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Transboundary impact assessment in the north-western Iberian Peninsula

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Acronyms

BHT – Broad Habitat Types

CEA – Cumulative Effect Assessment

CI – Cumulative Index

CIA – Cumulative Impact Assessment

EBA – Ecosystem Based Approach

EUNIS – European Union Nature Information System

LSCI – Local Sensitivity Confidence Index

LSI – Land Sea Interactions

MPA – Marine Protected Area

MSFD – Marine Strategy Framework Directive

MSP – Maritime Spatial Planning

SEA – Strategic Environmental Assessment

SPA – Special Protected Area

WFD – Water Framework Directive

GIS – Geographic Information Systems

1 Introduction

Sustainable development and specifically Sustainable Blue Economy[1] asks for an Ecosystem Based Approach (EBA) to Maritime Spatial Planning (MSP) to identify the utilization of marine space for different uses in the most efficient and sustainable way. Therefore, addressing Cumulative Effects/Impacts (CE/CI) is an essential part of this process as it supports the identification, description and evaluation of significant effects of implementing the plan on the marine environment.

Cumulative effects are a key aspect of Strategic Environmental Assessment (SEA) for Maritime Spatial Planning (MSP) and also to comply with the objectives of the Marine Strategy Framework Directive (MSFD). Cumulative effects are defined as "*changes to the environment that are caused by an action in combination with other past, present and future human actions*" (Casimiro, D. et al., 2021; Hegmann et al., 1999).

This document describes a proposed methodology for Cumulative Effects Assessment (CEA) to assess cumulative impacts/effects at a transboundary scale. The work was conducted in a specified case study in the north-western Region of the Iberian Peninsula in a cross-border area between Portugal and Spain.

[1] COM/2021/240 final

2 Study area

The case study area is located at the north-western border between Spain and Portugal, (Figure 1). To be able to develop an effective exercise, the study area was designed in a way that it is coherent with the working areas and knowledge of the partners and balanced in extension between the two countries.

The north part of the Spanish area extends to the Finisterre cape in order to be coherent with the Portuguese area and to consider characteristics of activities and environmental conditions in a coherent manner. The southern border of the area in Portugal has an administrative character, corresponding to the land frontier of the Aveiro region. The outer limit corresponds to the 12 nautical miles of the territorial sea where most of the activities tend to be concentrated. The inner limit corresponds to the coastline; even though MSP processes don't include inner waters (which come under the competence of the Water Framework Directive (WFD)) this was chosen in order to include activities whose pressures could go beyond straight baselines (i.e., aquaculture activity in Spanish waters) to external waters.

