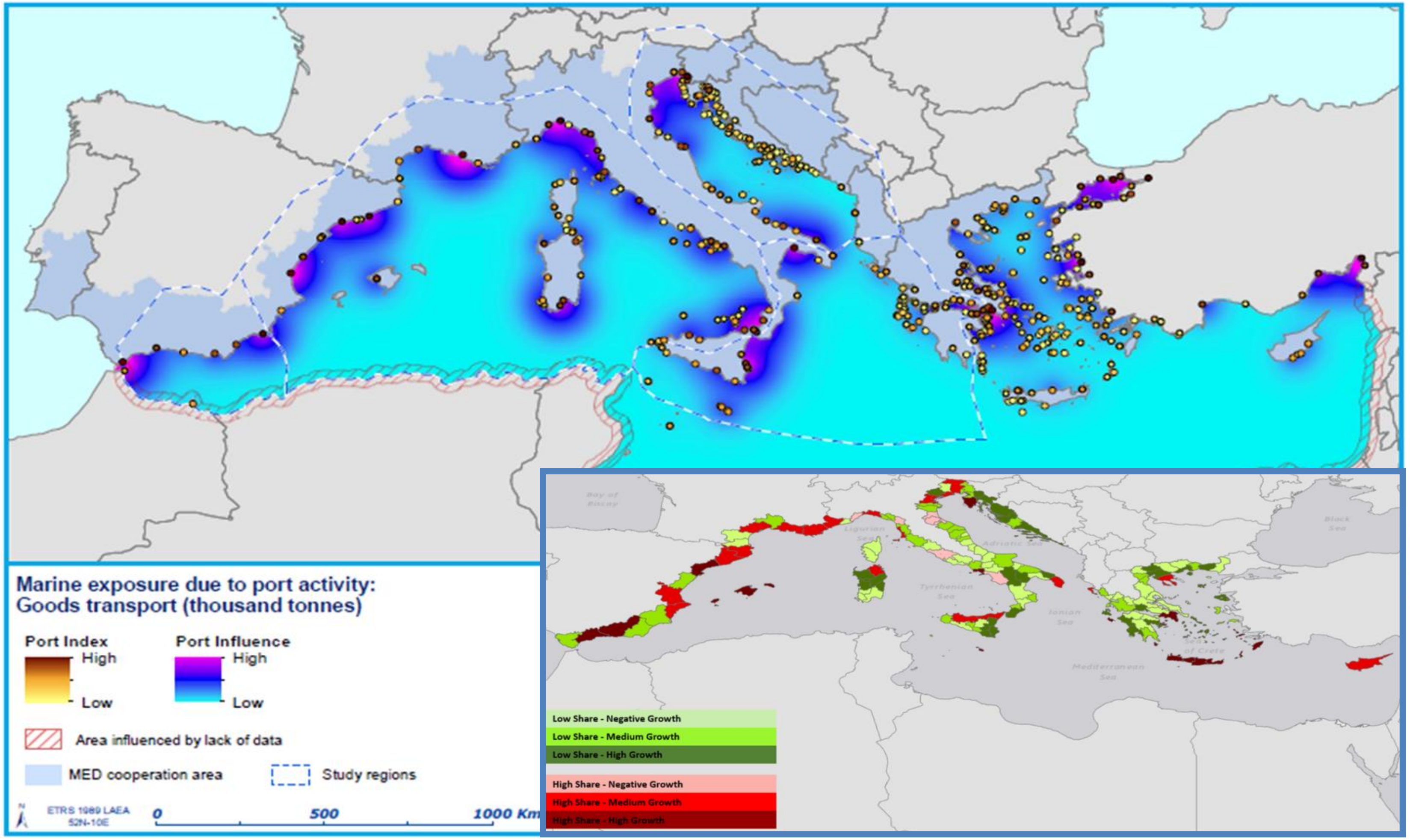


Figure 6: Correlation between potential goods transport pressure areas and current or upcoming tourism destinations

Source: Med-IAMER project (2015) and own elaboration

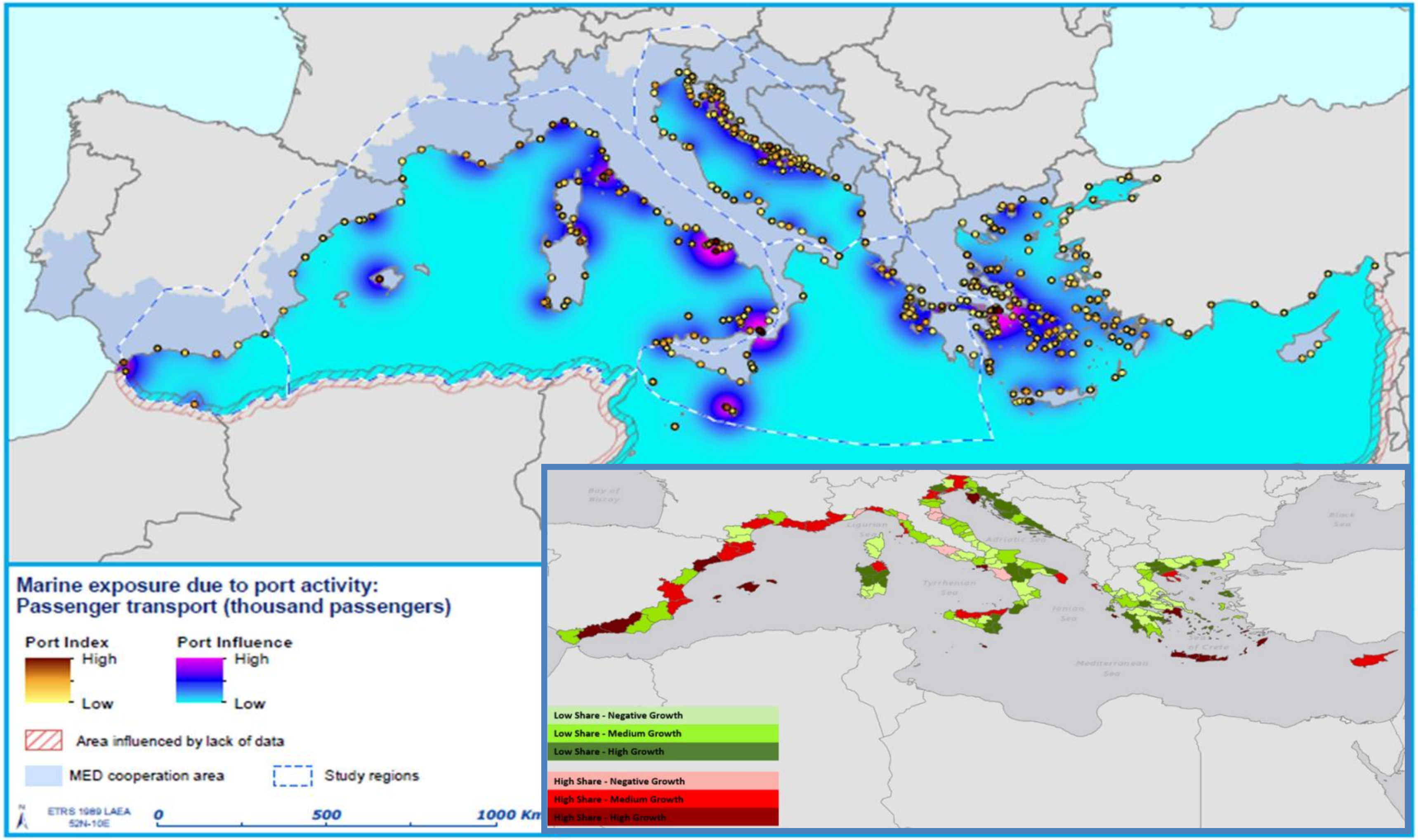


Figure 7: Correlation between potential passengers transport pressure areas and current or upcoming tourism destinations

