Deliverable D1.5

“DEVELOPMENT OF INTELLIGENT TOOLS FOR BIODIVERSITY INDICATORS”

Date: April 2017

Action Plans for Integrated Regional Monitoring Programmes, Coordinated Programmes of Measures and Addressing Data and Knowledge Gaps in Mediterranean Sea

ActionMed

11.0661/2015/712631/SUB/ENVC.2

Coordinator

Dr. Kalliopi Pagou

Project start date and duration

1st November 2015, 15 months

www.actionmed.eu

Acknowledgment

This report was produced as a result of the ActionMed (Action Plans for Integrated Monitoring Programmes of Measures and Addressing Data and Knowledge Gaps in Mediterranean Sea) project. The project was co-financed by the European Union (EU). Grant No. 11.0661/2015/712631/SUB/ENVC.2

This deliverable should be referenced as:

ActionMed deliverable 1.5 “Development of intelligent tools for biodiversity indicators” April 2017, 31p.

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EXECUTIVE SUMMARY

A new innovative BioTool named BHRA (Benthic Habitat Risk Assessment) related to Biodiversity (D1) and Seafloor Integrity (D6) descriptors, is designed to assess the interaction of habitats and pressures assessing the scale of impact (spatial extent and intensity).

Its aim is to provide a simple tool, to support scientists as well policy makers, managers, and stake-holders on MSFD monitoring requirements and Marine Spatial Planning. The product/tool can be applicable to the entire Mediterranean Sea, taking also into account the specific features within this regional sea.

The design of the GIS tool has been based on the outcomes of the UNEP/MAP Biodiversity online working group, the HELCOM Baltic Sea Impact and Baltic Sea Pressure Index (2010), and on scientific references on the vulnerability of marine ecosystems to anthropogenic threats. Thus, the main concept of the GIS tool is to relate the sensitivity of priority habitats in the Mediterranean to the pressure-type and intensity, based on their spatial distribution.

The list of priority biodiversity elements to monitor is related to the “reference list” of species and habitats included in the Initial Phase of the Integrated Monitoring and Assessment Programme (Initial Phase of IMAP) of UNEP/MAP and produced by the Biodiversity online group (UNEP(DEPI)/MED WG.420/Inf.11, 2015). The rationale for prioritizing the biodiversity elements for the initial phase of monitoring considered the Texel-Faial criteria the Pressure Exposure and their Feasibility for monitoring.

All benthic habitats and the listed major pressures (e.g. physical damage, eutrophication, etc) of the “reference list” will be included as a basis in the GIS Benthic Habitat Risk Assessment tool, when it will be fully developed. The tool is initially tested for the habitat type of seagrass meadows indicating the degree of vulnerability of this habitat type, taking into account the relevant human activities acting as pressure.

1. INTRODUCTION: DESIGNING THE BENTHIC HABITAT RISK ASSESSMENT GIS TOOL

The concept

The benthic habitats are affected by various human activities and consequent pressures, and this is reflected on environmental status classifications. The need for an assessment of anthropogenic pressures on the marine environment components has been recognized worldwide. Mapping where the pressures occur, in relation to the affected habitat type, is important for management issues. This fact will provide the basis for setting environmental targets, i.e., the reduction in pressure that is required to achieve GES. Recent methodological papers by Halpern *et al*. (2007, 2008) are the first attempts to produce a method for an assessment of the cumulative pressures that human activities are causing on the seas.

The Benthic Habitat Risk Assessment Index is a risk-ranking method designed for benthic habitats, indicating the degree of exposure of a given habitat to stressors associated with different human activities. The main idea for the BHRA methodology development is to provide an integrated and simple way to analyse and visualize the benthic habitats' sensitivity related to the pressures acting upon them, based on a sequence of spatial analysis techniques.

Actually, BHRA index is a tool or else wise a methodological approach, fully implemented within a GIS platform, for estimating the potential impacts of the anthropogenic pressures on the benthic priority habitats. The aim is to provide the whole functionality through a GIS toolbox for the assessment of the status or the potential status of a benthic habitat. A toolbox containing the required toolsets and geoprocessing steps, as well as the basic features, will be available when fully developed. The main subject of the work done during the ActionMed Project, and especially within the framework of the Activity 1, Task 1.1, Subtask 1.1.4 "Development of intelligent tool for biodiversity indicators", was to define and describe the required elements and the processing steps of the tool.

The outcomes of the UNEP/MAP Biodiversity online working group regarding the "reference list" of species and habitats to be monitored in the Initial Phase of the Integrated Monitoring and Assessment Programme (Initial Phase of IMAP) of UNEP/MAP constitute the basis of the tool. Thus, regarding this list, communities in the mediolittoral and infralittoral zones that are based on bio-construction, hard beds associated with communities of photophilic algae, seagrass meadows, hard bottom habitats associated with coralligenous communities, sciaphillic algae and semi-dark caves, deep reefs and finally maerl communities are the priority habitat types to be included (Table 1). The main pressures have been taken into account, as one of the criteria for prioritizing these biodiversity elements, and are also included as basic element of the tool (Table 2).

The progress of the availability of the spatial information in a global, regional, and local scale is critical for the cartographic representation of human pressures. The European Marine Observation and Data Network (EMODnet), the European Environmental Agency (EEA), the International Council for the Exploration of the Sea (ICES) etc, consist sources of marine data, metadata and products, which are interoperable and free of restrictions on use to public and private users. Moreover, the fact that the geospatial datasets describing human activities can be produced through GIS and Remote Sensing techniques more easily and with less cost, compared to the oceanographic-field collected data, facilitates the implementation of the proposed habitat risk assessment methodology.

Since the geospatial datasets are made available from various sources and scales or can also be produced in various scales, it is important for the tool to be designed to support the analysis on a multi-scale spatial resolution. This means, that it will be applicable for the entire Mediterranean Sea region, but also in a sub-regional or local level, taking into account the specific features within the regional sea, which is important for the comparability of the results across the whole region.

Table 1. The minimum list of the priority specific habitat types and associated communities to be monitored in the Initial Phase of the Integrated Monitoring Assessment Programme for the Mediterranean according to the UNEP/MAP Biodiversity online working group

Predominant habitats	**Specific habitat type to be monitored**	**ADDITIONAL INFORMATION: Invertebrates associated with habitats**
Seabed - mediolittoral - infralittoral rock	Communities in the mediolittoral and infralittoral that are based on bio-construction	(e.g. vermetid reefs, e.g. *Dendropoma paetreum*, Cladocora, *Astroides calicularis*, some *Cystoseira* spp. belts, ...)
Seabed - infralittoral rock	Hard beds (bottoms, substrates, reefs) associated with communities of photophilic algae	e.g. facies with *Cystoseira amentacea, Mytilus galloprovincialis, Corallina elongata/Herposiphonia secunda, Dasycladus vermisularis, Alsidium helminthochorton, Gelidium spinosum, Lobophora variegata, Cladocora caespitosa, Cystoseira brachycarpa, Cystoseira crinita, Cystoseira crinitophylla, Cystoseira sauvageauana, Cystoseira spinosa, Sargassum vulgare, Dictyopteris polydioides, Calpomenia sinuosa, Stypocaulon scoparium, Cystoseira compressa, Pterothamnion crispum/Compsothamnion thuyoides, Schottera nicaeensis, Rhodymenia ardissonei/Rhodophyllis divaricata* or facies with big hydrozoans
Seabed - mediolittoral-infralittoral sediment	Seagrass meadows	*Posidonia oceanica, Cymodocea nodosa, Zostera* sp
Seabed - circalittoral rock	Hard bottom habitats associated with coralligenous communities, sciaphillic algae and semi dark caves, deep reefs (dominated by sponges and other filter	e.g. facies with *Cystoseira zosteroides, Mesophyllum lichenoides, Lithophyllum frondosum/Halimeda tuna, Rodriguezella strafforelli, Eunicella* spp., *Lophogorgia, Paramuricea, Parazoanthus* spp. or facies of

	feeders)	*Corallium rubrum, Leptosammia* spp.
Seabed - circalittoral sediment	Maerl communities	e.g. *Lithothamnion corallioides, Phymatolithon calcareum*

Table 2. The main pressures had taken into account, as one of the criteria for prioritizing each predominant habitat according to the UNEP/MAP Biodiversity online working group. The brown colour means that the corresponding pressure is of high important for the habitat and the white is of not occurring.

Minimum list	Main pressures (binary=occurring or not: to be prioritized (ranked) for each specific representatives habitats)								
Specific habitat type to be monitored	Physical loss of habitat	Physical damage to habitat	Nutrient enrichment	Contaminants	Removal by fishing	Hydrological changes	Other disturbances to species	UW noise	NIS
Communities in the mediolittoral and infralittoral that are based on bio-construction									
Hard beds (bottoms, substrates, reefs) associated with communities of photophilic algae									
Seagrass meadows				?					
Hard bottom habitats associated with coralligenous communities, sciaphillic algae and semi dark caves, deep reefs				?	?				
Maerl communities				?					

The components

A number of geospatial datasets are required to apply the BHRA methodology. One of the basics is the reference grid on which the analysis and the processing will take place. The reference grid of EEA is the grid that is chosen and will be included in the geodatabase to be provided with the toolbox. This is a spatial layer which is based on the recommendation at the 1st European Workshop on Reference Grids in 2003 and later INSPIRES geographical grid systems and is available in EEA service as vector dataset that can be downloaded. This particular option satisfies the requirement for the methodology to be applied on a multi-scale spatial resolution according to user-defined level of the analysis, also maintaining the comparability of the results. This is achieved because the EEA grid is provided in the same coordinate reference system, ETRS89-LAEA Europe (EPSG: 3035), and in various resolutions for the member countries.

For each EEA member country, and for Europe as a whole, three polygon shapefiles are made available, according to grid resolutions of 1, 10 and 100 km (Figure 1). Being based on an equal area projection, the EEA reference grid is suitable for generalizing data, statistical mapping and analytical work, whenever a true area representation is required. Recommended grid resolutions are 100 m, 1 km, 10 km and 100 km. Alternatively, 25 m or 250 m resolution can be used for analysis purposes, where the standard 100 m or 1 km grid cell size is not appropriate (EEA 2013). The grids cover at least country borders - plus 15 km buffer - and, where applicable, marine Exclusive Economic Zones v7.0 - plus 15 km buffer - (www.vliz.be/vmdcdata/marbound). Note that the extent of the grid into the marine area does not reflect the extent of the territorial waters.

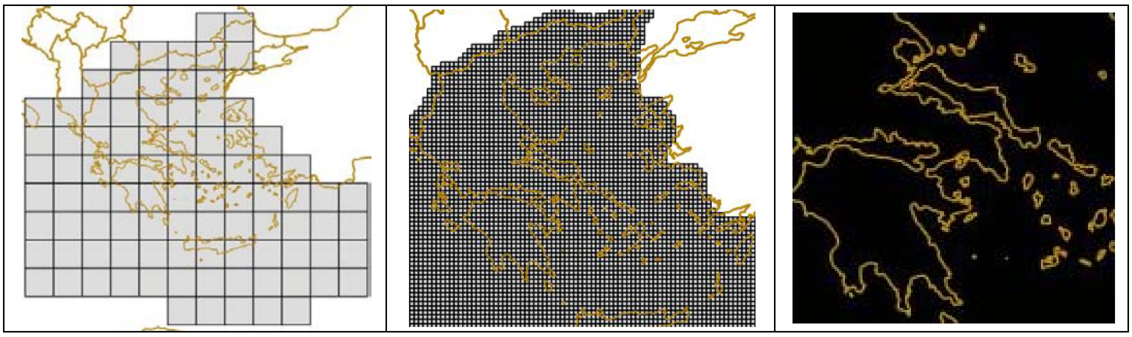


Figure 1. *EEA reference grid in various resolution for Greece (left: 100 km, center: 10 km and right: 1 km pixel size).*

The spatial distribution of the priority habitat to be assessed is also required. This should be a polygon feature or a raster dataset derived from mapping, remote sensing techniques or modeling. This layer is also important; because it defines the spatial extend of the processing. Qualitative and quantitative characteristics of the habitat are not needed at the present phase of the tool development.

The list of the main pressures affecting the health of the selected benthic habitat (Table 2) will be the guide to define the human activities and consequently the corresponding spatial datasets. The selection of the pressures according to Table 2 has been predefined, but the user can change this option, by removing or adding pressures from the main list. The identification of the human activities acting as stressors upon the main biodiversity components, are described as follows, whereas in Table 3, a summary of pressure type, the corresponding human activities and the type of geospatial dataset represents each human activity are presented.

Physical (total) loss of the habitat is generally a result of sealing and smothering by man-made structures or disposal of dredge spoil. It is considered to be permanent or long-lasting damage of the habitat related to an activity, whether one-off or continuous, that results in a degraded environmental state. Associated activities include the installation of infrastructure e.g. surface of platforms or wind farms, marinas, coastal defenses, pipelines and cables.

Physical damage to habitat to the seabed constitutes one of the major pressures. Physical damage is attributed to changes in siltation and abrasion. It is caused by the exploitation of mineral resources, dredging, disposal of dredged material, bottom trawling, constructions on the seabed, coastal shipping and mooring areas.