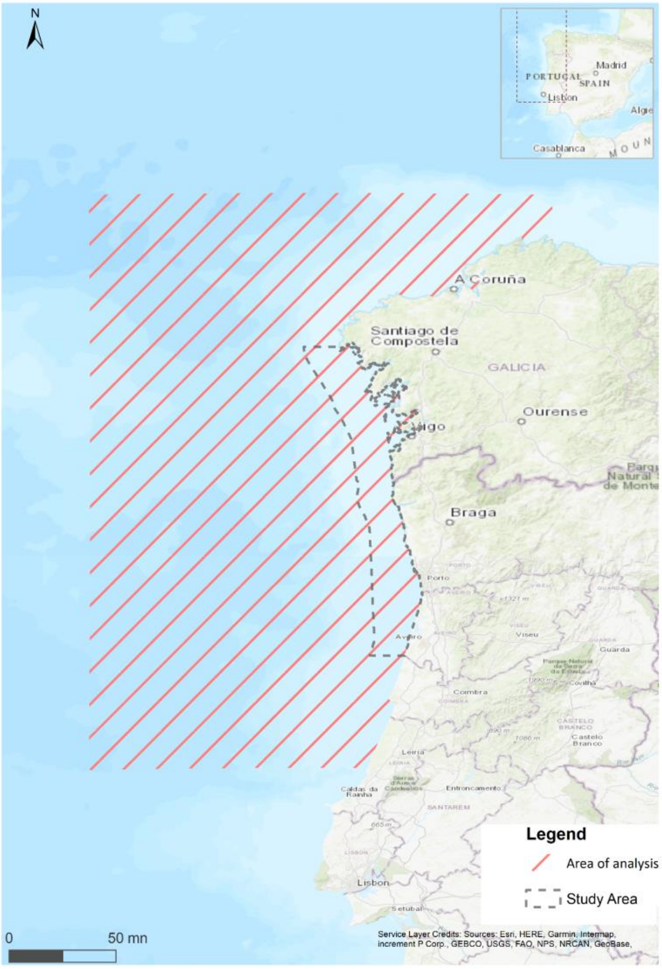

Figure 1. Study area (black dotted line) and area of GIS analysis (red hatching).

The area used for the GIS analysis extended beyond the study area in order to consider the influence distance of some of the pressures and their impact on some of the ecological components outside the study area.

2.1 Ecological components

Two main groups of ecological components were considered as receptors of the pressures produced by the activities: benthic habitats and functional groups of pelagic species.

2.1.1 Benthic habitats

Habitats considered for the case study were derived from MSFD Broad Habitat Types Maps (BHT17) (Commission Decision (EU) 2017/848). Figure 2 shows the study area and the existing habitats identified from this classification. The distribution of these habitats outside the study area is also considered in order to analyse the impacts of pressures that trespass its borders. See Annex I for details about the crosswalk between MSFD BHT17 and marine benthic habitats in EUNIS level 2.

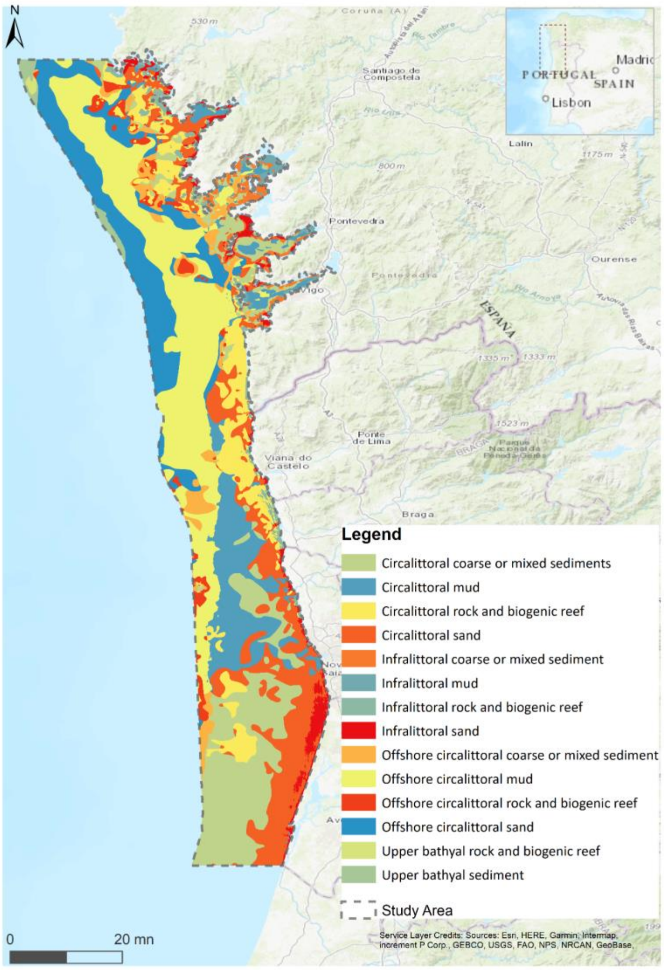

Figure 2. MSFD Broad Habitat Types in the study area (Source: EMODNET).

2.1.2 Functional groups

In this study, three functional groups of pelagic species were considered in regard to exposure to pressures: cetaceans, seabirds and marine turtles. For the applied methodology, as they are “movement” elements, it was considered that they could appear in any place of the case study area at any moment. In this sense, they were homogeneously taken into account in the analysis across the study area and beyond, having the same weight in the GIS analysis.