Source: Med-IAMER project (2015) and own elaboration

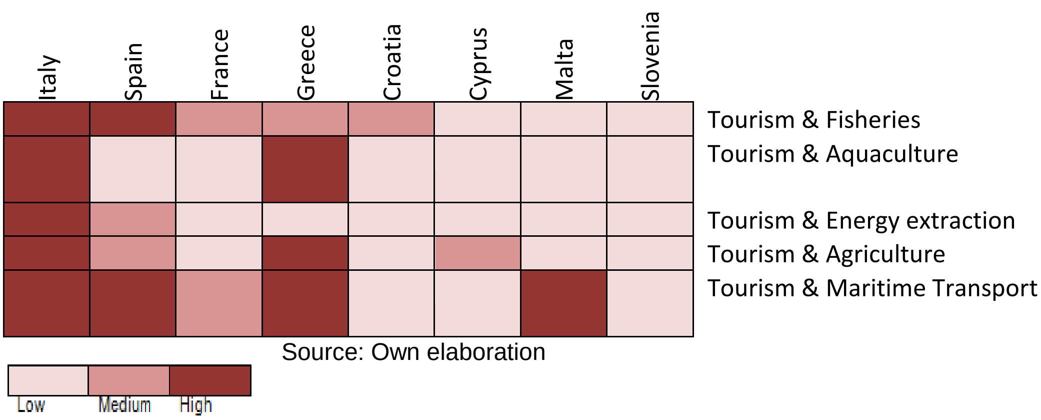
2.2 Identification of pressured coastal zones and potential hotspots in the Mediterranean zone

The Mediterranean coastal zone is an area of interchange between environmental, economic and socio-cultural activities. Intense littoralization and coastal development over the past decades have resulted in increasing competition over the use and allocation of coastal and marine resources. Sectoral activities – mainly tourism and recreation, agriculture, fisheries and aquaculture, energy extraction and maritime transport –either conflicting or synergetic, use and exploit coastal and maritime resources for economic and social purposes. Each activity is related to several environmental impacts in coastal areas but it is their interactions and combined impacts that generate critical pressures and chain reactions affecting the ecosystem (UNEP/MAP, 2012, MITOMED Project, 2015).

Multiple uses of coastal and maritime resources occurring simultaneously increase exponentially the impacts of certain threats on the environment compared to when occurring individually. However, understanding and recording cumulative impacts is exceptionally difficult in the absence of a pressure monitoring system (UNEP/MAP, 2012, Fernandes et al, 2016).

Based on existing knowledge (Figure 9), the interactions between tourism and other major economic activities vary significantly along the Mediterranean coastal and marine environment. Building on previous analysis, Italy and especially the Adriatic coast, shows high intensity of such interactions, followed by Greece and Spain (Figure 8). The cumulative pressure indicator shown in Figure 10 is indicative of the intensity and spatial extent of such interactions and their combined impact on the Mediterranean basin.

Figure 8: intensity of interactions between tourism and major economic activities per country