Nutrient enrichment. Inorganic nutrients and organic matter entering the sea may have a great impact on the ecosystem. Excessive nutrients foster the growth of photosynthetic plants and algae leading to an unbalanced energy flow in the ecosystem. The main pathways of nutrient inputs to the sea are: the riverine loads, the surface runoff in coastal areas with intense agricultural activity, the mariculture and aquatic farming of fish and crustaceans in the marine environment, urbanization and point sources, such as municipal wastewater treatment plants or industry.

Contaminants. River estuaries, harbors, shipyards, marinas and shipping lanes, accidental oil spills from ships can contribute significantly to the input of hazardous substances to the sea. Also, the surface runoff in coastal areas with intense agricultural activity can introduce hazardous substances to the marine environment.

Removal by fishing (target non-target). The extraction of fish by commercial fishing through both direct removal of target fish, and indirectly by removing non-target species and by physically impacting essential habitats. VMS data at the appropriate spatial and temporal scale are required.

Hydrological changes. Coastal power plants, desalination plants and wastewater treatment plants are major local sources of inputs of warm and/or fresh water to the sea. Warm water in such an area is known to change local productivity and species composition significantly.

Other disturbances to species. Marine litter and visual disturbance are referred as other disturbances to species. The macroscopic marine litter mainly originates from fishing, shipping, leisure boating, tourism, coastal urban areas and rivers.

Under Water (UW) noise. It's a pressure that does not affect the habitats according to Table 2. It mainly affects the species that are included in the “reference list” of species and habitats to be monitored in the Initial Phase of the Integrated Monitoring and Assessment Programme (Initial Phase of IMAP) of UNEP/MAP. The main sources of underwater noise are commercial shipping, fishing, military activities, construction activities, seismic explorations, recreational boating and operational wind farms.

Non Indigenous Species (NIS). Non-indigenous species can harm a local ecosystem. They can expand rapidly if they can outcompete indigenous species and when natural enemies are absent. By competition for space, food or other factors, non-indigenous species can sometimes replace indigenous species in the area. Several human activities form pathways for the introduction of non-indigenous species such as the ballast water of freighters, fouling of ships etc.

It is important to mention that for the *mapping* of intensity for each pressure type, related field or satellite data can be included. Especially, for the pressure referred to nutrient enrichment and hazardous substances, the toolboxes developed in the framework of IRIS-SES project, named "Eutrophication Status" and "Contaminants in sediments" toolboxes can be used. The models output for each tool can capture either by itself or in combination with other spatial layers, the intensity of the related pressure type.

Table 3. Pressure type, the corresponding human activities and the type of geospatial dataset represents each human activity.

Pressure type	**Corresponding Human activities**	**Geospatial data type**
Physical (total) loss of the habitat	harbors, offshore wind farms, cables, bridges, coastal dams, coastal defense structures, oil platforms	vector datasets (point, line & polygon features)
Physical damage to habitat	bottom trawling (VMS), dredging, disposal of dredged material, mooring areas, extraction of minerals	vector datasets (point & polygon features) raster dataset (grids)
Nutrient enrichment	estuaries, coastal agricultural areas, urban areas, wastewater treatment plants	vector datasets (point, line & polygon features) raster dataset (grids)
Contaminants	river estuaries, harbors, shipyards, marinas and shipping lanes, accidental oil spills	vector datasets (point, line & polygon features) raster dataset (grids)
Removal by fishing (target non-target)	fishing ports (artisanal fishing), VMS	vector datasets (point features)
Hydrological changes	coastal power plants, desalination plants and wastewater treatment plants	vector datasets (point features)
Other disturbances to species	Rivers mouths in relation to dumping grounds and urban areas, leisure boating	vector datasets (point and line features)
Under Water (UW) noise	ports, recreational boating, shipping lanes, areas for military activities, construction activities, seismic explorations, and operational wind farms	vector datasets (point, line & polygon features)
Non Indigenous Species (NIS)	large ports, marinas, shipping lanes, roadstead	vector datasets (point, line & polygon features)

The work flow

The workflow of the Benthic Habitat Risk Assessment tool is shown in Figure 2.

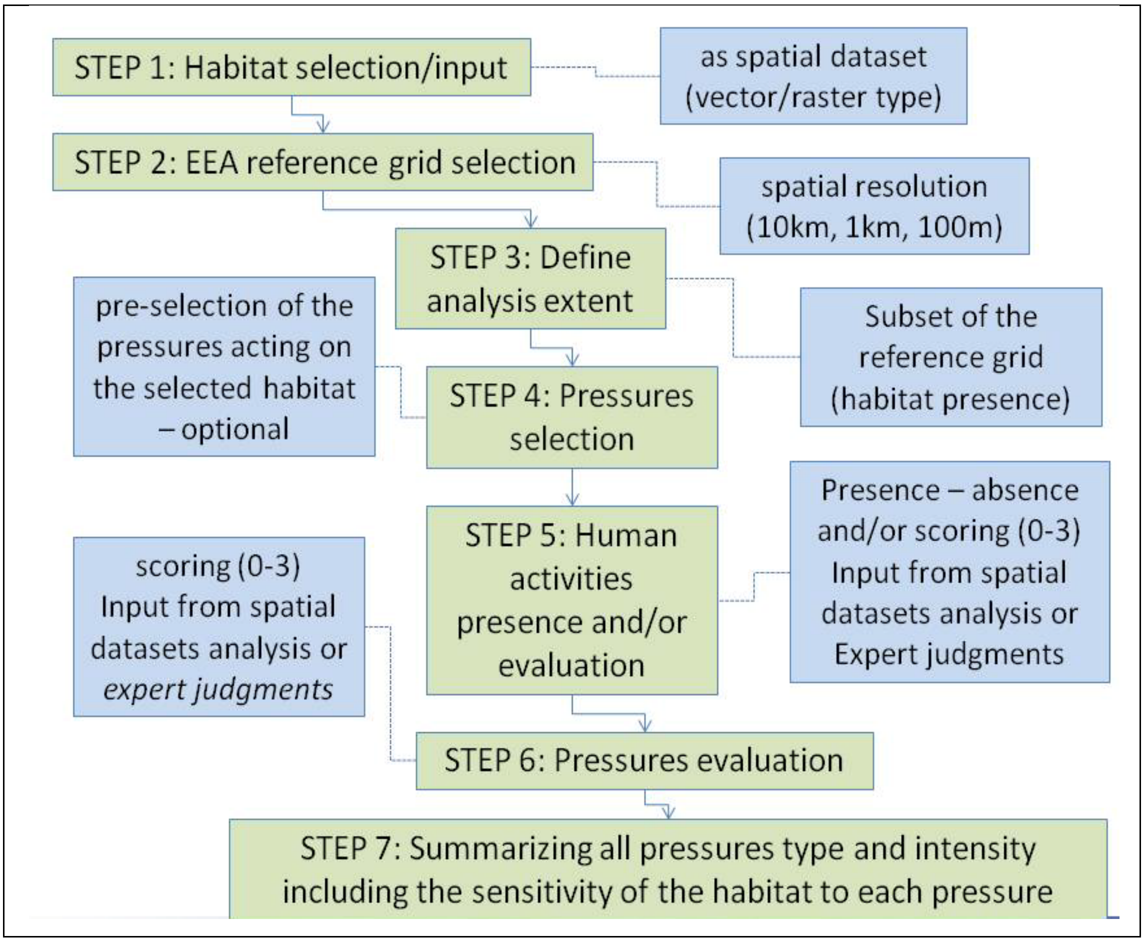


Figure 2. *The workflow of the Benthic Habitat Risk Assessment tool.*

The steps are described below in more detail:

1. The user will select the habitat type to be assessed regarding the potential impacts of the anthropogenic pressures, from the included list of the priority habitats. The selected habitat will be added in the *GIS Data Frame*, as polygon feature or raster dataset. The need of this layer is fundamental, because it defines the spatial extent of the analysis and also the type and intensity of the pressures acting on it. The final formula of the calculation is related to the habitat type.

2. The next step is to define the spatial resolution. According to the extent of the study area, as well the resolution of the available datasets in the area regarding the habitat and the human activities, the user will select the appropriate reference grid (10 km, 1 km or 100 m).

3. A spatial selection of the grid cells where the habitat is present, defines the area that the analysis will take place. Thus, a subset of the selected reference grid is created, representing the presence of the habitat.

4. Selection of the main pressures (P_i) affecting the health of the habitat is the next step. A pre-selection of the pressures according the UNEP Biodiversity working group will be proposed to the user.

5. All the spatial layers illustrating the human activities will be selected and added in the *data frame* area where the analysis occurs. In the attribute table of the subset of the reference grid created during the third step, new fields (columns) will be created related to each one of the layers of the human activities (HA_j). These new fields will be filled by 0 or 1 for the absence or presence and/or by an intensity value from 0 to 3 (0 = no impact, 1= low, 2=moderate, 3=high impact) for each activity in every cell of the grid.

6. The evaluation of each pressure will take place according to the presence/absence and/or the intensity of the associated human activities. Each pressure will be analyzed separately. New fields, one for each pressure type, will also be created in the attribute table of the subset of the reference grid as for the human activities. The scoring for each pressure ranges from 0 (no impact) to 3 (high impact). Two approaches of the pressures' scoring were studied. The first is, that "one bad all bad" in line with the Water Framework Directive. The highest value (0-3) of an element-activity defines the score of the corresponding pressure for each grid's cell. The second approach is the cumulative one. The score of each grid's cell is the total presence of the corresponding activities.

7. Finally, the degree of vulnerability of benthic habitats to human stressors (BHRA index) is the sum of each pressure's score (p_i). The score of the stressors (pressures) considered the most important for the habitat (p_j) that is assessed (UNEP Biodiversity WG) is double added ($\Sigma P_i + \Sigma 2P_j$).

<u>Important note.</u> All spatial datasets should be referred in the same coordinate reference system. As mentioned previously, the coordinate reference system (CRS) that the analysis will be implemented is the ETRS89-LAEA Europe, also known in the EPSG Geodetic Parameter Dataset under the identifier: EPSG:3035. The Geodetic Datum is the European Terrestrial Reference System 1989 (EPSG:6258). The Lambert Azimuthal Equal Area (LAEA) projection is centred at 10 °E, 52 °N. Coordinates are based on a false Easting of 4321000 meters, and a false Northing of 3210000 meters. Thus layers referred in other coordinate system should be projected on the ETRS89-LAEA Europe.

2. TESTING THE BENTHIC HABITAT RISK & ASSESSMENT GIS TOOL: THE CASE OF SEAGRASS MEADOWS IN THE IONIAN SEA

In order to be able to complete the development of the tool, it was necessary to implement all the steps described above and test the methodology. The tests will be applied for each habitat type. The tool has been initially tested for the habitat type of seagrass meadows in the Ionian Sea - Greece, indicating the degree of vulnerability of this habitat type taking into account all the relevant existing and potential human activities acting as pressures. The results of all the steps described above are presented in the following figures. Note that the method is still under development and the results need to be assessed against existing quantitative and qualitative scientific information.