2.2 Activities and uses

To be coherent across borders, the criteria to select the activities to be analysed was based on their inclusion in the MSP processes in both countries. In this regard, current activities were considered for both countries, meanwhile, potential activities to be developed in the future were only considered for Portugal, while for Spain this information was not available due to it being at an earlier stage in the MSP process.

Table 1. Selected activities and its presence in each country's waters.

Activities	Portugal	Spain
Aquaculture	X	X
Dredging disposal	X	X
Artificial reefs and structures of disposal	X	
Renewable energies (including Energy cables)	X	
Fisheries	X	X
Maritime Transport	X	X

For activities mapped with relevance or intensity maps, such as fisheries and maritime traffic, only core areas of maximum intensity were selected. The distribution of activities can be seen in Figure 3.

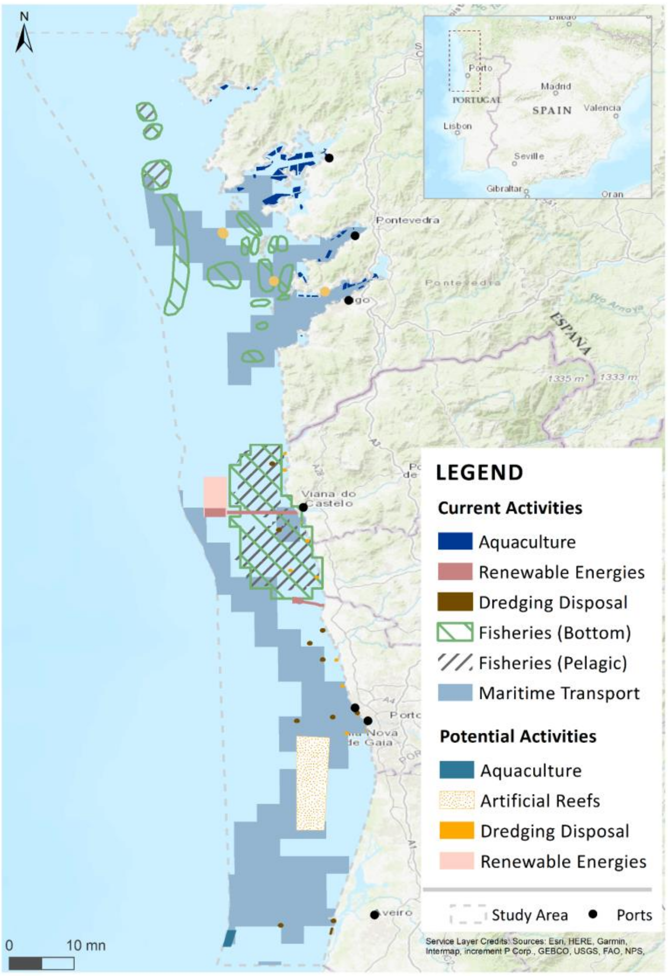

Figure 3. .Activities in the study area.

3 Method

The framework was developed to explore the cause-effect relationships between activities-pressures-impacts and was divided into three main steps. In general, it follows the approach developed previously by Halpern et al., (2008) with adaptations to fit the Case Study.

The first step is the identification of the most likely pressures resulting from activities within the study area. This step also includes definition of the distance of influence for each pressure and an assessment of the intensity of the pressures for each pairwise activity-pressure. The second step is a sensitivity assessment of the ecological components present in the study area to the identified pressures, through a sensitivity matrix. Finally, the third step involves calculation of the Cumulative Impacts, as illustrated in Figure 4. This process was informed by expert judgment of the definition of the sensitivity values and on the distance of influence of the pressures.

Figure 4. Schematic methodology applied adapted from Halpern et al., (2008).