Source: Own elaboration

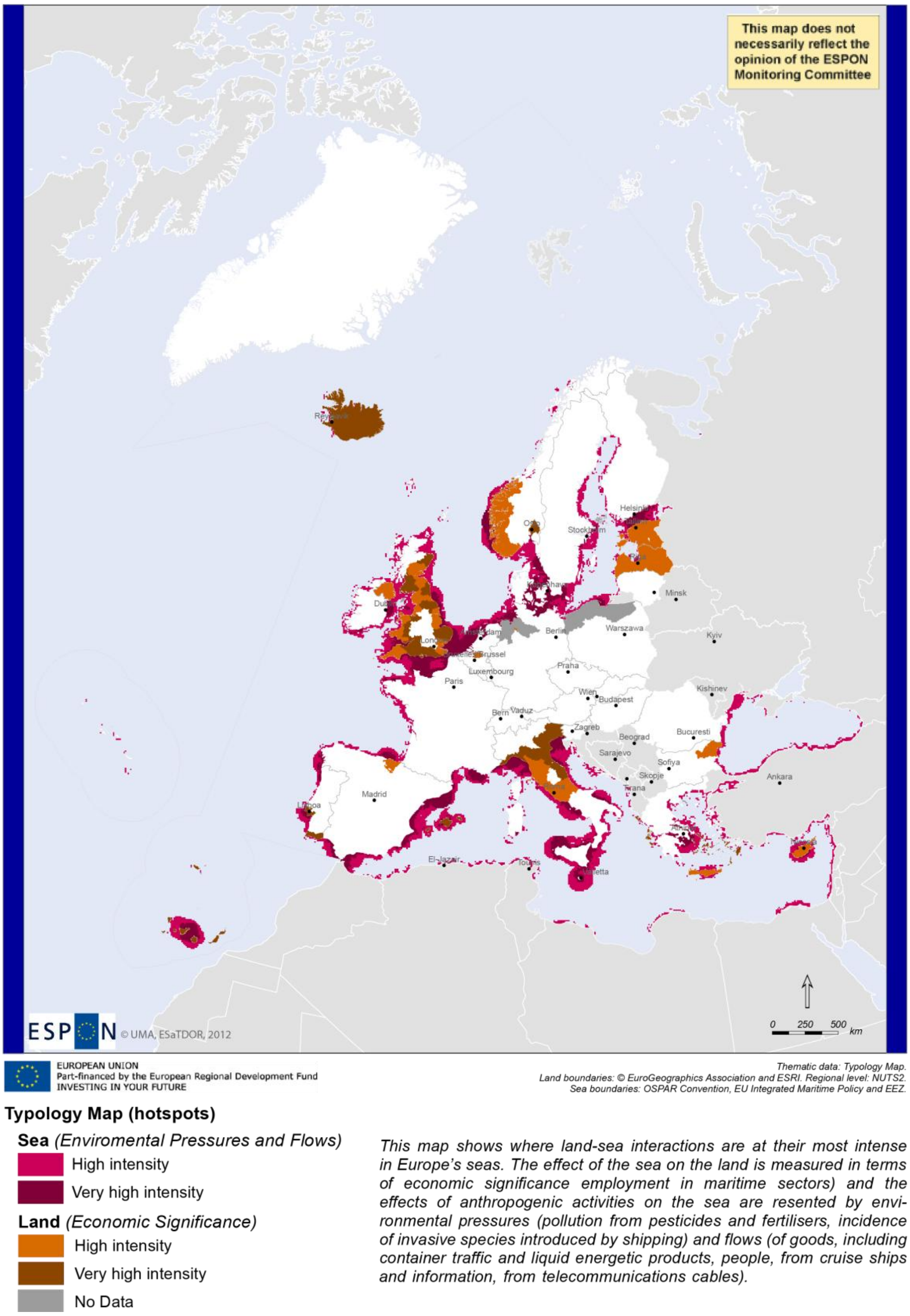


Figure 9: "Hot-Spots" of Land Sea Interactions

Source: ESPON, 2013

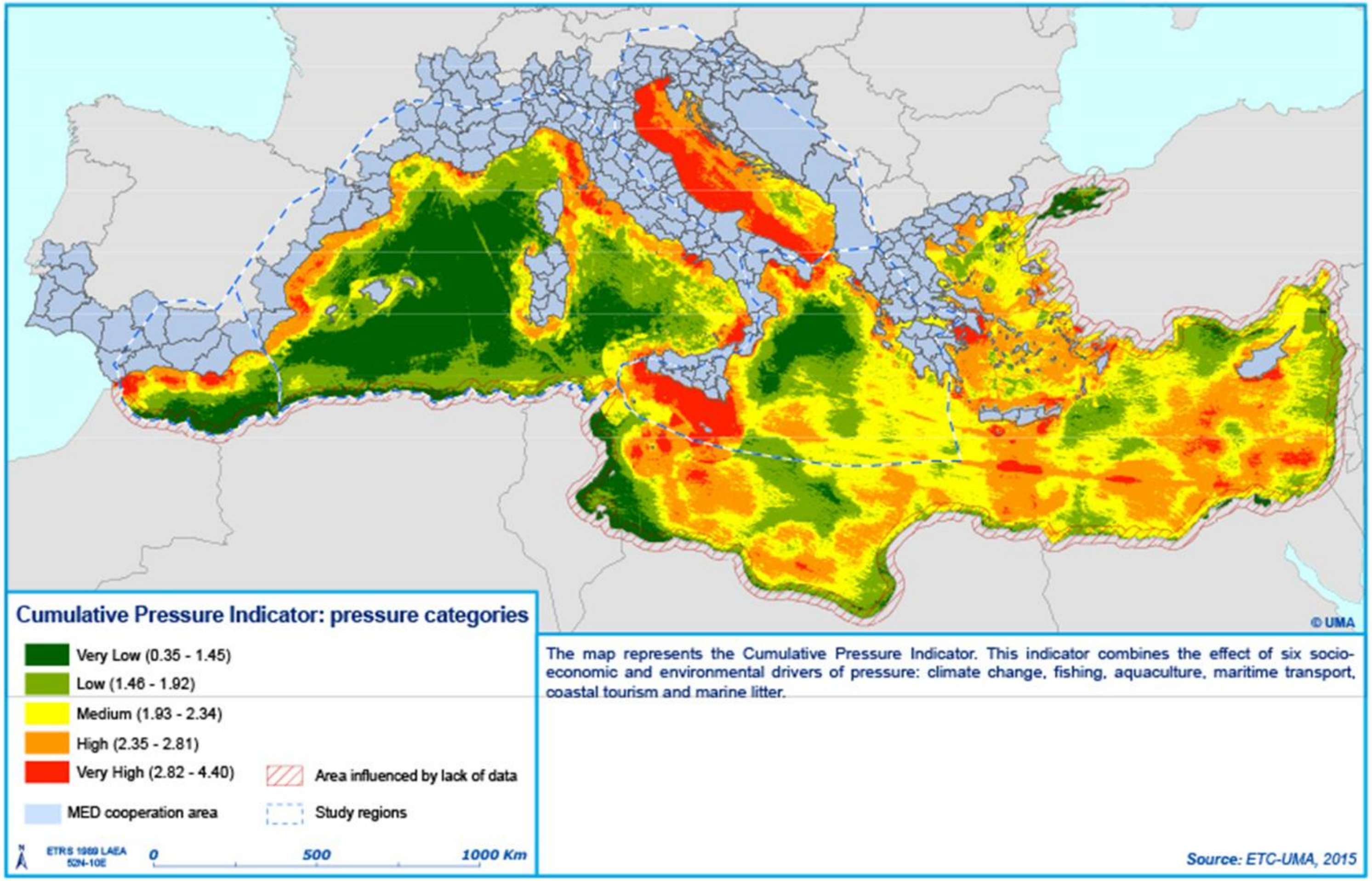


Figure 10: Identification of cumulative pressure areas

Source: Med-IAMER project (2015)

Building on previous analysis and the typology set in Deliverable 3.16.1, 'Hot spots' of tourism pressures in relation to other coastal and maritime uses have been identified. Areas with recorded high pressures from different economic activities (Fishing, Aquaculture, Energy Extraction, Agriculture and Maritime Transport) have been correlated with mature and developing tourism destinations with high dynamic. The results are presented by country and in color scale according to the type of destination and intensity of tourism activity in Table 6 (for definitions on typology see 3.16.1). Areas with no interaction recorded between tourism and other economic activities are marked with an x.

The table can be assessed a) horizontally, showing potential pressured areas from the interaction between tourism and a specific economic activity in relation to tourism intensity in each specific area and/or b) vertically, highlighting potential hotspots from the cumulative impacts of various economic activities in each destination. It should be noted that, based on existing knowledge, the intensity of tourism development may prove critical to the emergence of conflicts or the configuration of synergies between tourism and other economic activities.

Table 6: 'Hot spots' of tourism pressures in relation to other coastal and maritime uses

Potential Hotspots	Spain						Greece																France	
	Malaga(SP)	Granada(SP)	Tarragona(SP)	Valencia(SP)	Barcelona(SP)	Girona(SP)	Attiki(GR)	Chalkidiki(GR	Dodekanisa(GR)	Zakynthos(GR)	Kerkyra(GR)	Rethymno(GR)	Irakleio(GR)	Lasithi(GR)	Kerkyra(GR)	Argolida(GR)	Kefallinia(GR)	Ileia(GR)	Messinia(GR)	Lesvos(GR)	Kavala(GR)	Rodopi(GR)	Hérault(FR)	Bouches-du-Rhône(FR)
Fishing	High Share-High Growth	High Share-High Growth	High Share-High Growth	High Share-Medium Growth	High Share-Medium Growth	X	High Share-High Growth	High Share-High Growth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Aquaculture	X	X	X	X	X	High Share-Medium Growth	X	X	High Share-High Growth	X	X	X	X	X	High Share-Medium Growth	Low Share-High Growth	X	X	X	X	X	X	High Share-Medium Growth	X
Energy extraction	X	X	High Share-High Growth	X	High Share-Medium Growth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	High Share-Medium Growth
Agriculture	X	High Share-High Growth	High Share-High Growth	High Share-Medium Growth	X	X	X	X	X	High Share-High Growth	High Share-High Growth	High Share-High Growth	High Share-High Growth	High Share-High Growth	High Share-Medium Growth	X	Low Share-High Growth	Low Share-High Growth	Low Share-High Growth	Low Share-High Growth	Low Share-High Growth	Low Share-High Growth	X	X
Maritime Transport	X	X	High Share-High Growth	High Share-Medium Growth	X	X	High Share-High Growth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	High Share-Medium Growth

Potential Hotspots	Italy																					Mt-Cy-Hr		
	Napoli(IT)	Genova(IT)	Palermo(IT)	Venezia(IT)	Padova(IT)	Livorno(IT)	Lecce(IT)	Messina(IT)	Udine(IT)	Roma(IT)	Salerno(IT)	Lucca(IT)	Ravenna(IT)	Forli-Cesena(IT)	Savona(IT)	Sassari(IT)	Calabria(IT)	Siracusa(IT)	Ragusa(IT)	Brindisi(IT)	Ogliastra(IT)	Malta	Cyprus	Istria(HR)
Fishing	X	High Share-Medium Growth	High Share-Medium Growth	High Share-Medium Growth	High Share-Medium Growth	High Share-Medium Growth	X	X	X	High Share-Low Growth	X	High Share-Low Growth	High Share-Low Growth	High Share-Low Growth	X	Low Share-High Growth	Low Share-High Growth	Low Share-High Growth	X	X	X	X	X	High Share-High Growth
Aquaculture	High Share-High Growth	X	X	High Share-Medium Growth	High Share-Medium Growth	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Energy extraction	X	X	X	X	X	X	High Share-Medium Growth	X	X	High Share-Low Growth	X	X	High Share-Low Growth	High Share-Low Growth	High Share-Low Growth	X	X	Low Share-High Growth	X	X	X	X	X	High Share-High Growth
Agriculture	X	X	High Share-Medium Growth	X	High Share-Medium Growth	X	High Share-Medium Growth	High Share-Medium Growth	High Share-Medium Growth	High Share-Low Growth	High Share-Low Growth	X	X	X	X	X	Low Share-High Growth	X	Low Share-High Growth	Low Share-High Growth	Low Share-High Growth	X	High Share-Medium Growth	X
Maritime Transport	High Share-High Growth	High Share-Medium Growth	X	High Share-Medium Growth	X	High Share-Medium Growth	X	High Share-Medium Growth	X	X	X	X	X	X	X	X	Low Share-High Growth	X	X	X	X	High Share-High Growth	X	X

High Share-High Growth	(darkest shade)
High Share-Medium Growth	(medium shade)
High Share-Low Growth	(light shade)
Low Share-High Growth	(lightest shade)

3. Towards a methodological approach for assessing land use conflicts and land sea interactions at local scale

3.1 Review of existing research on land use conflict assessment

Several approaches and methodologies have been developed in order to identify land use compatibility and potential conflicts between neighbouring land uses. Reviewing the existing literature, these approaches can be grouped in three wider methodological categories for identifying potential land use conflicts through the use of: a) qualitative data and statistical models, b) participatory mapping and risk assessment systems and c) pressure evaluation matrices. Typical examples for each group of methodological approach are given in the following sections.

Methods for identifying potential land use conflicts using qualitative data and statistical models

Torre et al. (2014) developed a multidimensional approach to identify conflict patterns based on the combination and triangulation of different sources of data collection and data processing. The survey resulted in the setup of a Conflict Database that incorporates three main data tables (Figure 11): a) variables determining the location of conflicts, b) variables describing the conflicts according to sectional categories and c) information regarding the actors involved. The structure of the database focuses on the quantification and coding of data as well as on enabling comparisons between different data sources and survey areas. The conclusions drawn from the study highlighted the wide range and high diversity of land use conflicts depending on the activities, the surrounding uses, the territory in which they occur and the profile of the actors involved (Torre et al., 2014).