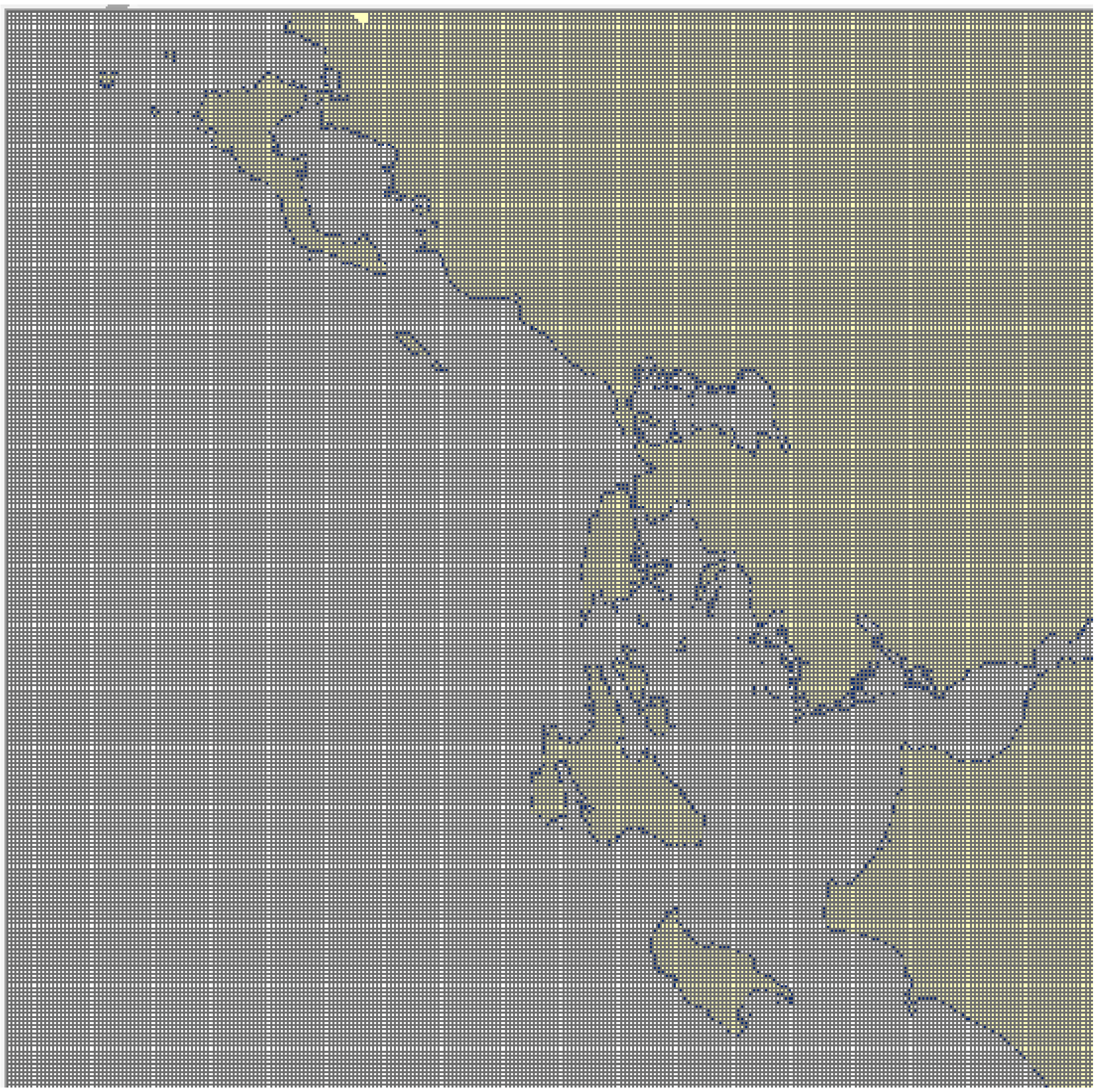
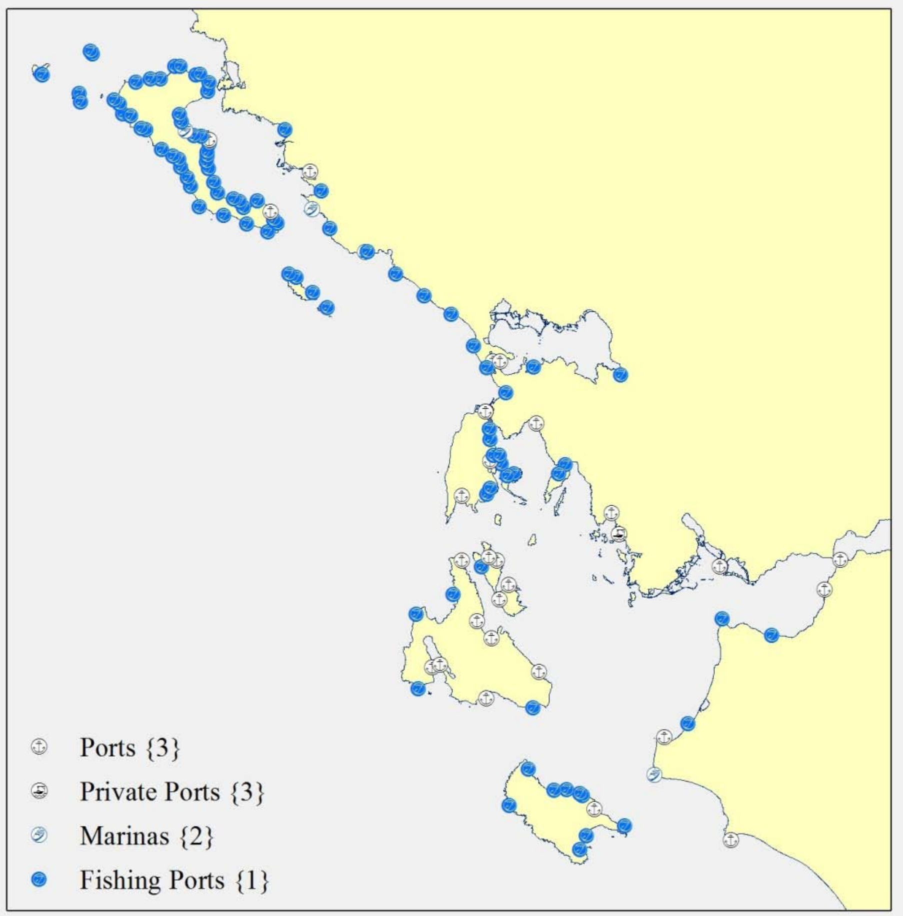


Figure 3. *EEA reference grid in 1 km resolution for the Ionian Sea, Greece (step 2).*

Figure 4. *Seagrass meadows presence applied on EEA Reference Grid of 1x1 km (step 3).*

Physical (total) loss of the habitat



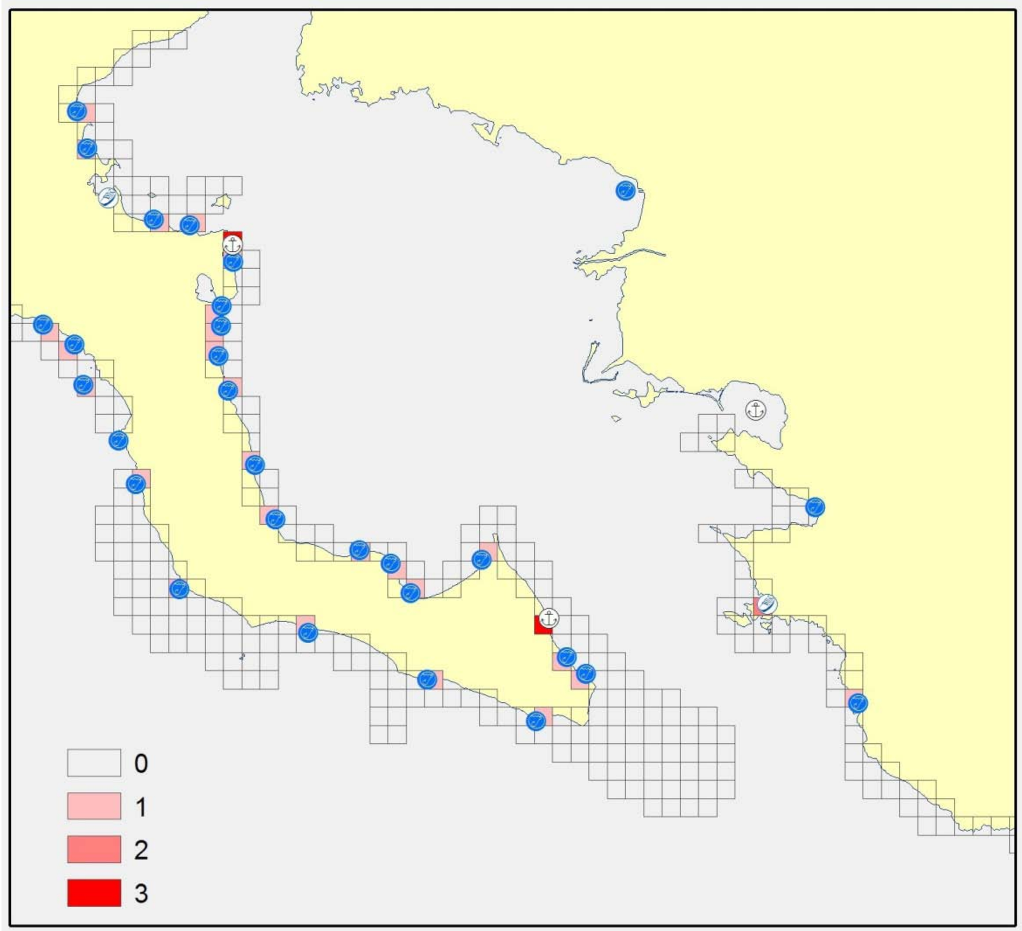


Figure 5. *Presence of ports in the study area (left) and on the 1 km grid of the extent of the meadows (zoom area on the right). The scoring is according to the type of port (steps 4, 5).*

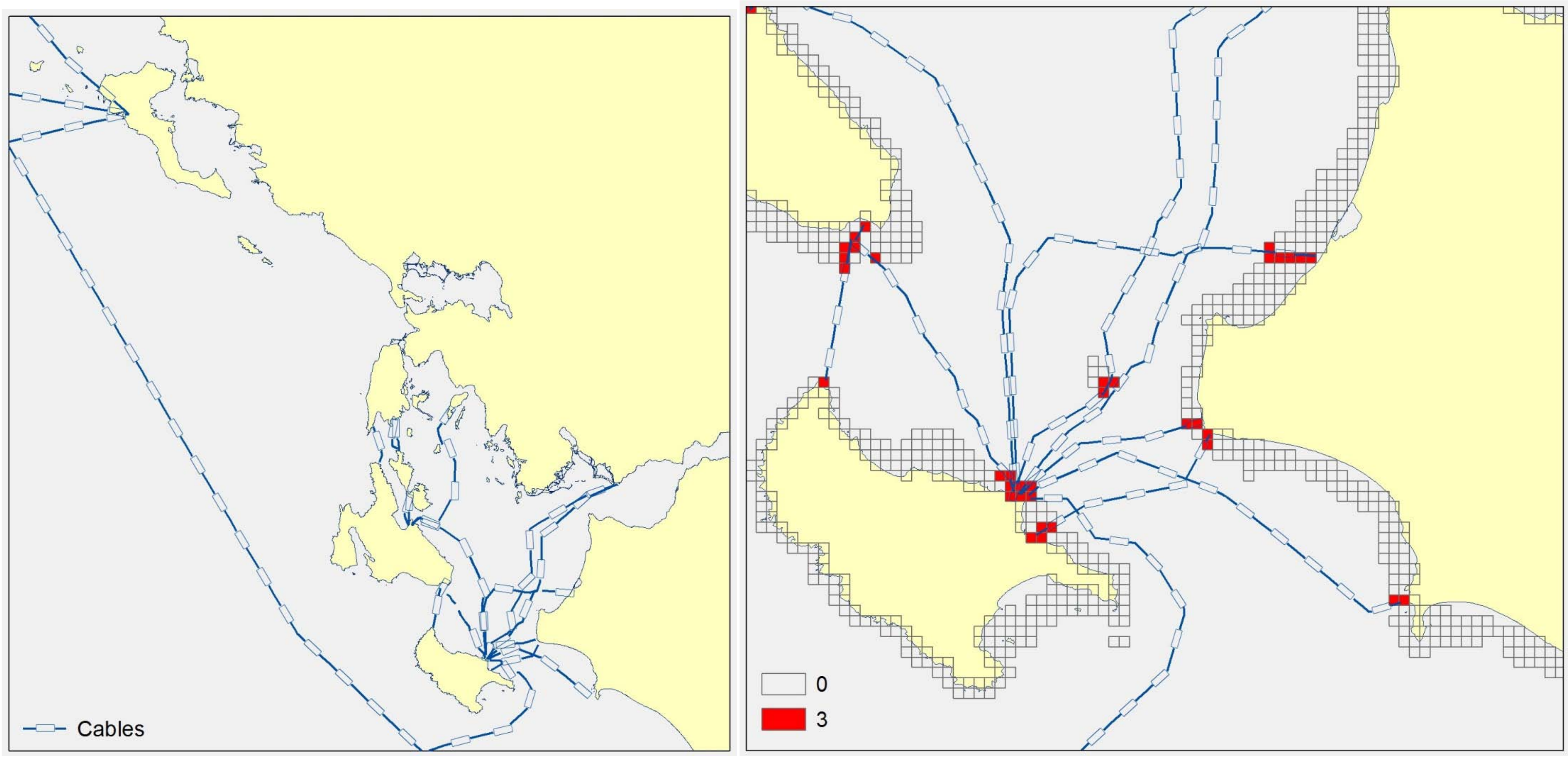


Figure 6. *Presence of underwater cables in the study area (left) and on the 1 km grid of the extent of the meadows (zoom area on the right) (steps 4, 5).*