The Cumulative Index (CI) is the cumulative impact and is calculated as the sum of the product of all pressures (*Pi*) effect on all ecological components (Ej), given the particular sensitivity of every ecological component to every pressure (Uij) and a specific Intensity of each pair Activity-Pressure (*Iki)*. The EEA reference grid[2], 1 km per 1km was adapted to be

[2] https://www.eea.europa.eu/data-and-maps/data/eea-reference-grids-2

used in the transboundary area between the Portuguese and Spanish areas. The output is a GIS based map with the predicted cumulative impacts for the study area.

$$\mathrm{CI} = \sum_{i=1}^{n} \sum_{j=1}^{m} \sum_{k=1}^{l} Pi * Ej * Uij * Iki$$

3.1 Identification of Pressures

The identification of pressures follow the definition adopted from the Marine Strategy Framework Directive (MSFD, 2008/56/EU) in Table 2 of Annex III. Table 2 shows the relationship between pressures and activities/uses and their influence distance (in kilometres), adapted from previous works of Fernandes et al., (2020) and updated with information given by the expert group.

Table 2. Pressures and their influence distance for each activity

Pressures	Influence Distance (Km)	Aquaculture	Dredging disposal	Renewable energies (including submarine energy cables)	Artificial reefs & structures disposal	Fishing (Bottom & Pelagic & artisanal)	Maritime transport
Physical							
Physical disturbance to seabed (temporary or reversible)	Local	x	x	x		x	x
Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate)	Local	x	x	x	x		
Changes to hydrological conditions	1km		x	x	x		
Substances, litter and energy							
Input of nutrients — diffuse sources, point sources, atmospheric deposition Input of organic matter — diffuse sources and point sources	10km	x	x			x	
Input of other substances (e.g., synthetic substances, non-synthetic substances, radionuclides) — diffuse	10km	x	x		x		

sources, point sources, atmospheric deposition, acute events							
Input of litter (solid waste matter, including micro-sized litter)	100km	x			x	x	x
Input of anthropogenic sound (impulsive, continuous)	20km	x	x	x	x	x	x
Input of other forms of energy (including electromagnetic fields, light and heat)	5km			x			
Biological							
Input of microbial pathogens	50km	x					
Input or spread of non-indigenous species Input of genetically modified species and translocation of native species Loss of, or change to, natural biological communities due to cultivation of animal or plant species	100km	x					x
Disturbance of species (e.g., where they breed, rest and feed) due to human presence	10km	x		x		x	x
Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities)	10km					x	x

3.2 Experts consultation

A group of experts from Portugal and Spain was invited to participate in this assessment by completing a detailed questionnaire, which was followed by a workshop that took place as an online event on the 30th June, 2021. In total, nine answers were received to the questionnaire and six experts participated in the workshop. The questionnaire followed the approach of Hammar et al., (2020) and aimed to understand the sensitivity of the different ecosystem components to the pressures. Experts were asked to quantify the effects of pressures on individual taxa, ranging from “No response or negligible effect” to “Permanent destruction/change”, and on habitats, ranging from “No change or negligible effect” to “Very high mortality”. Besides the sensitivity of the functional groups and habitats, the experts were asked to classify their answer according to their level of confidence. A distance of influence (Influence distance) of the pressure's effects was also provided and experts were asked to validate it. More information on the questionnaire and workshop can be found in Annex II.

3.3 Definition of sensitivity and intensity of pressures

Specific characteristics by which to define and assess the activity, pressures and effects, such as spatial and temporal dimension, frequency, intensity or persistence, as defined in Elliot, et al., (2020) are highly advisable. In the case study it was not possible to fill these aspects of the activities and determine the magnitude of activity-pressure-footprint with the different characteristics they may comprise. This was mainly due to a lack of consistent and available information from both countries. Therefore, pressures were characterised by their Influence Distance, the Sensitivity of each ecological component to each of them and their Intensity with regard to the activity that produces them.