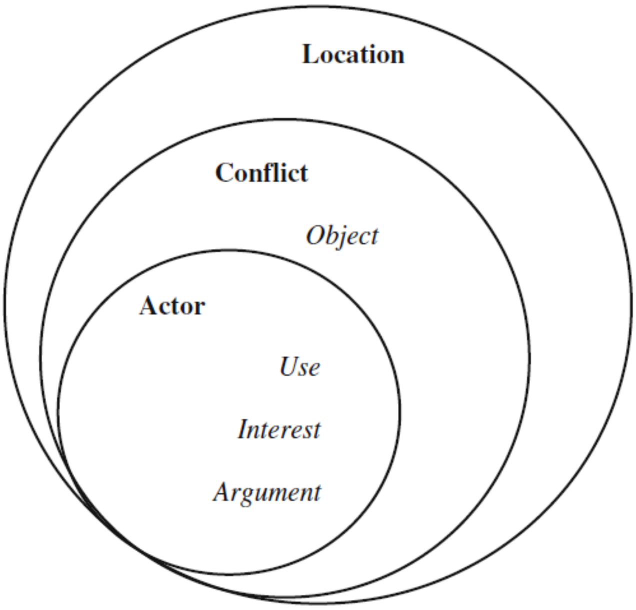


Figure 11: Graph representing the Conflict Database structure

Torre et al., 2014

Yang and Zhu (2013) followed a different approach by using the Pressure-State-Response (PSR) model and Fuzzy Mathematics Method to define and evaluate the types and intensity of land use conflicts. It is a combined method of quantitative and qualitative data where the type of conflicts can be determined through site visits and research whereas land use intensity and conflict mechanisms can be analyzed with mathematical models.

More specifically, Yang and Zhu (2013) defined a Regional Comprehensive Index of Land Use conflict Intensity (ILU) to measure the development degree of regional land use conflicts. Pressure indicators can be selected according to specific conditions of regional development and determined with correlation analysis and main component analysis of various influencing factors (Table 7).

Table 7: Evaluation index system of intensity of land use conflicts

Criteria	Indices	Weight
Pressure	Pressure indices reflect the influence and threats posed to the environment by human activities as well as the utilization intensity of resources. Example: per capita arable land area X_i	Weight value of each index determined with the use of specific calculation methods such as Analytic Hierarchy Process (AHP)
State	State indices reflect the changes of factors of land use environment, referring to land material, economic output and resources use efficiency. Example: arable land percentage X_i	
Response	Response indices refer to actions taken o mitigate, prevent or restore unfavorable changes of the land use system. Example: ratio of environmental protection investment to fiscal expenditure X_i	

Yang and Zhu, 2013

Using a weighting function to calculate each index, the ILU is calculated as follows:

$$ILU = \sum_{i=1}^{3} \left(\sum_{j=1}^{n} X_{ij} W_{ij} \right) R_i$$

where X_{ij} is the standardized value of the j-th individual index of the i-th category index, W_{ij} is the weight corresponding to the j-th individual index of the i-th category index and R_i is the weight of the i-th category index (Yang and Zhu, 2013).

Methods for identifying potential land use conflicts using participatory mapping and risk assessment systems

The use of GIS applications in local and regional land use planning has increased significantly over the past years. The use of advanced GIS techniques and spatial data sets to identify areas of potential land use conflict and produce land use conflict maps have been presented in several research papers and case studies (Brown and Raymond, 2013).

Brown and Raymond (2013) presented a new conceptual model (Figure 12) of land use conflict potential where conflicts emerge through the mapping of values and preferences of the local stakeholders involved. The model is based on the assumption that the highest potential for land use conflict will occur in areas where there is development preference disagreement and high landscape value intensities whereas the lowest potential will take place in areas where agreement on land use is combined with low place importance.

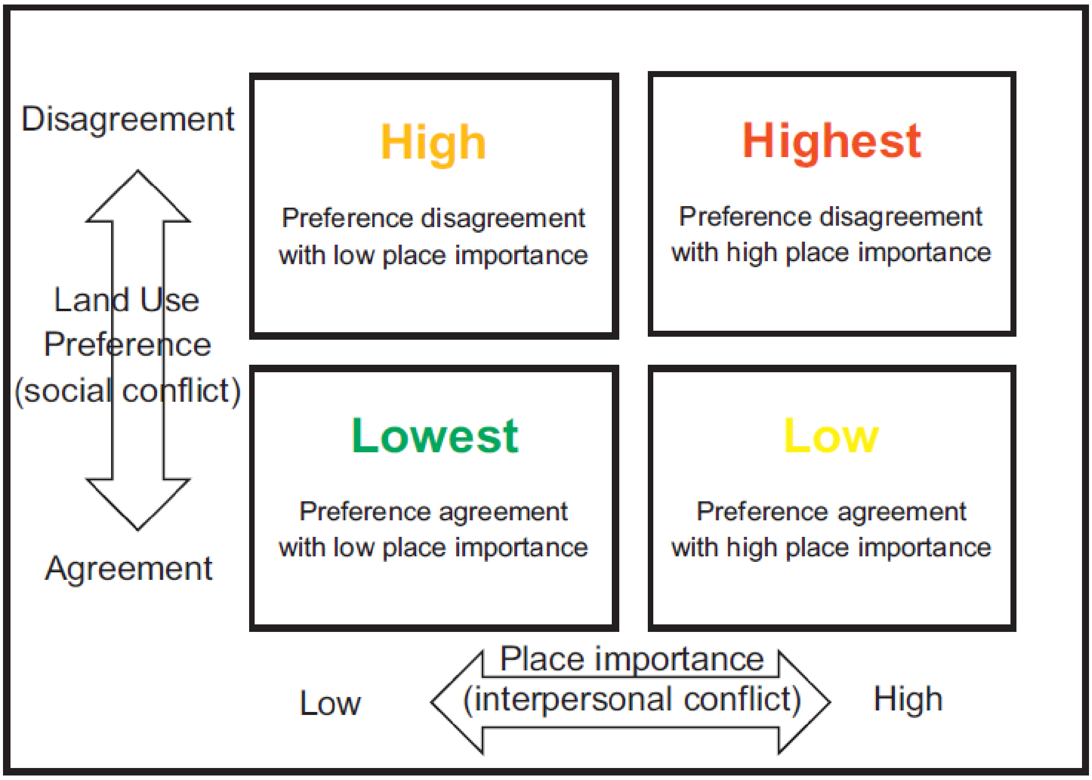


Figure 12: Land use conflict potential as a combination of the level of agreement on land use preferences and place importance

Brown and Raymond, 2013

The model was operationalized in a case study area by using GIS spatial data sets and two types of land use as examples to how land use conflict potential can be identified and mapped in the region. Using a series of statistical methods and spatial data that measure the two dimensions of conflict potential (social and interpersonal), Brown and Raymond (2013) developed an index (PVS) that combines both dimensions and presented regional maps comprised from the values and preference indices.

The preference and value score (PVS) represents a conflict potential index where higher scores are associated with higher conflict potential:

$$PVS = \frac{MAX(MIN(P_S, P_O), 0.1)}{MAX(P_S P_O)} * V_c$$

where PVS is the preference and value score per sampling grid cell, P_S is the number of preferences supporting the land use, and P_O is the number of preferences opposing the land use, and V_c is the total count of all landscape values in the cell (Brown and Raymond, 2013).

Mapping the results in the selected case study area (using residential development as an example)(Figure 13), Brown and Raymond (2013) indicated that the combined conflict index is influenced by both the value and preference dimensions of conflict potential and that larger numbers of the index show increasing conflict potential.