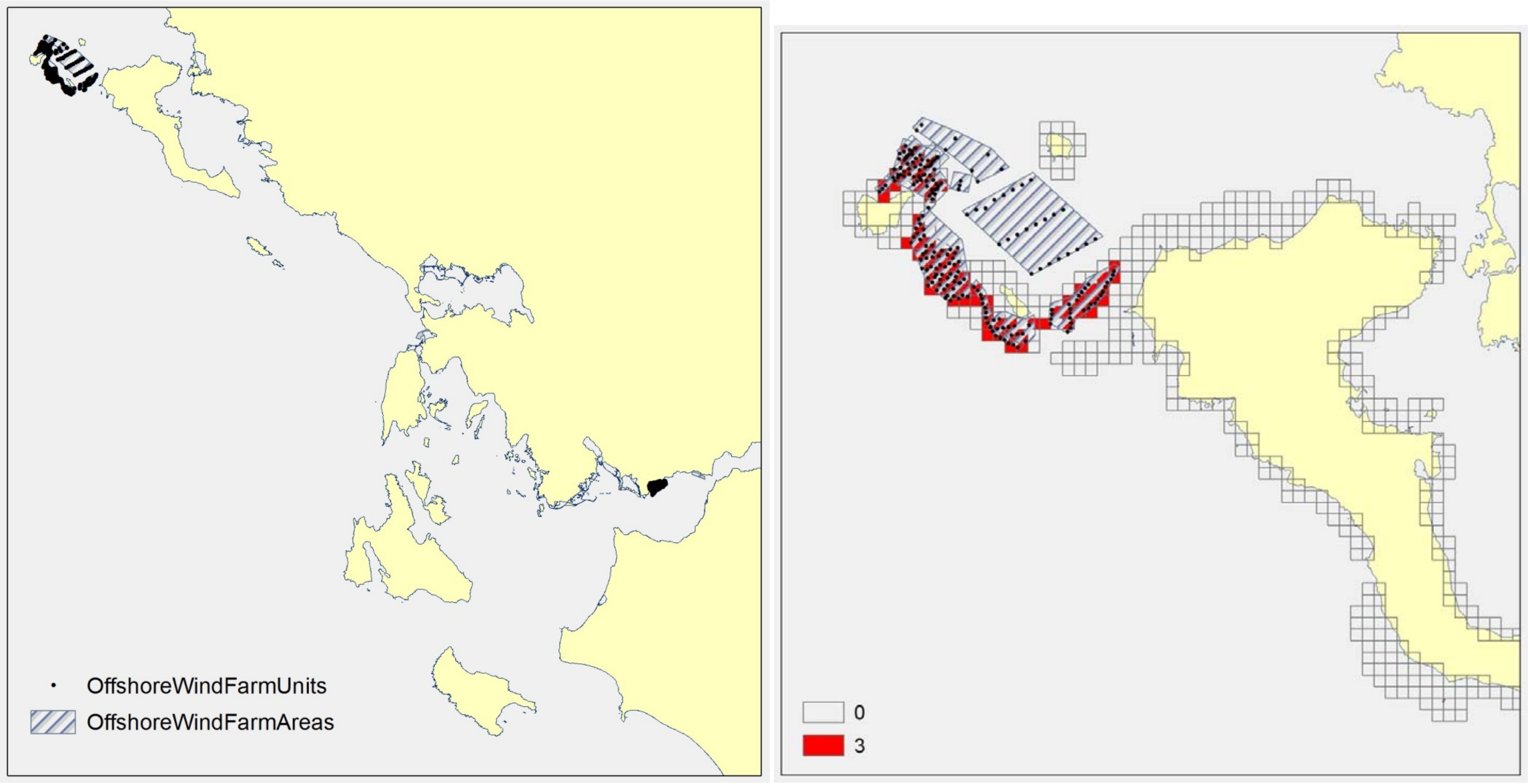
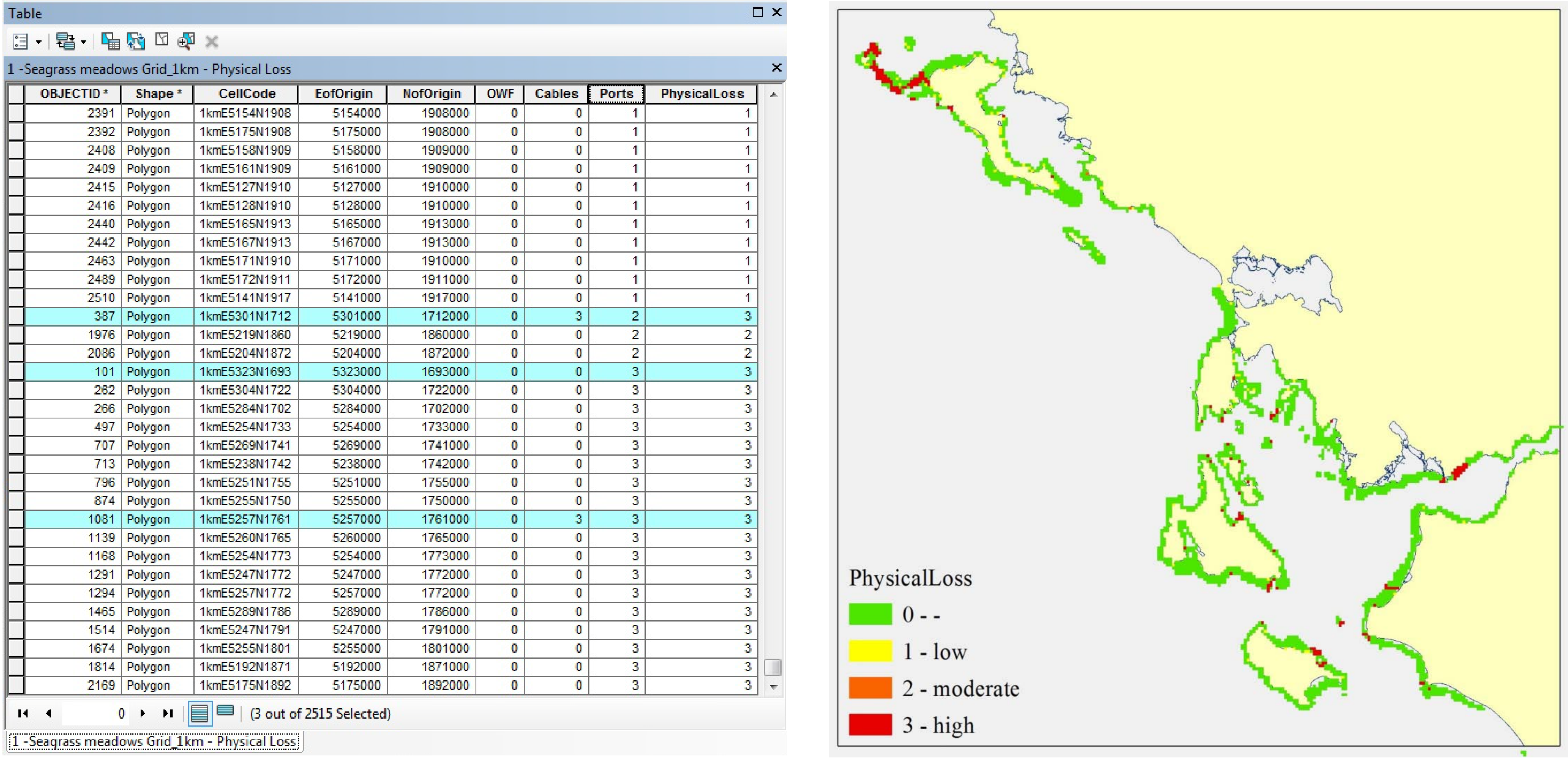


Figure 7. *Presence of the offshore wind farm units under evaluation (left) and on the 1 km grid of the extent of the meadows (zoom area on the right). This activity is not yet established in the area. It has been included in the analysis as potential stressor on the habitat (steps 4, 5).*



OBJECTID *	Shape *	CellCode	EofOrigin	NofOrigin	OWF	Cables	Ports	PhysicalLoss
2391	Polygon	1kmE5154N1908	5154000	1908000	0	0	1	1
2392	Polygon	1kmE5175N1908	5175000	1908000	0	0	1	1
2408	Polygon	1kmE5158N1909	5158000	1909000	0	0	1	1
2409	Polygon	1kmE5161N1909	5161000	1909000	0	0	1	1
2415	Polygon	1kmE5127N1910	5127000	1910000	0	0	1	1
2416	Polygon	1kmE5128N1910	5128000	1910000	0	0	1	1
2440	Polygon	1kmE5165N1913	5165000	1913000	0	0	1	1
2442	Polygon	1kmE5167N1913	5167000	1913000	0	0	1	1
2463	Polygon	1kmE5171N1910	5171000	1910000	0	0	1	1
2489	Polygon	1kmE5172N1911	5172000	1911000	0	0	1	1
2510	Polygon	1kmE5141N1917	5141000	1917000	0	0	1	1
387	Polygon	1kmE5301N1712	5301000	1712000	0	3	2	3
1976	Polygon	1kmE5219N1860	5219000	1860000	0	0	2	2
2086	Polygon	1kmE5204N1872	5204000	1872000	0	0	2	2
101	Polygon	1kmE5323N1693	5323000	1693000	0	0	3	3
262	Polygon	1kmE5304N1722	5304000	1722000	0	0	3	3
266	Polygon	1kmE5284N1702	5284000	1702000	0	0	3	3
497	Polygon	1kmE5254N1733	5254000	1733000	0	0	3	3
707	Polygon	1kmE5269N1741	5269000	1741000	0	0	3	3
713	Polygon	1kmE5238N1742	5238000	1742000	0	0	3	3
796	Polygon	1kmE5251N1755	5251000	1755000	0	0	3	3
874	Polygon	1kmE5255N1750	5255000	1750000	0	0	3	3
1081	Polygon	1kmE5257N1761	5257000	1761000	0	3	3	3
1139	Polygon	1kmE5260N1765	5260000	1765000	0	0	3	3
1168	Polygon	1kmE5254N1773	5254000	1773000	0	0	3	3
1291	Polygon	1kmE5247N1772	5247000	1772000	0	0	3	3
1294	Polygon	1kmE5257N1772	5257000	1772000	0	0	3	3
1465	Polygon	1kmE5289N1786	5289000	1786000	0	0	3	3
1514	Polygon	1kmE5247N1791	5247000	1791000	0	0	3	3
1674	Polygon	1kmE5255N1801	5255000	1801000	0	0	3	3
1814	Polygon	1kmE5192N1871	5192000	1871000	0	0	3	3
2169	Polygon	1kmE5175N1892	5175000	1892000	0	0	3	3

Figure 8. *Assessment of the potential physical or total loss of the meadows in the study area. The scoring of each grid cell (left: attribute table; right: the map) (step 6).*

Physical damage of the habitat

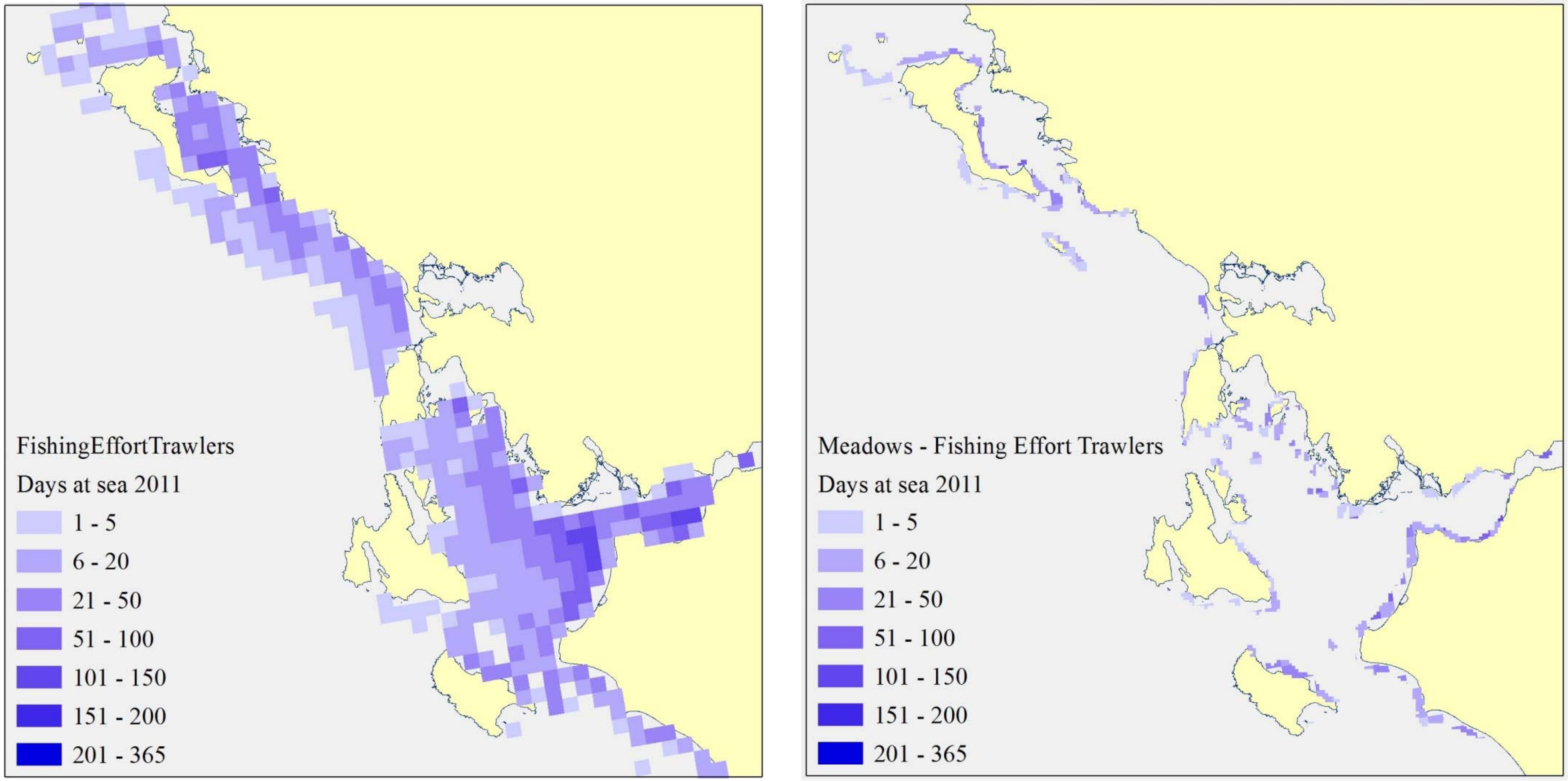


Figure 9. *Fishing effort of trawlers in the Ionian Sea during 2011 (left) and on the extent of the seagrass meadows 1 km grid (right) (steps 4, 5).*