Table 3. Sensitivity matrix

Ecosystem component	Marine mammals	Turtles	Seabirds	Circalittoral coarse and/or mixed sediment	Circalittoral mud	Circalittoral rock and biogenic reef	Circalittoral sand	Infralittoral coarse and/or mixed sediment	Infralittoral mud	Infralittoral rock and biogenic reef	Infralittoral sand	Offshore Circalittoral coarse and/or mixed sediment	Offshore Circalittoral mud	Offshore Circalittoral rock and biogenic reef	Offshore Circalittoral sand	Upper bathyal rock and biogenic reef	Upper bathyal sediment
Pressures																	
Physical disturbance to seabed (temporary or reversible)	0.24	0.30	0.15	0.27	0.27	0.50	0.30	0.30	0.30	0.40	0.15	0.27	0.30	0.47	0.20	0.47	0.40
Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate)	0.40	0.33	0.20	0.60	0.60	0.75	0.55	0.55	0.55	0.60	0.40	0.60	0.70	0.73	0.53	0.80	0.73

Changes to hydrological conditions	0.35	0.47	0.33	0.50	0.45	0.45	0.40	0.45	0.45	0.40	0.40	0.35	0.40	0.35	0.35	0.40	0.35
Input of nutrients — diffuse sources, point sources, atmospheric deposition	0.28	0.13	0.35	0.30	0.25	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Input of organic matter — diffuse sources and point sources	0.32	0.13	0.35	0.30	0.30	0.25	0.25	0.25	0.25	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events	0.47	0.40	0.50	0.40	0.45	0.33	0.30	0.30	0.35	0.30	0.30	0.30	0.35	0.30	0.30	0.30	0.30

Input of litter (solid waste matter, including micro-sized litter)	0.00	0.30	0.47	0.33	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Input of anthropogenic sound (impulsive, continuous)	0.40	0.27	0.13	0.10	0.10	0.13	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Input of other forms of energy (including electromagnetic fields, light and heat)	0.36	0.20	0.20	0.20	0.10	0.13	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Input of microbial pathogens	0.50	0.47	0.40	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Input or spread of non-indigenous species	0.35	0.40	0.40	0.40	0.30	0.35	0.30	0.35	0.35	0.40	0.30	0.30	0.30	0.40	0.30	0.30	0.30
Input of genetically modified species and translocation of native species	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40

Loss of, or change to, natural biological communities due to cultivation of animal or plant species	0.40	0.47	0.45	0.40	0.33	0.40	0.33	0.40	0.33	0.40	0.33	0.33	0.27	0.33	0.27	0.27	0.27
Disturbance of species (e.g. where they breed, rest and feed) due to human presence	0.50	0.60	0.60	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities)	0.40	0.40	0.40	0.65	0.65	0.65	0.65	0.67	0.65	0.65	0.65	0.65	0.60	0.60	0.60	0.60	0.60

Influence distance was obtained as the spatial distribution of pressures. It resulted from the application of a buffer (matching the pressures influence distance) to the activities that produced them.

Intensity was defined for each pairwise Activity-Pressure ranging from 1 (low) to 3 (high). This means that the same pressure, for example, *Input of Anthropogenic sound* may have a value of 1 if produced by aquaculture or a value of 3 if produced by marine transport. Table 4 shows the complete relationship

Table 4. Intensities assigned to pressures produced by activities.

Activity	**Aquaculture**	**Dredging disposal**	**Renewable energies**	**Artificial reefs & structures disposal**	**Fishing (Bottom)**	**Fishing (Pelagic)**	**Maritime transport**
Pressure	***Physical***						
Physical disturbance to seabed (temporary or reversible)	1	3	2		3	1	1
Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate)	2	3	2				
Changes to hydrological conditions		2	2	3			

Substances, litter and energy							
Input of nutrients — diffuse sources, point sources, atmospheric deposition Input of organic matter- diffuse sources and point sources	2	2			1	1	
Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events	2	2		1			
Input of litter (solid waste matter, including micro-sized litter)	2			1	2	2	1
Input of anthropogenic sound (impulsive, continuous)	1	2	2	2	2	2	3
Input of other forms of energy (including electromagnetic fields, light and heat)			3				

Biological							
Input of microbial pathogens	2						
Input or spread of non-indigenous species Input of genetically modified species and translocation of native species Loss of, or change to, natural biological communities due to cultivation of animal or plant species	2						3
Disturbance of species (e.g. where they breed, rest and feed) due to human presence	1		2		3	3	3
Extraction of, or mortality/injury to, wild species (by commercial and recreational fishing and other activities)					3	3	1

4 Results

The sum of all impacts in all Ecological Components from both countries is seen in the following Figures 5 to 9.