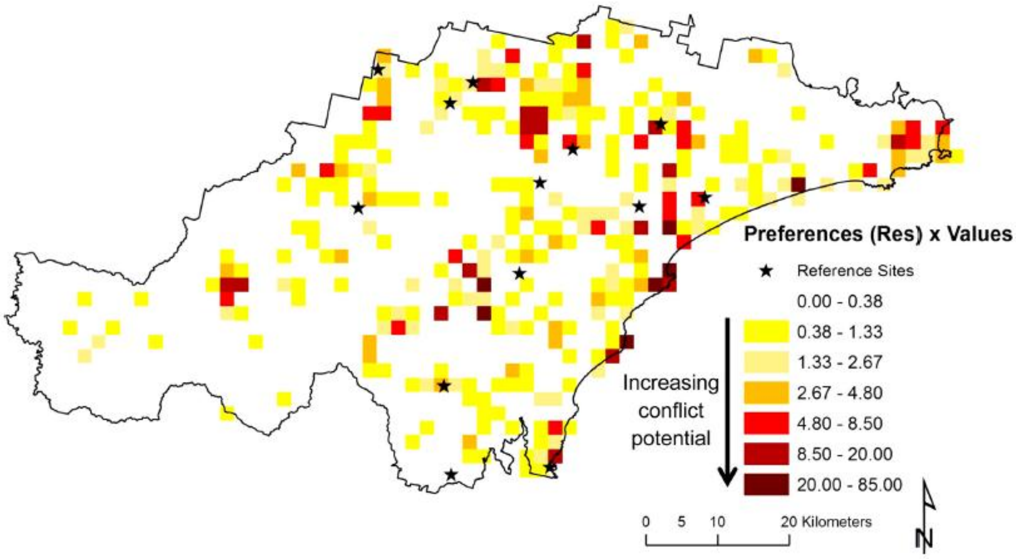


Figure 13: Map of conflict potential for residential development[1]

Brown and Raymond, 2013

In a similar stakeholder-oriented approach, a land use suitability analysis was developed from the Land Use Conflict Identification Strategy (LUCIS). The LUCIS model aims to identify conflicts between different land uses and balance those conflicts according to user-defined criteria, using ArcGIS to perform raster-based land use suitability analysis. It is based on a rating system where major stakeholder groups (urban, agriculture and ecological significance in this case) evaluate the available lands according to their particular preferences. By comparing the results,

[1] Map of conflict potential for residential development derived from the difference in mapped residential development preferences (in each sampling grid cell) that are amplified (multiplied) by the number of landscape values mapped in each cell (Brown and Raymond, 2013).

areas of potential conflicts emerge (LUCIS Technical Report). The process followed in LUCIS is shown in Table 8:

Table 8: The six steps comprising LUCIS process

Step	Description
1	Define goals and objectives that become criteria for determining suitability
2	Inventory data resources relevant to each goal and objective
3	Analyze data to determine a relative suitability for each goal
4	Combine the relative suitabilities of each goal to determine preference
5	Normalize and collapse the preferences for each land use into three categories – high, medium and low
6	Compare the ranges of land use preference to determine likely areas of conflict

LUCIS Technical Report

Suitability analysis is performed for all the goals identified using ArcGIS. The next step involves assigning preference to the suitability rasters, meaning that each stakeholder group must rate the individual goals according to their relative importance. In order to compare the rasters, each one is normalized and their values reflect three categories - high, medium and low preference. The preference rasters are then combined to create the land use conflict raster (Figure 14).

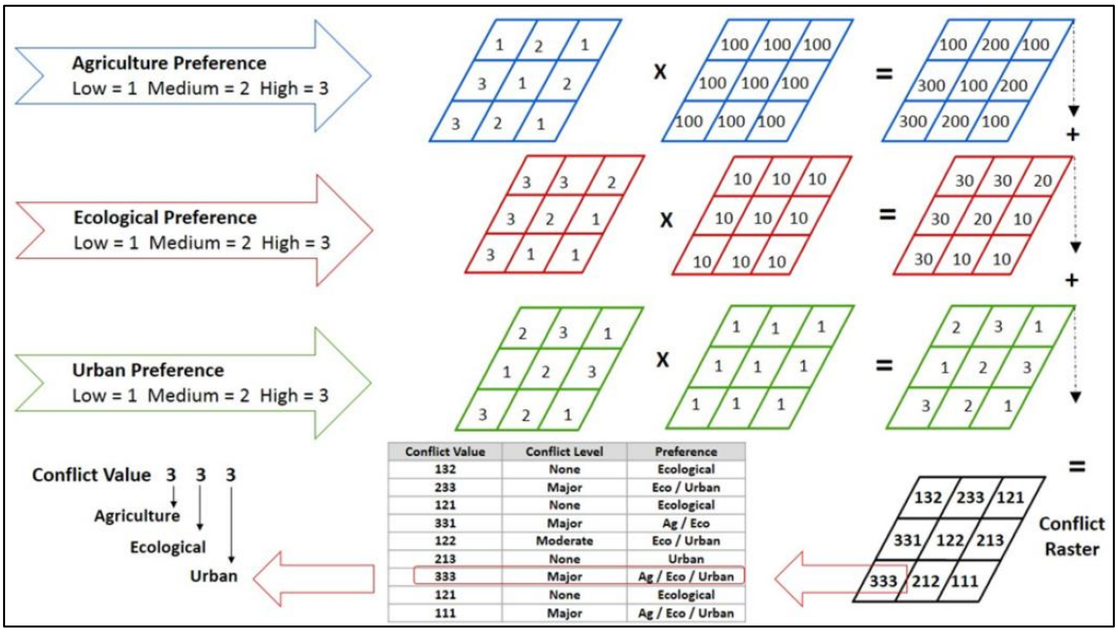


Figure 14: Combination of preference rasters to create land use conflict raster

LUCIS Technical Report

LUCIS uses three classifications to rate land use conflicts – none, moderate and major. In cases where a single land use type has the highest preference value and the other land uses in the conflict score have lower values, there is no conflict (none) recorded. Moderate conflicts are recorded when two land uses have the same preference value and no other land use type has a higher value. In case all land use types have the same preference values, the conflict is recorded as major (LUCIS Technical Report).

In the same context, Land Use Conflict Risk Assessment (LUCRA) was developed by the Department of Primary Industries on behalf of the NSW Government to identify potential land use conflicts and assess the associated risk of occurrence (NSW/Department of Trade and Investment, 2011). The process followed in LUCRA is shown in Table 9:

Table 9: The four steps comprising LUCRA process

Step	Description
1	Gather information about proposed land use change and associated activities
2	Evaluate the risk level of each activity
3	Identify risk reduction management strategies
4	Record LUCRA results

NSW/Department of Trade and Investment, 2011

LUCRA uses a risk ranking matrix – from 25 being the highest magnitude of risk to 1 being the lowest- to rate the identified potential land use conflicts. The matrix is composed from five levels probability and five levels of consequence to identify the risk level of each potential conflict (Figure 15) (NSW/Department of Trade and Investment, 2011).

Probability table

Level	Descriptor	Description
A	Almost certain	Common or repeating occurrence
B	Likely	Known to occur, or 'it has happened'
C	Possible	Could occur, or 'I've heard of it happening'
D	Unlikely	Could occur in some circumstances, but not likely to occur
E	Rare	Practically impossible

Measure of consequence

Level	Descriptor	Description
1	Severe	Severe and/or permanent damage to the environment
2	Major	Serious and/or long-term impact to the environment
3	Moderate	Moderate and/or medium-term impact to the environment and community
4	Minor	Minor and/or short-term impact to the environment and community
5	Negligible	Very minor impact to the environment and community

Risk Ranking Matrix

PROBABILITY	A	B	C	D	E
Consequence					
1	25	24	22	19	15
2	23	21	18	14	10
3	20	17	13	9	6
4	16	12	8	5	3
5	11	7	4	2	1

Figure 15: Process of LUCRA risk ranking matrix

NSW/Department of Trade and Investment, 2011

Methods for identifying potential land use conflicts using pressure evaluation matrices

A more straightforward method in identifying and visualizing potential land use conflicts is the use of Pressure Evaluation Matrices (PEMs). These templates provide a visualized impact assessment of human activities (potential pressures) on selected environmental factors and have served in several cases as decision support tools, especially in MSP (Balance Technical Report, 2008).

In this context, Tyler-Walters et al. (2001) in Marine Life Information Network (MarLIN) developed a "*Maritime and coastal activities to environmental factors*" matrix (Figure 16) to highlight the environmental factors that were likely to change due to specific maritime and coastal activities.