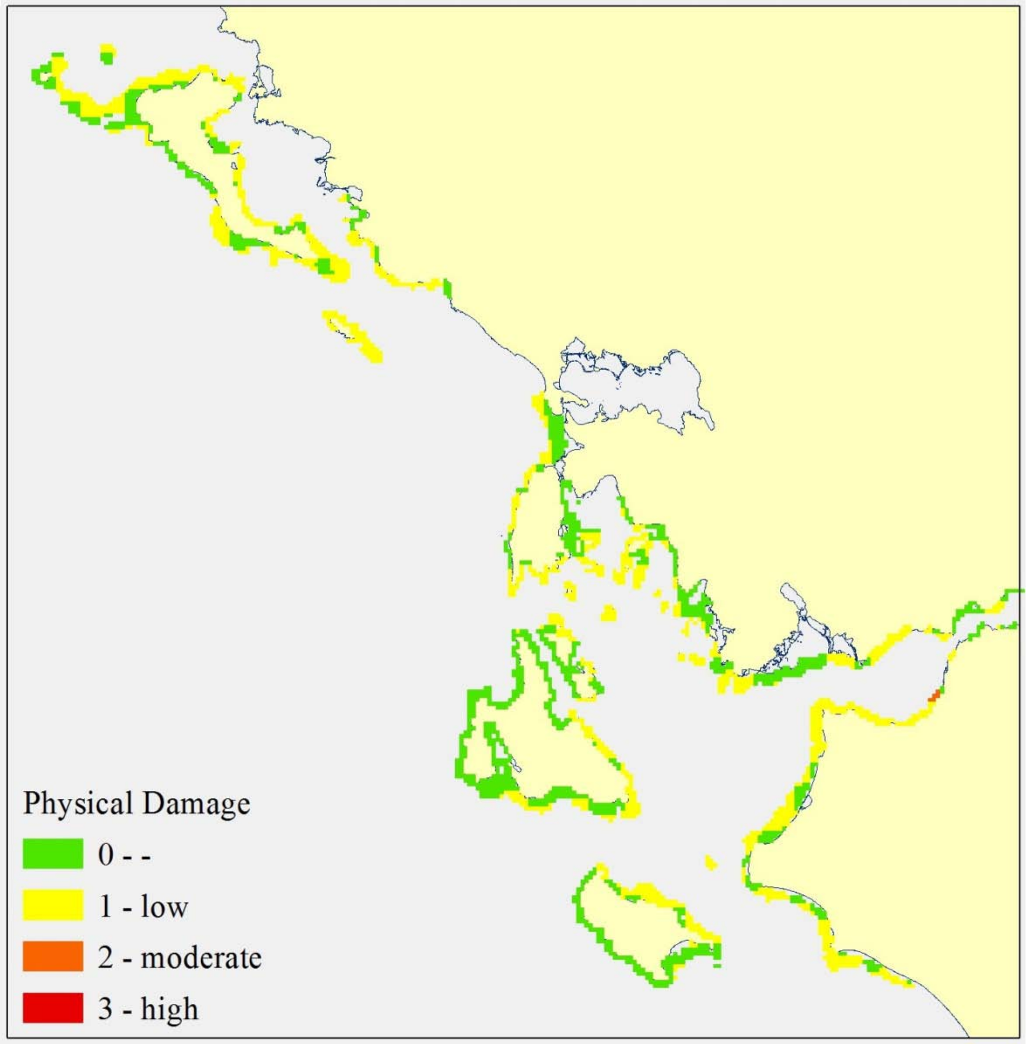


Figure 10. *Assessment of the physical damage of the meadows regarding the bottom trawlers activity (step 6).*

Nutrient enrichment

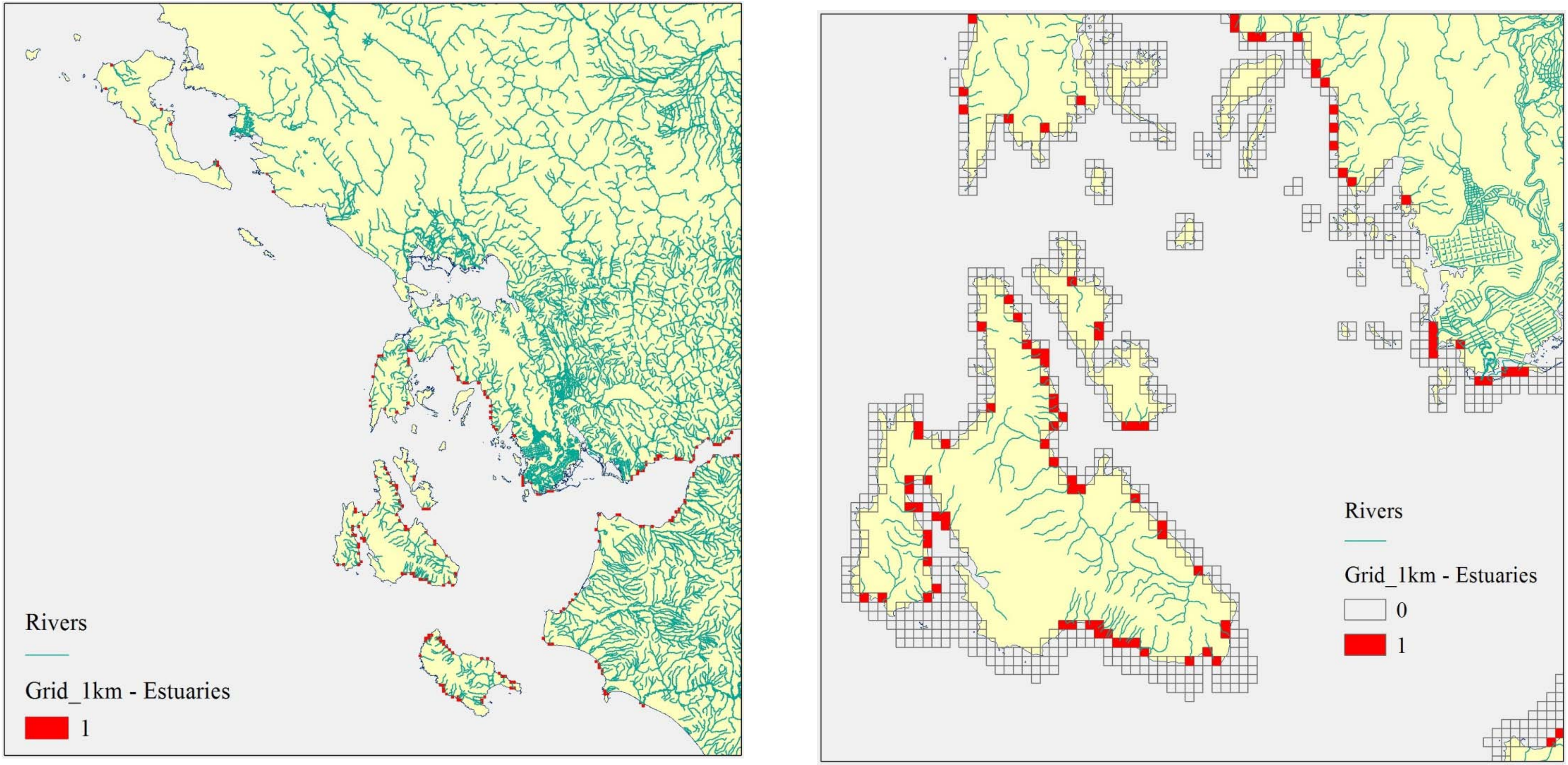


Figure 11. *River mouths - estuaries presence on 1 km grid of seagrass meadows (left - whole study area, right - zoom area) (steps 4, 5).*

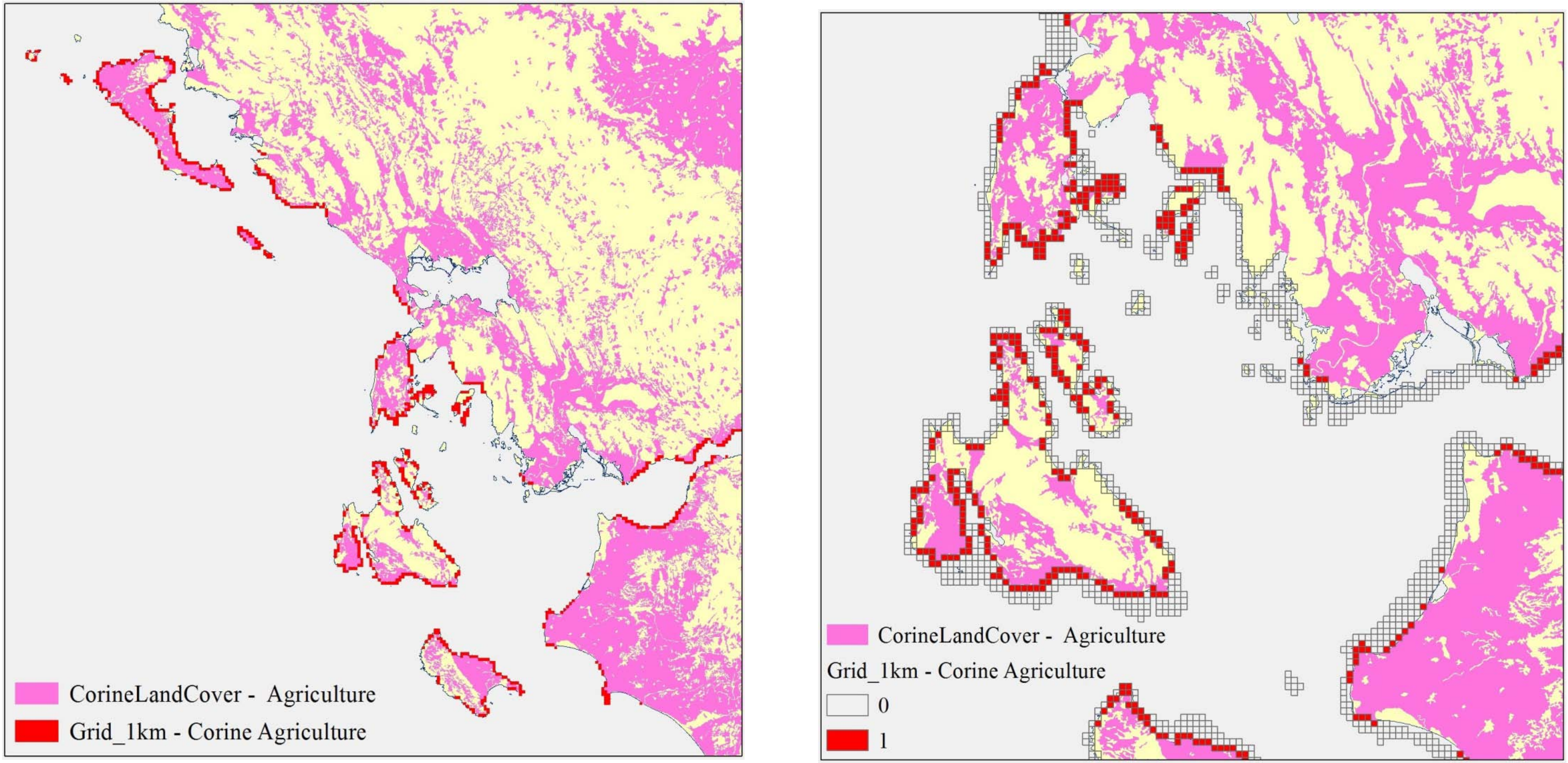


Figure 12. *Agricultural activity by Corine land cover. Sea grass meadows grid 1 km affected by the surface runoff of this activity (left - whole study area, right - zoom area) (steps 4, 5).*