The impacts produced from current activities in Portugal are concentrated along the northern border, crossing the border to the Spanish province of Galicia, while the impacts from current activities in Spain are located on the northern limit of the study area. Impacts occupy all the study area and expand for several kilometres.

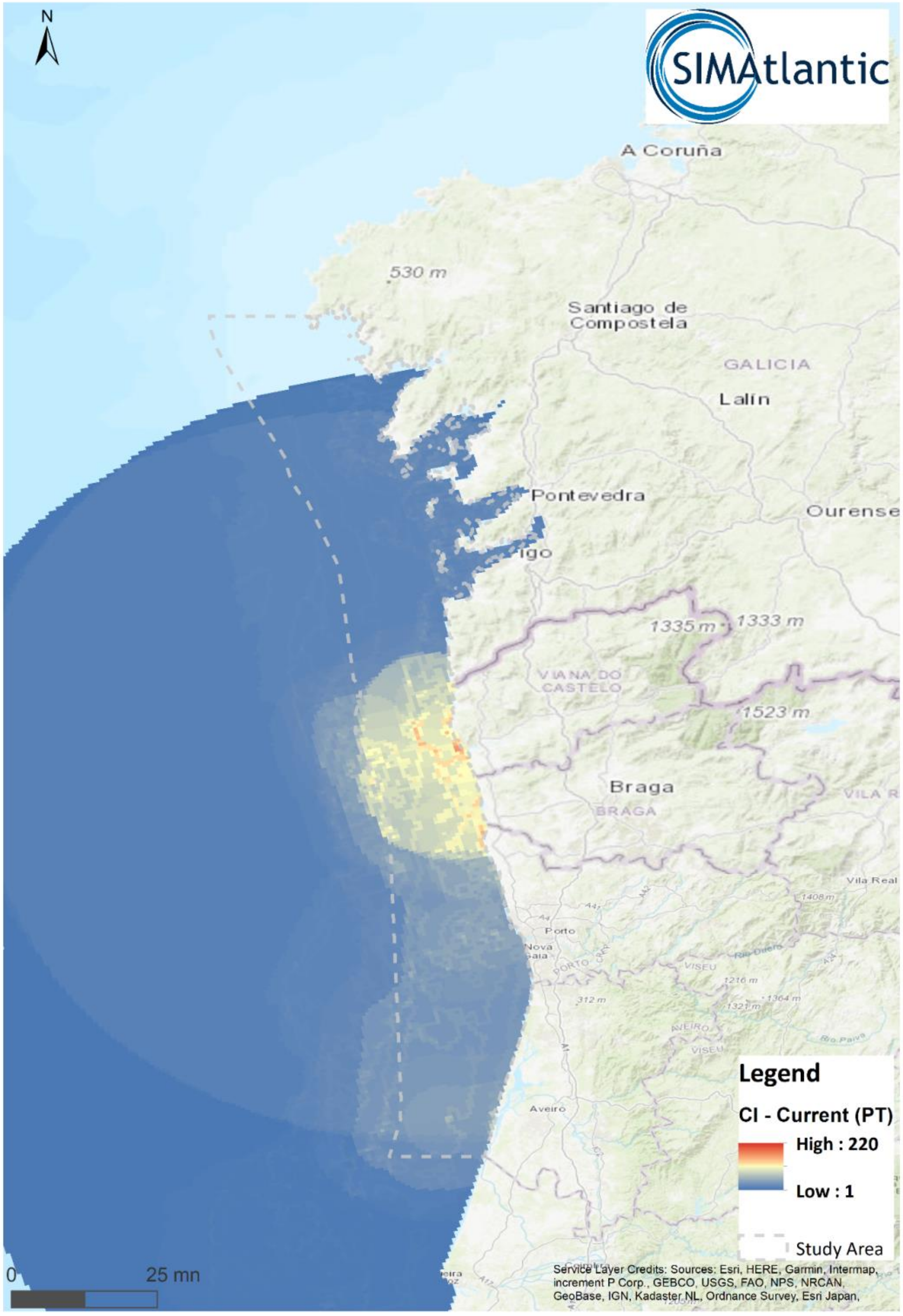

Figure 5. Cumulative impacts from current activities in Portugal.