The matrix establishes links between activities and environmental factors in the following cases:

- the environmental effects of a given activity are known
- a relationship between a given activity and environmental effects has been reported
- an activity is considered likely to change an environmental factor

A link is either regarded as *probable* or *possible*. Probable are the links where the activity is known to change the relevant environmental factor in most cases whereas possible are the links are where an activity is likely to change the relevant environmental factor in certain cases or under particular circumstances. The selected activities and factors comprising the matrix should be used as guiding examples and not as definitive or exhaustive. The matrix does not indicate the magnitude of the environmental effects nor the cumulative impact from multiple activities. As underlined in the report, a detailed study of the magnitude of conflicts should be site specific (Tyler-Walters et al., 2001).

Building on MarLIN experience, a Pressure Evaluation Matrix (Figure 17) was developed in the frame of BALANCE project for Baltic Sea Management (INTERREG IIIB) presenting the relationship between specific human activities and their estimated degree of impact on specific landscapes, habitats and species (Balance Technical Report, 2008).

		ENVIRONMENTAL FACTORS																							
		Physical													Chemical							Biological			
Coastal & Maritime Activities / Events	Sub-activites /events	Substratum loss	Smothering	Suspended sediment	Desiccation	Changes in emergence regime	Changes in water flow rate	Changes in temperature	Changes in turbidity	Changes in wave exposure	Noise disturbance	Visual presence	Abrasion / Physical disturbance	Displacement	Synthetic compound contamination	Heavy metal contamination	Hydrocarbon contamination	Radionuclide contamination	Changes in nutrient levels	Changes in salinity	Changes in oxygenation	Introduction of microbial pathogens / parasites	Introduction of non-native species	Selective extraction of target species	Selective extraction of non-target species
Aquaculture	Fin-fish		R	R			R		R		P	P	R		R				R		R	R	R		
	Macro-algae		P	P			P		P		P	P							P		P	R	R	R	R
	Predator control										R	R			P										
	Shellfisheries		R	R			R		R		R	R	R		R				R		R	R	R	R	R
Climate change	Current change						R	R	R										R	P		R	R		
	Sea level change				R	R	R			R										R					
	Temperature change				R			R	R										R		R	R	R		
	Weather pattern change				R			R														R	R		
Coastal defence	Barrage	R	R	R	R	R	R		R	R	R	R	R	R	P	P	P		R	R	R				
	Beach replenishment	P	R	R	R	R	R		R	R	R	R	R	R	P	P	P		R		R				
	Groynes	P	P	R	R		R		R	R		R		P							P				
	Sea walls / breakwaters	P	P	R	R	R	R		R	R		R		P							P				
Collecting	Bait digging	R	R	R	R				R		R	R	R	R										R	
	Bird eggs										R	R	R											R	
	Curios										P	P	R	R										R	R
	Higher plants	R		R			R				R	R	R	R					R					R	R
	Kelp & wrack harvesting	R		R	R		R		R	R	R	R	R	R					R		R			R	R
	Macro-algae	R			R		R				R	R	R	R	P									R	R
	Peelers (boulder turning)		R		R	R	R				R	R	R	R										R	
	Shellfish	R	R	R	R				R		R	R	R	R										R	R
Development	Construction phase	R	R	R	R	R	R	P	R	R	R	R	R	R	P	P	P	P	R	R	R				
	Artificial reefs		P	R			R		R	R					P	P	P		R		R				
	Communication cables		P	R			R		R			R													
	Culverting lagoons			R	R	R	R	R	R	P									R	R	R				
	Dock/port facilities		R	R			R	P	R	R	R	R	R	R	R	P	R	P	R	P	R	R	R		
	Land claim	R	R	R	R	R	R		R	R									R	R	R				
	Marinas		R	R	R	P	R	P	R	R	R	R	R	R	R	P	R		R		R	R	R		
	Oil & gas platforms		R				R		R		R	R	R		R	R	R		R		R				
	Urban			R					R		R	R	R		R	R	R		R	R	R	R			
Dredging	Captial dredging	R	R	R	R	R	R		R	R	R	R	R	R	P	P	P	P	R	P	R				
	Maintenance dredging	R	R	R					R		R	R	R	R	P	P	P	P	R		R				
Energy generation	Nuclear power generation		P	R				R	R		R	R			R	P		P	R	P	R				
	Power stations		P	R				R	R		R	R			R	R	P		R	P	R				
	Renewable (wind/tide/wave)		P	P	P	P	R		P	R	P	P			R		P				P				
Extraction	Maerl	R	R	R			R		R		R	R	R	R					R		R			R	R
	Rock/minerals (coastal quarrying)	R	R	R					R		R	R	R	R	R	R	R		R		R				
	Oil & gas		R								R	R			R	R	R		R		R				
	Sand / gravel (aggregates)	R	R	R			R		R	P	R	R	R	R	P	P	P	P	R		R				
	Water resources (abstraction)				P	P	R												R	R	R				
Fisheries/ Shellfisheries	Benthic trawls (e.g. scallop dredging)	R	R	R					R		R	R	R	R	P	P	P		R		R			R	R
	Netting (e.g. fixed nets)										R	R	R	R										R	R
	Pelagic trawls										P	P												R	R
	Potting / creeling		R								R	R	R	R										R	R
	Suction (hydraulic) dredging	R	R	R					R		R	R	R	R	P	P	P		R		R			R	R
Recreation	Angling										R	R	R	P										R	R
	Boating / yachting								P		R	R	R		R	P	R		R		R	R	R		
	Diving / dive site										R	R	R	R										R	
	Public beach										R	R	R						P						
	Tourist resort			R					R		R	R	R		R	R	R		R		R				
	Water sports										R	R	R		R	P	R								
Uses	Animal sanctuaries										P	P	P						P			P	P		
	Archaeology	R	R	R					R		R	R	R	R	P	P	P		R		R				R
	Coastal farming		R	R					R		R	R	R		R	P	R		R		R	P			
	Coastal forestry		R	R					R		R	R	R		R	P	R		R		R				
	Education/interpretation										R	R	R	R										R	R
	Military										R	R	R		P	P	P	P							
	Mooring / beaching / launching		R	R			R		R		R	R	R	R	R	P	R					P	P		
	Research	P									R	R	R	P	P	P	P		P			P	P	R	P
	Shipping		P	R					R		R	R	R	R	R	R	R	P	R		R	R	R		