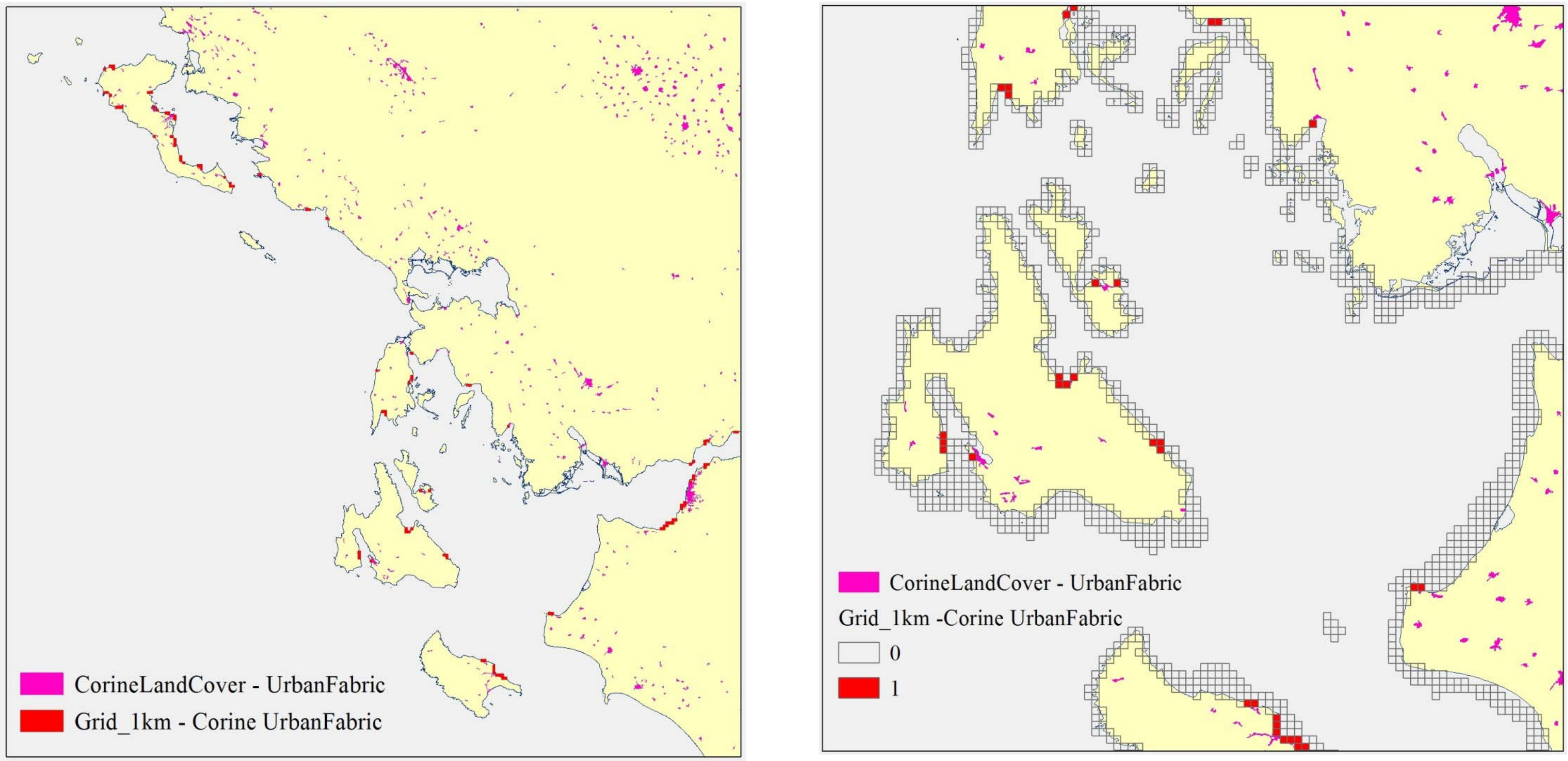


Figure 13. *Urban areas by Corine land cover. Sea grass meadows grid 1 km affected by this activity (left - whole study area, right - zoom area) (step 4, 5).*

Table

3 -Seagrass meadows Grid_1km -Nutrient enrichement

OBJECTID *	Shape *	CellCode	EofOrigin	NofOrigin	estuaries	agriculture	UrbanFabric	NutrientEnrichmen
2508	Polygon	1kmE5130N1917	5130000	1917000	0	0	0	0
2509	Polygon	1kmE5131N1917	5131000	1917000	0	0	0	0
2510	Polygon	1kmE5141N1917	5141000	1917000	0	0	0	0
2511	Polygon	1kmE5142N1917	5142000	1917000	0	0	0	0
2512	Polygon	1kmE5141N1918	5141000	1918000	0	0	0	0
2513	Polygon	1kmE5142N1918	5142000	1918000	0	0	0	0
2514	Polygon	1kmE5143N1918	5143000	1918000	0	0	0	0
2515	Polygon	1kmE5144N1918	5144000	1918000	0	0	0	0
16	Polygon	1kmE5335N1690	5335000	1690000	1	0	0	1
27	Polygon	1kmE5268N1694	5268000	1694000	1	0	0	1
40	Polygon	1kmE5322N1694	5322000	1694000	1	1	0	2
87	Polygon	1kmE5334N1691	5334000	1691000	1	1	0	2
111	Polygon	1kmE5280N1691	5280000	1691000	1	1	0	2
117	Polygon	1kmE5272N1692	5272000	1692000	1	0	0	1
118	Polygon	1kmE5273N1692	5273000	1692000	1	0	0	1
119	Polygon	1kmE5280N1692	5280000	1692000	1	1	0	2
137	Polygon	1kmE5270N1693	5270000	1693000	1	0	0	1
139	Polygon	1kmE5272N1693	5272000	1693000	1	1	0	2
140	Polygon	1kmE5281N1693	5281000	1693000	1	1	0	2
146	Polygon	1kmE5290N1698	5290000	1698000	1	1	0	2
147	Polygon	1kmE5291N1698	5291000	1698000	1	1	0	2
154	Polygon	1kmE5323N1694	5323000	1694000	1	1	0	2
158	Polygon	1kmE5267N1695	5267000	1695000	1	0	0	1
170	Polygon	1kmE5322N1695	5322000	1695000	1	1	0	2
172	Polygon	1kmE5267N1696	5267000	1696000	1	0	0	1
176	Polygon	1kmE5290N1696	5290000	1696000	1	1	0	2
177	Polygon	1kmE5291N1696	5291000	1696000	1	1	0	2
184	Polygon	1kmE5266N1697	5266000	1697000	1	0	0	1
185	Polygon	1kmE5267N1697	5267000	1697000	1	0	0	1
202	Polygon	1kmE5321N1702	5321000	1702000	1	1	0	2
207	Polygon	1kmE5287N1700	5287000	1700000	1	1	1	3
208	Polygon	1kmE5288N1700	5288000	1700000	1	1	1	3

0 (4 out of 2515 Selected)

3 -Seagrass meadows Grid_1km -Nutrient enrichement

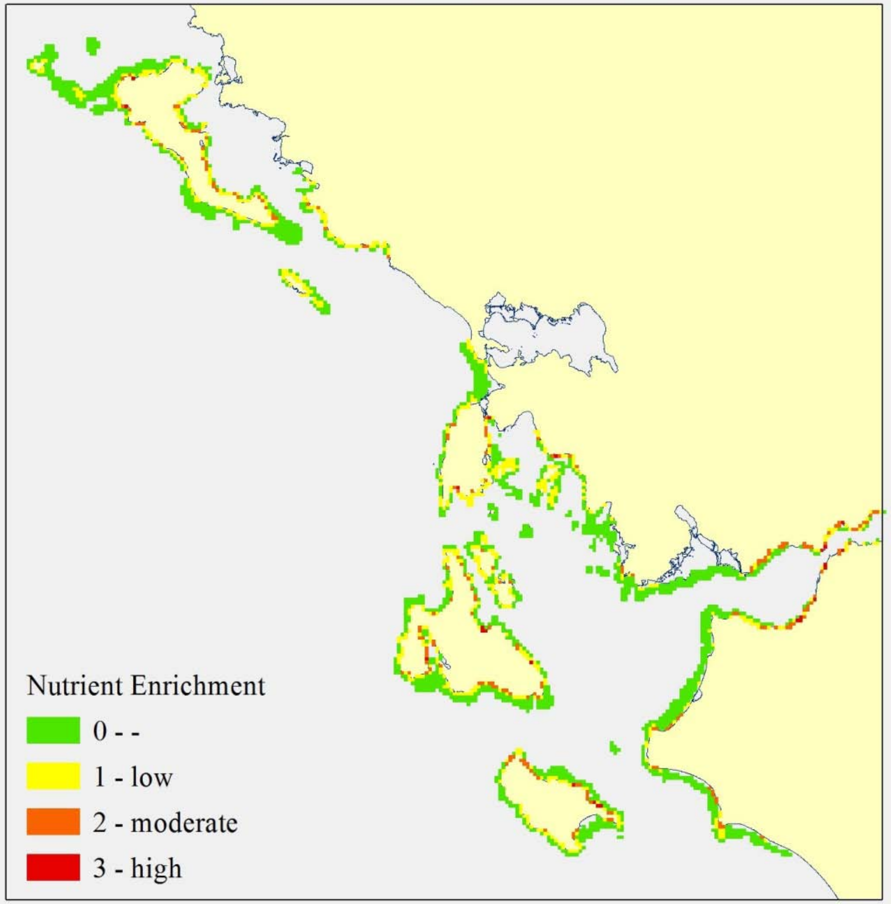


Figure 14. *Assessment of the nutrient enrichment stressor to the habitat. The scoring of each grid cell (left: attribute table; right: the map) (step 6)*.

Hydrological changes

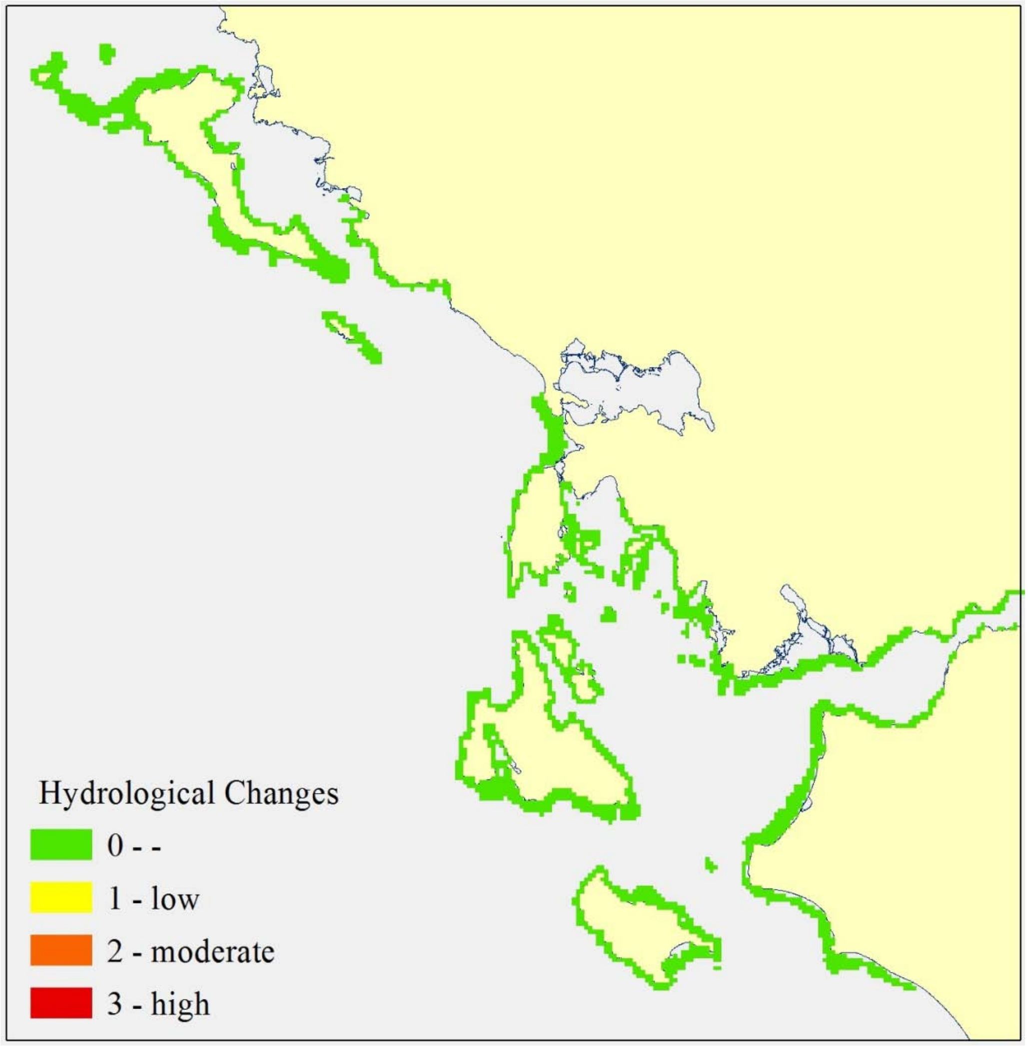
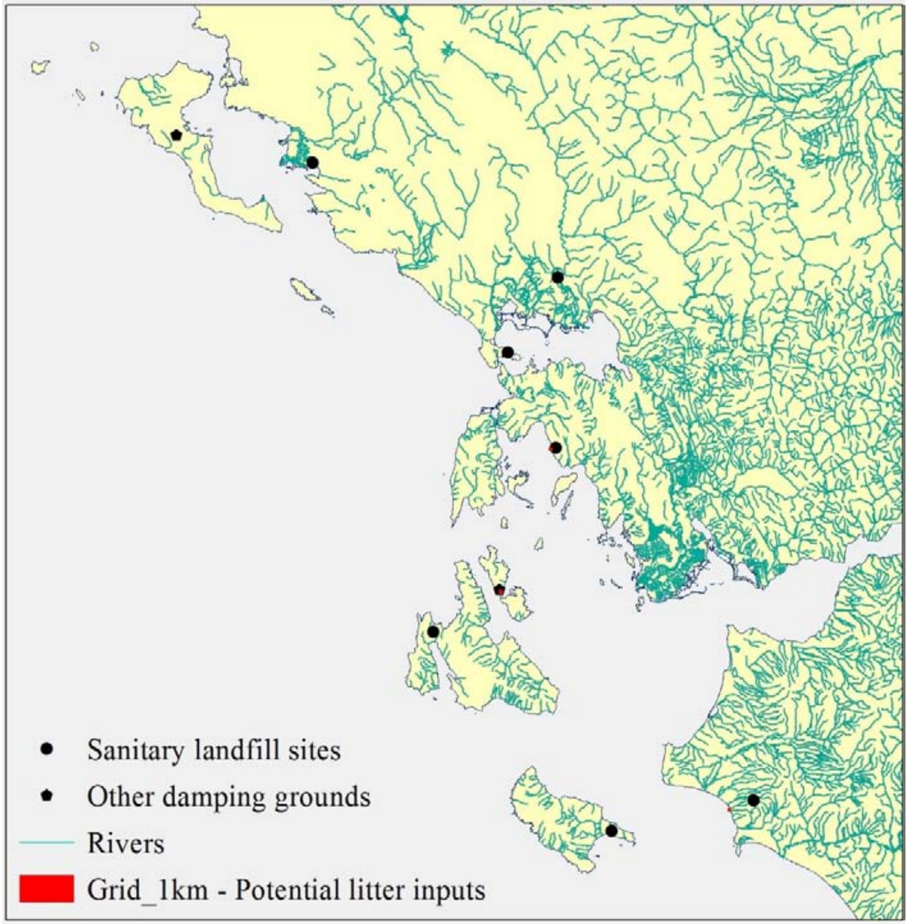