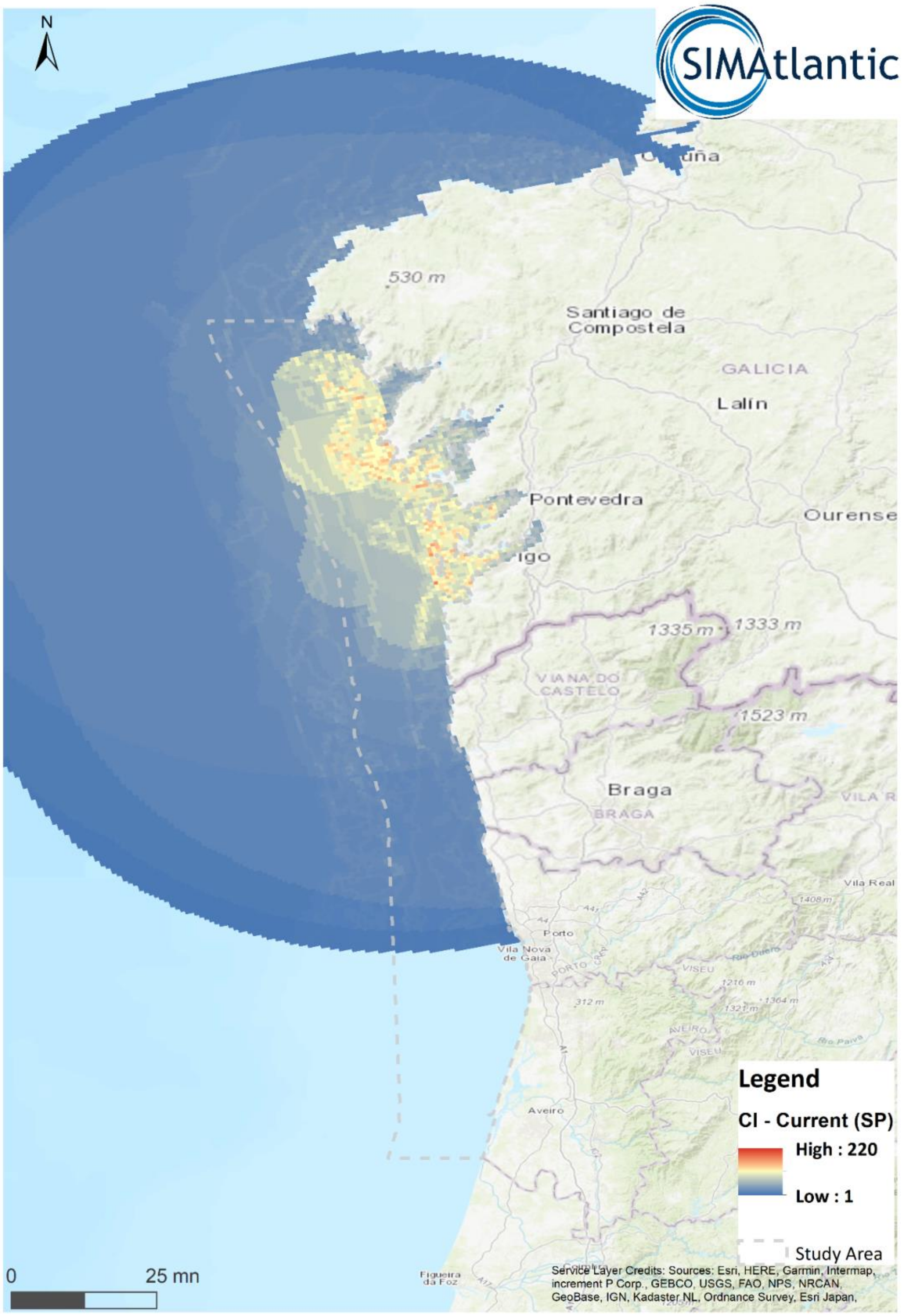

Figure 6. Cumulative impacts from current activities in Spain.