Figure 16: Maritime and coastal activities to environmental factors matrix

Tyler-Walters et al., 2001

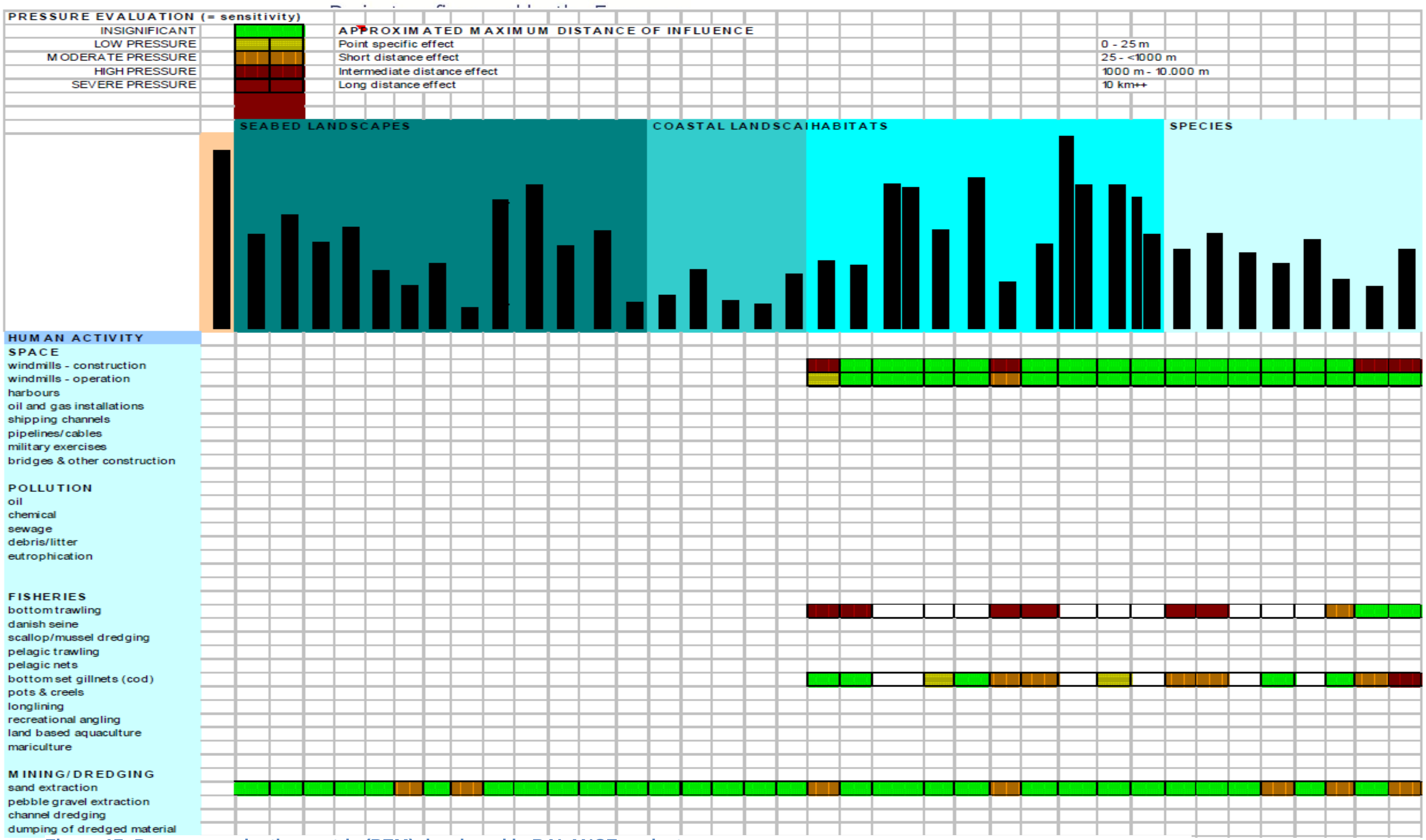


Figure 17: Pressure evaluation matrix (PEM) developed in BALANCE project

Balance Technical Report., 2008

Taking a step further towards the identification of land use conflicts, Ehler and Douvere (2009) presented a compatibility matrix (Figure 19) that assesses the level of compatibility between neighbouring land uses. The level of compatibility serves as an index of potential land use conflicts or synergies.

A typical application of the compatibility matrix is presented in Massachusetts Integrated Coastal Ocean Management Plan. The matrix is used to organize and visualize the potential interactions between different uses and between uses and resources. Part of the matrix is shown in Figure 18 (Massachusetts Ocean Partnership, 2009). Similar approach was followed in Seychelles Marine Spatial Planning (MSP) Initiative where compatibilities between uses were identified and articulated in the form of a compatibility matrix (SMSP, 2014).

This matrix represents existing conditions and does not consider possibililties related to advances in technologies/science		Renewable Energy			Sand & Gravel Mining	Navigation		
		Wind	Tidal (demonstration project)	Wave (demonstration project)	Sand & gravel mining	Shipping	Anchorages	Ferry routes
Renew-able Energy	Wind							
	Tidal							
	Wave							
Sand & Gravel Mining	Sand and gravel mining					T		T
Navigation/ Transportation	Shipping				T			
	Anchorages							
	Ferry routes				T			

Figure 18: Land use compatibility matrix (partial) for Massachusetts Integrated Coastal Ocean Management Plan

Massachusetts Ocean Partnership, 2009

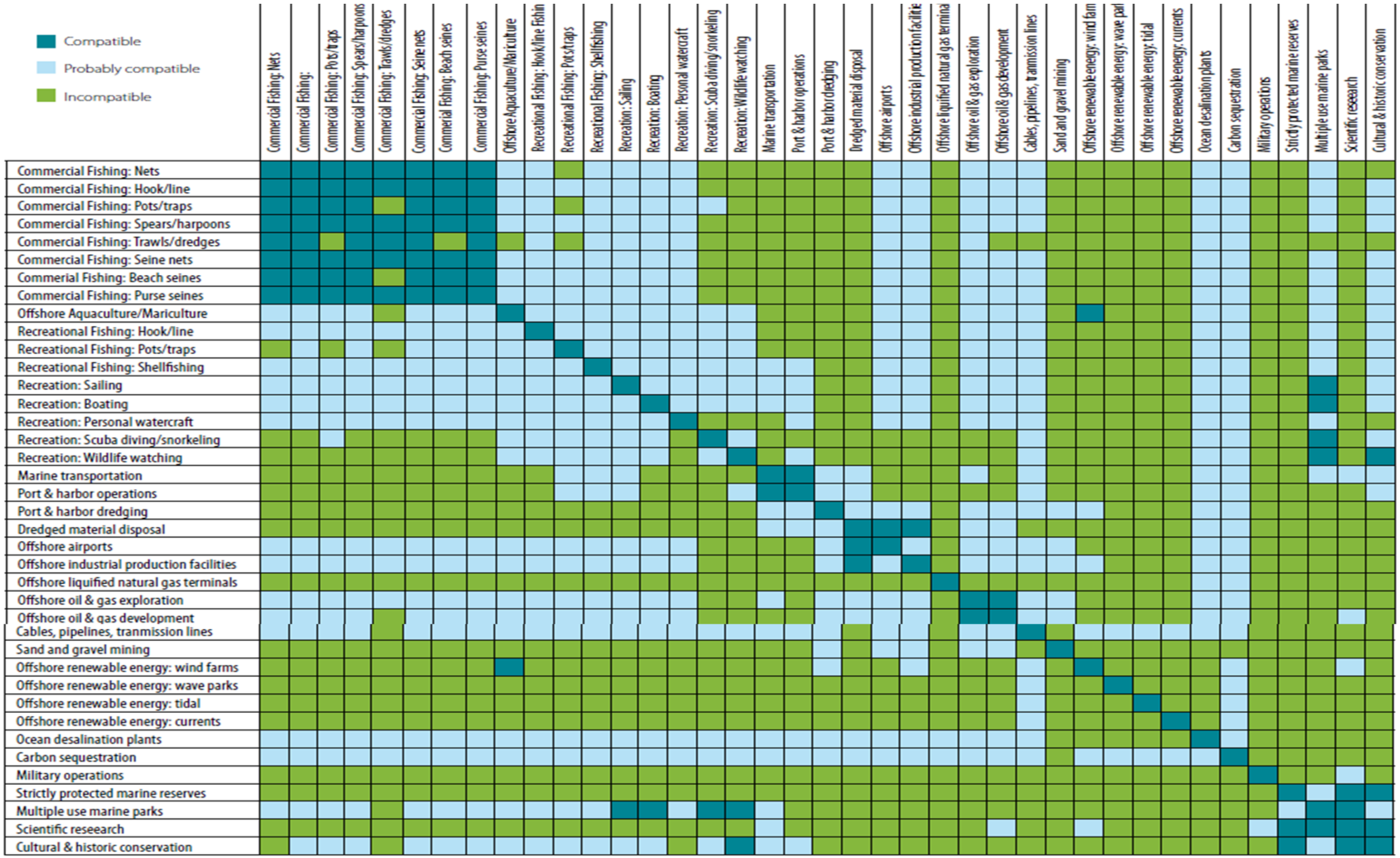


Figure 19: Land use conflicts and compatibility matrix

Ehler and Douvere, 2009

In the same context, Papatheochari et al. (2015) highlighted the contribution of COEXIST project in identifying and quantifying the existing conflicts and synergies between different types of activities in coastal areas (Figure 20). In the framework of COEXIST project, expert knowledge and numerical scoring was used to calculate the *"Direct[2] Spatial Conflict Score"* of different activities in marine coastal zones. The process involves three steps: a) Definition of activities of interest; b) Setting spatial and temporal attributes of each activity; and c) Applying rules to calculate the conflict score of each pair of activity. The outcomes of direct spatial conflict scores may also be displayed in maps with the use of GRID (GeoReference Interaction Database – tool also developed in the framework of COEXIST project) (Schulze et al., 2013).