Figure 15. *Assessment of the hydrological changes to the habitat (no impact since no coastal power plants and desalination plants are located) (step 6).*

Other disturbances to species



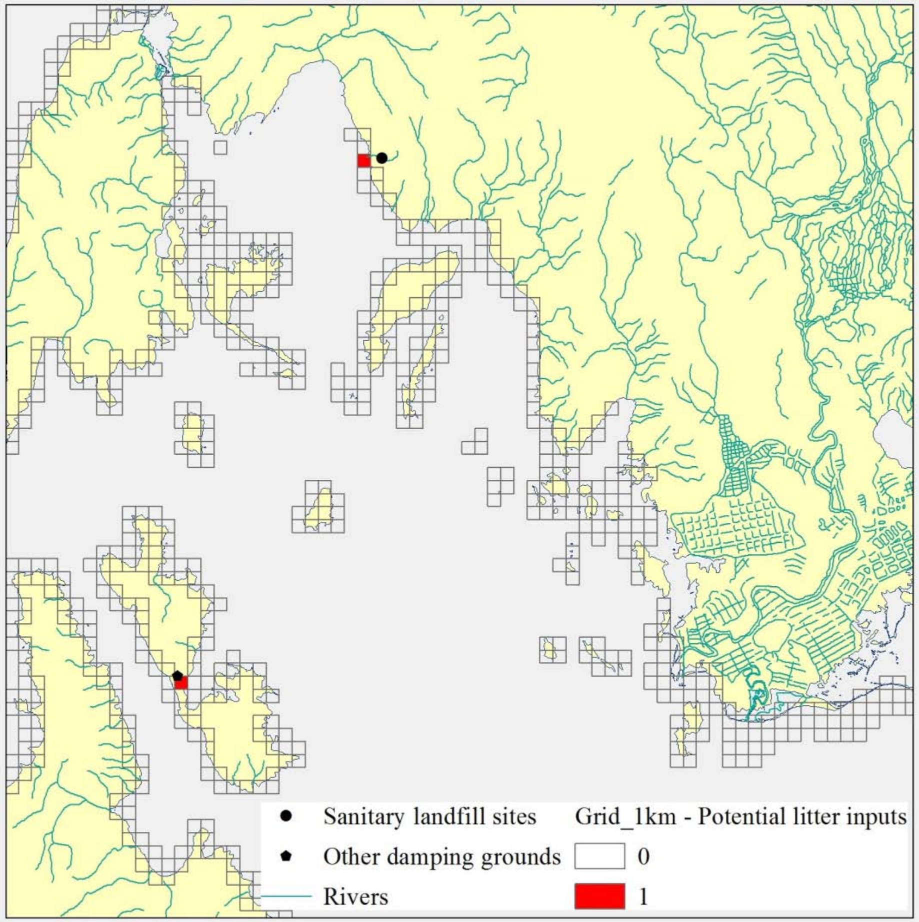
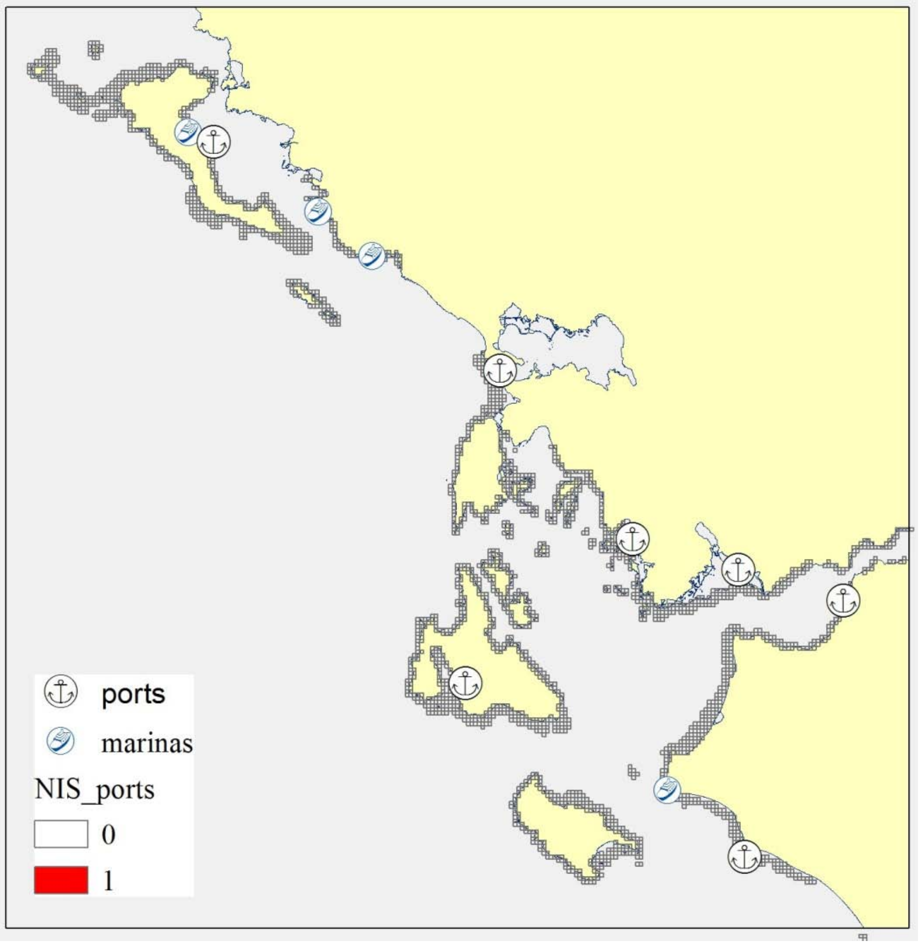


Figure 16. *The presence of the land damping grounds in association to river network. River mouths as the potential entrance of the litter in the sea and the affected grid cells of the habitat (left: whole study area; right: zoom area) (steps 4, 5).*

Figure 17. *Assessment of the marine litter as stressor to the habitat (step 6).*

Non Indigenous Species



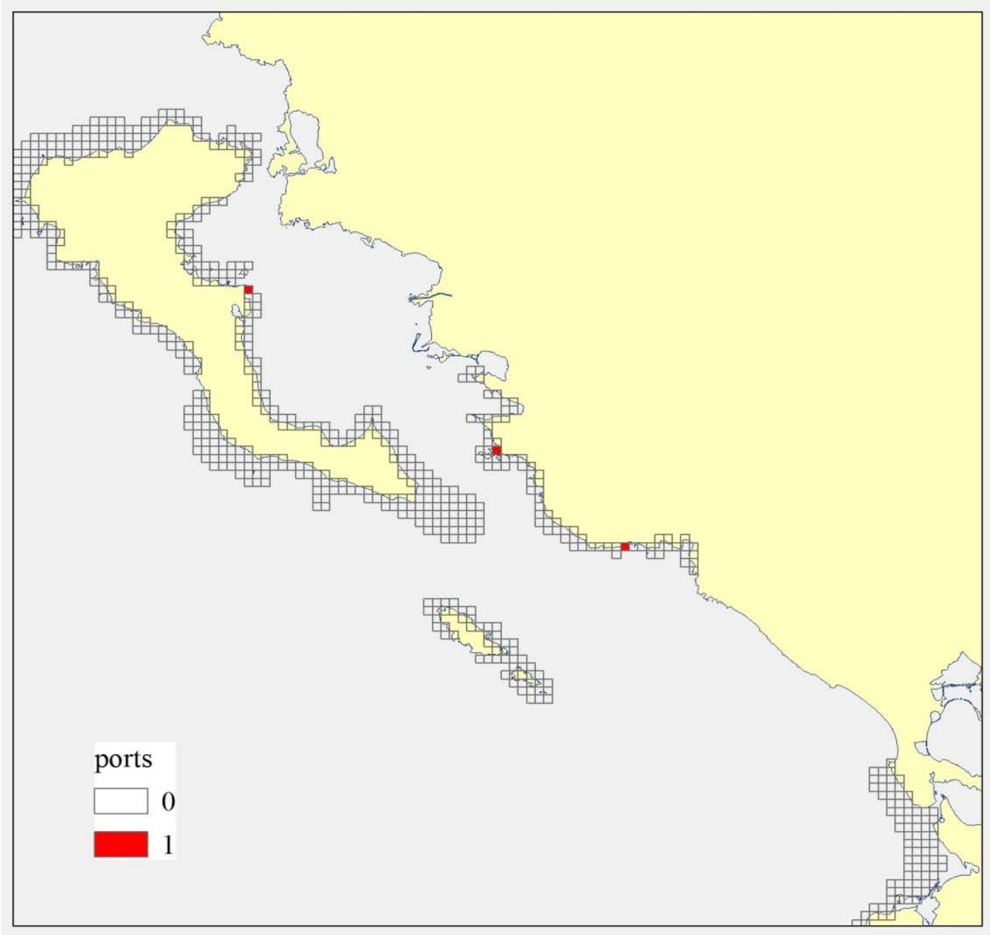
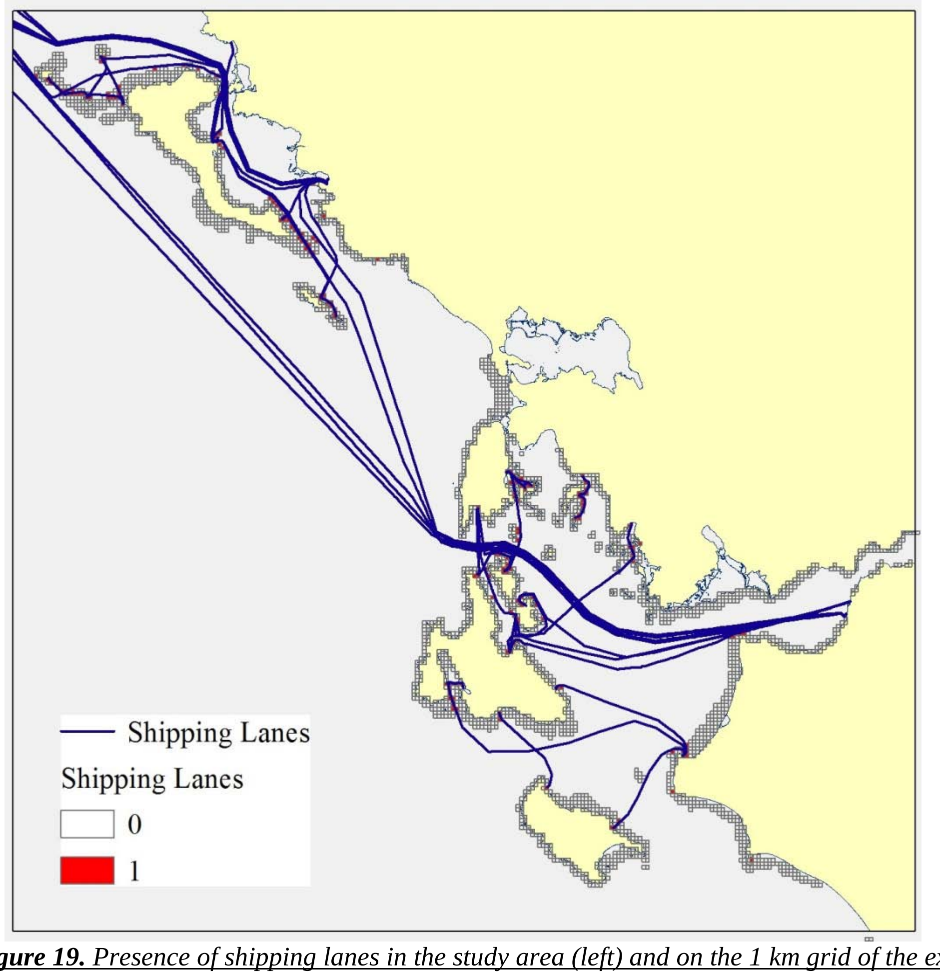


Figure 18. *Presence of large ports and marinas in the study area (left) and on the 1 km grid of the extent of the meadows (zoom area on the right) (steps 4, 5)*.



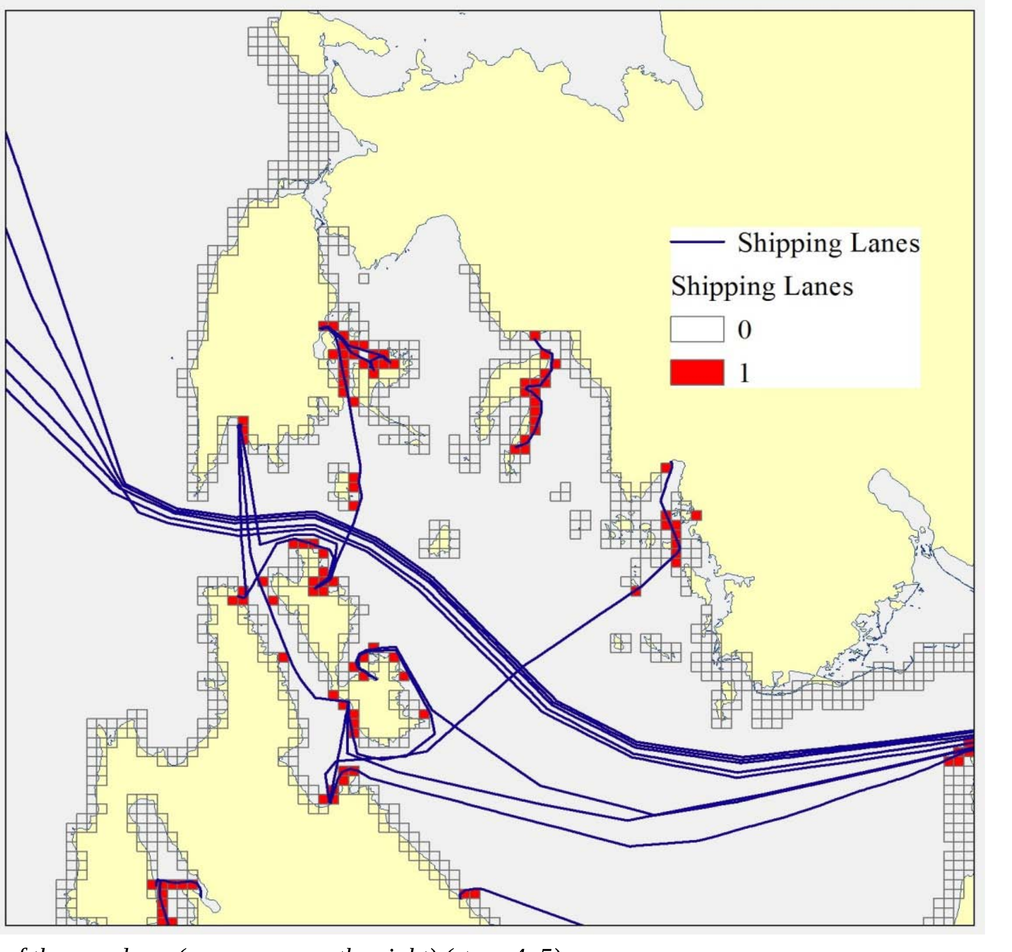


Figure 19. *Presence of shipping lanes in the study area (left) and on the 1 km grid of the extent of the meadows (zoom area on the right) (steps 4, 5).*

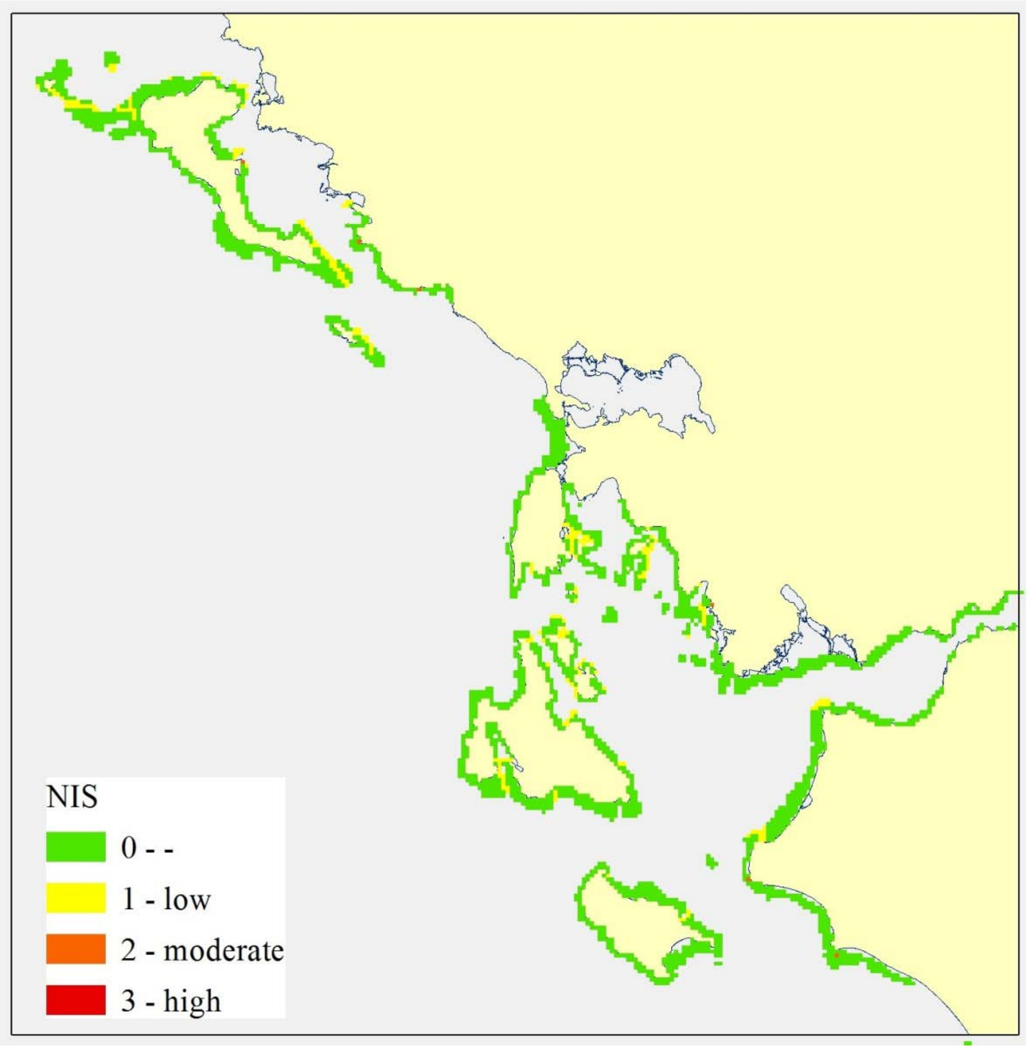


Figure 20. *Assessment of non-indigenous species (NIS) as stressor to the habitat (step 6).*

Seabed habitats risk assessment results

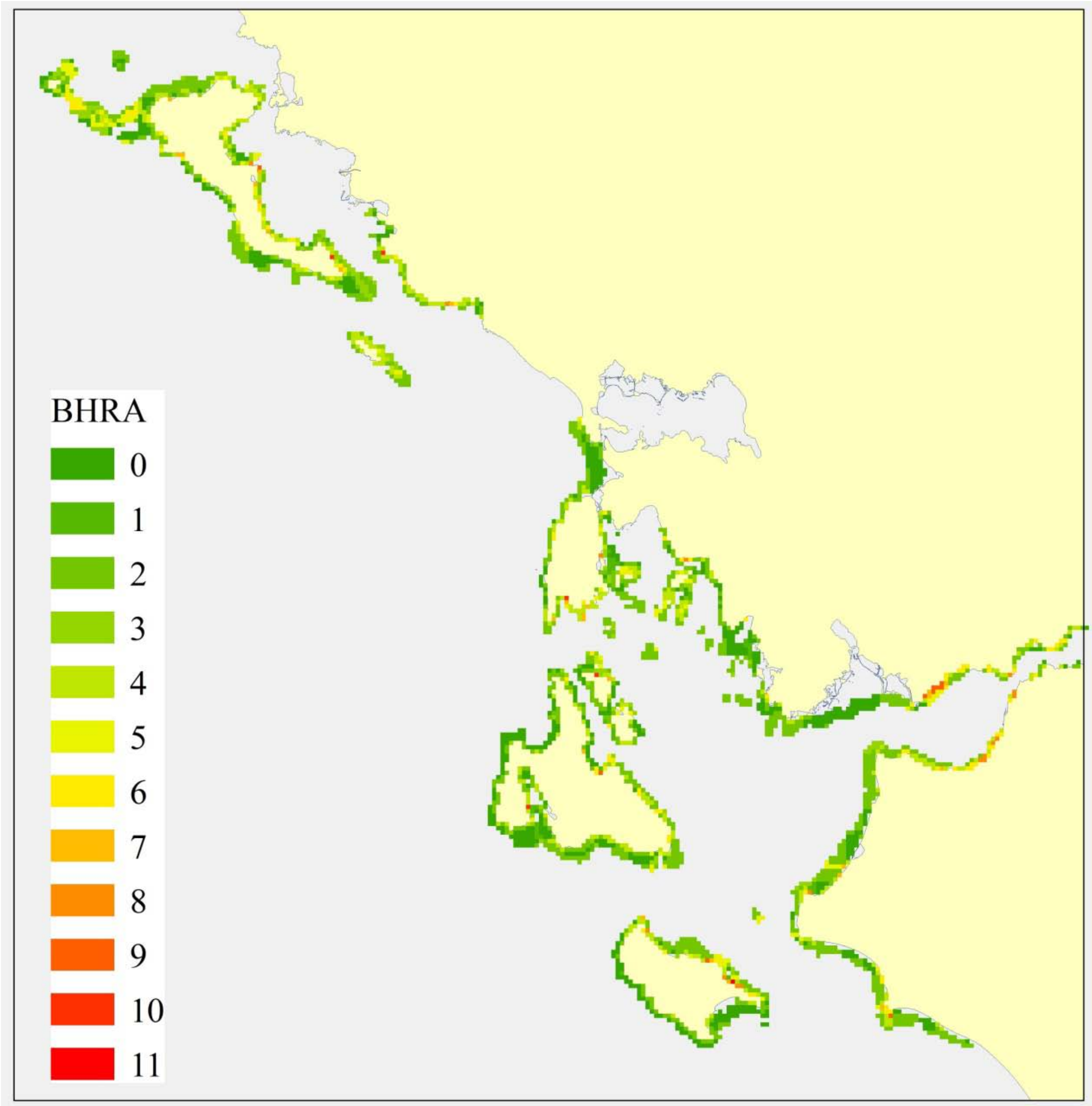


Figure 21. *The result map of the Benthic Habitat Risk Assessment tool tested for seagrass meadows. BHRA index is the sum of each pressure's score. The score of the stressors (pressures) considered the most important for the habitat that is assessed (UNEP Biodiversity WG) is double added (1*HabitatLoss + 2*PhysicalDamage + 2*NutrientsEnrichement + 1*HydrologicalChanges + 2*OtherDisturbances + 1*NIS) (step 7).*

3. DISCUSSION ON BHRA CONCEPT AND NEXT STEPS

In this report the design of the GIS-based BHRA tool was presented, in order to assess the degree of vulnerability of benthic habitats to human stressors. This tool proposes a methodology mainly based on geospatial data and analysis. The effort was made to develop a methodology by minimising the "expert judgement approach" for the evaluation of the pressure intensity, such in the most of the studies and scientific references is basic, and also to be applied using mainly objective criteria (e.g., size, extent, number, capacity) based on spatial datasets, which are mostly freely available or can readily be produced. The availability of survey biotope data and the extent and distribution of some modelled habitats, in particular deep habitats, as well the progress of spatial information accessibility for the cartographic presentation of human activities were crucial for the main concept.

The final picture from GIS is “simple” for the stakeholders and policy makers, giving a clear message also for the monitoring programmes. The final output should also be reliable not be necessarily highly accurate, but has at least to indicate the degree of vulnerability of the examined habitat. Moreover, this approach is in line with MSFD adopting a risk-based strategy for the biodiversity descriptors.

However, there is a need to further define the methodology used. The way of the ranking (i.e., including more details for each activity) is to be improved. The scoring will depend on the quality and sufficiency of data coverage, especially for the high-pressure study areas, where sensitive habitats are present. An accurate method for combining the cumulative effects of different pressures, as well as the specific weight of each pressure that forms the final score has yet to be developed for the BHRA index, whereas other benthic habitats should also be tested. The validation of the tool is underway to assess the results against well-studied areas. We are planning to score the reliability of the maps on the base of the quantity and quality of the scientific information included.

Finally, the GIS toolbox/extension for a commercial and/or open source GIS software, is planned to be developed integrating also the GIS tools developed under IRIS-SES project. The implementation of the tool as a fully operational toolbox is the next step, since the time frame of ActionMed was very limited. It is also planned to further build on the data of the MedSea CheckPoint and of the EU SeaMap, which recently produced seabed habitat mapping of European seabed including the Mediterranean and producing modelled benthic habitats. This is an important step to test and apply the present work in a wider area, and also link and communicate the GIS tool to other relevant projects. Moreover, the tool will continue to be tested for other benthic habitats types within the MEDCIS project.

4. REFERENCES

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