	COASTAL CONSTRUCTIONS	HARBORS	URBAN RESIDUES	URBAN DEVELOPMENT	DUMPING	CABLES AND PIPELINES	OIL AND GAS EXTRACTION	POTS	FYKE NETS	GILLNETS	TRAMMEL NETS	OTTER TRAWL	PELAGIC TRAWL	RAPIDO TRAWL	HYDRAULIC DREDGES	MUSSEL HARVESTING	ARTIFICIAL REEFS	MPAs	NATURA 2000 SITES	REFURBISH BEACHES	SHIP WRECKS	BEACH TOURISM	RECREATIONAL DIVING	MARINAS	RECREATIONAL FISHING	PASSENGER AND CARGO
MUSSEL FARMS	0	0	0	0	3	5	5	5	5	5	5	5	5	5	2	0	3	6	0	0	4	0	5	5	5	5
COASTAL PROTECTION		0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	3	3	3	0	3	0	3	0	3
HARBORS			0	5	0	6	0	0	0	0	0	0	0	0	0	0	0	6	6	0	0	5	0	0	3	3
URBAN RESIDUES				0	0	0	0	0	0	0	0	0	0	0	0	2	0	6	6	0	0	5	5	0	5	0
URBAN DEVELOPMENT					0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	0	5	0	5	0	0
DUMPING						0	5	0	4	3	3	3	3	0	3	3	5	6	6	0	4	0	4	0	0	0
CABLES AND PIPELINES							3	6	6	6	6	6	6	6	6	6	6	6	6	0	6	4	6	6	6	0
OIL AND GAS EXTRACTION								5	5	5	5	5	5	5	5	0	0	6	6	0	0	5	5	0	5	0
POTS									4	4	4	4	4	4	4	0	3	0	0	0	5	0	5	0	5	5
FYKE NETS										4	4	4	4	4	4	0	5	0	0	0	5	0	5	0	5	5
GILLNETS											4	4	4	4	4	4	3	0	0	0	3	0	5	0	5	5
TRAMMEL NETS												4	4	4	4	4	3	0	0	0	3	0	5	0	5	5
OTTER TRAWL													1	1	1	0	5	6	0	0	4	0	1	0	1	1
PELAGIC TRAWL														1	1	0	5	6	0	0	4	0	1	0	1	1
RAPIDO TRAWL															1	0	5	6	0	0	4	0	1	0	1	1
HYDRAULIC DREDGES																0	5	6	0	0	4	0	1	0	1	2
MUSSEL HARVESTING																	3	0	0	0	3	0	4	0	4	2
ARTIFICIAL REEFS																		3	3	0	3	0	3	0	3	0
MPAs																			3	3	3	0	0	0	0	0
NATURA 2000 SITES																				3	0	0	3	3	0	0
REFURBISH BEACHES																					0	3	0	0	0	0
SHIP WRECKS																						0	3	0	3	0
BEACH TOURISM																							0	0	0	0
RECREATIONAL DIVING																								0	1	1
MARINAS																										3
RECREATIONAL FISHING																										1

Figure 20: Interaction matrix of the human activities carried out in the coastal area of Marche region – the level of interaction is scored between 0 and 6 (red squares: conflicts; green squares: synergies; white squares: no interaction)

Papatheochari et al., 2015

[2] Immediate competition for space is considered "direct" while adverse or beneficial effects from one activity on another are considered "indirect" when mediated by changes in the condition of the space used by the second activity. The matrix of conflict scores covers the direct spatial conflicts.

3.2 Developing a comparative approach on land use conflict assessment

Based on existing knowledge and previous analysis, the examination of conflicts and compatibilities can only be attempted at a local scale. The current approach focuses on the development of a specific methodological framework for assessing land use conflicts in the Mediterranean region and identifying potential impacts at a local scale, taking into account the indications highlighted in previous sections.

The comparative approach is based on the review of existing assessment methodologies described above and considers both the compatibility and intensity of the predominant economic activities identified in Deliverable 3.6.1. The objective is to identify possible conflicts and synergies among coastal and maritime activities, especially in relation to tourism, and provide a comparative analysis of pressures and impacts in each local area. In this context, land sea interactions can be assessed:

- Vertically, covering the interactions between land and sea that include the flows (accessibility, transportation, networks etc), the coastal dynamics (socio-economic pressures) and coastal ecosystems (environmental pressures)
- Horizontally, addressing the interactions among coastal and maritime activities that cover both land and sea based on the interactions identified in 3.6.1, in order to prioritize the emphasis that should be given to the co-evolution of land and sea interactions

More specifically, two matrices need to be developed at a local level, in order to examine:

- The interactions among coastal and maritime activities in terms of compatibility (including probability) and intensity
- The impacts of coastal and maritime activities on social, economic and environmental aspects.

Assessment in terms of compatibility and intensity

For the purposes of the current methodological approach, "spatial compatibility" is hereby defined as the ability of different land uses to share the same physical space and will be used as an assessment tool to point out potential conflicts between different uses (Gee et al., 2006). More specifically, "spatial compatibility" will be used in the context of Co-evolve as a tool to differentiate spatially impacting and non-impacting land uses and evaluate the ability of different land uses to co-exist within limited space.

Although acknowledging the several constraints and knowledge gaps encountered in international literature in defining the level, pattern and dynamic of land use interactions, intensity assessments of the most significant interactions between tourism and other activities can also be integrated in the proposed framework. In this respect, the complexity and multidimensional nature (social, economic and environmental aspects) of the factors that influence land use conflicts need to be taken into consideration (Erb et al., 2013· Yang and Zhu, 2013).

The interactions of the most important activities taking place can be identified through the development of a simple matrix, indicating *Intensity* (1=None, 2=Low, 3=Moderate, 4=High, 5=Very high) and *Compatibility* (1= Compatible, 2= Probably compatible, 3= Incompatible) (Table 10). The average of both scores will provide a synthetic index under which a comparative analysis could be achieved, in order to understand the activities showing the highest levels of pressure in terms of co-existing.

Table 10: Interactions assessment matrix

	Tourism		Fisheries		Aquaculture		Energy		Transport		Agriculture		Other	
Tourism														
Fisheries														
Aquaculture														
Energy														
Transport														
Agriculture														
Other														
	I	C	I	C	I	C	I	C	I	C	I	C	I	C

Intensity		Compatibility	
1	None	1	Compatible
2	Low	2	Probably compatible
3	Moderate	3	Incompatible
4	High		
5	Very high		

I	Intensity
C	Compatibility

Impact assessment of coastal and maritime activities

Following international practices (European Communities, 1999; IFC, 2013), impact assessment is integrated as a key step within the proposed framework in order to fully ascribe the multidimensional and complex nature of interactions and ensure that the associated impacts are taken into consideration in decision making processes and sustainable development policies. Towards this direction, the cumulative impacts that arise from the interaction of tourism with other important economic activities and would not be expected in the case of a stand-alone activity, can be assessed and analyzed in terms of their social, economic and environmental aspects.

Such approach is closely linked to the concept of an integrated multifunctional space and requires methods of assessment that go beyond static forms of zoning in order to measure cumulative impacts and evaluate the degree of compatibility of this complex form of land-sea interchange (Gee et al., 2006).

For the **i**ntera**c**tions identified in table 10, a second matrix could be developed indicating _positive impacts (+)_, _negative impacts (-)_ and _no impacts (o)_ to the Social (S), Economic (E) and Environmental (EN) conditions of each area (Table 11).

Table 11: Impact assessment matrix

Land use interaction	Impact			Short description
	Social	Economic	Environmental	
Tourism-Fisheries				Social: Economic: Environmental:
Tourism-Aquaculture				Social: Economic: Environmental:
Tourism-Energy				Social: Economic: Environmental:
Tourism-Transport				Social: Economic: Environmental:
Tourism-Agriculture				Social: Economic: Environmental:
Tourism-Other				Social: Economic: Environmental:

+	Positive impact
-	Negative impact
□	No impact

The output of the table 11 could provide indications of pressures generated by the interactions identified in table 10 contributing to the knowledge of co-evolution of human activities with coastal and maritime tourism. The synthesis of the results coming from both matrices (table 10 and 11) could prove an important insight on land-sea interactions, however, based on qualitative assessments of local stakeholders and public consultation, experts' opinion and questionnaires as well as key findings of research projects and international literature. Emphasis should be given in pilot areas and pressured coastal zones (hot spots) identified in the context of Co-Evolve, in order to provide a synthetic grid of the land sea interactions and associated impacts taking place in Mediterranean coastal destinations.

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