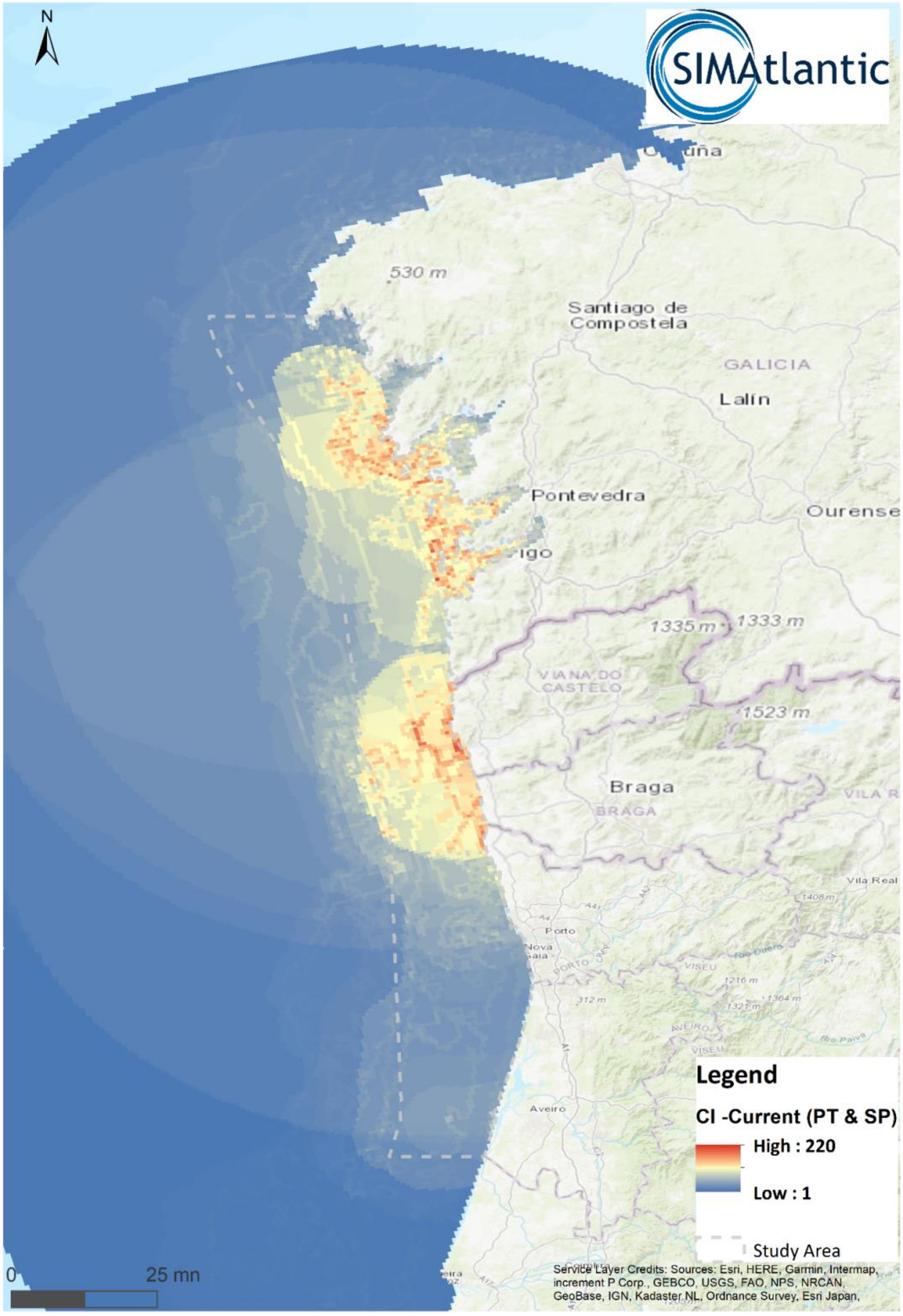

Figure 7. Cumulative impacts from current activities in Portugal and Spain.

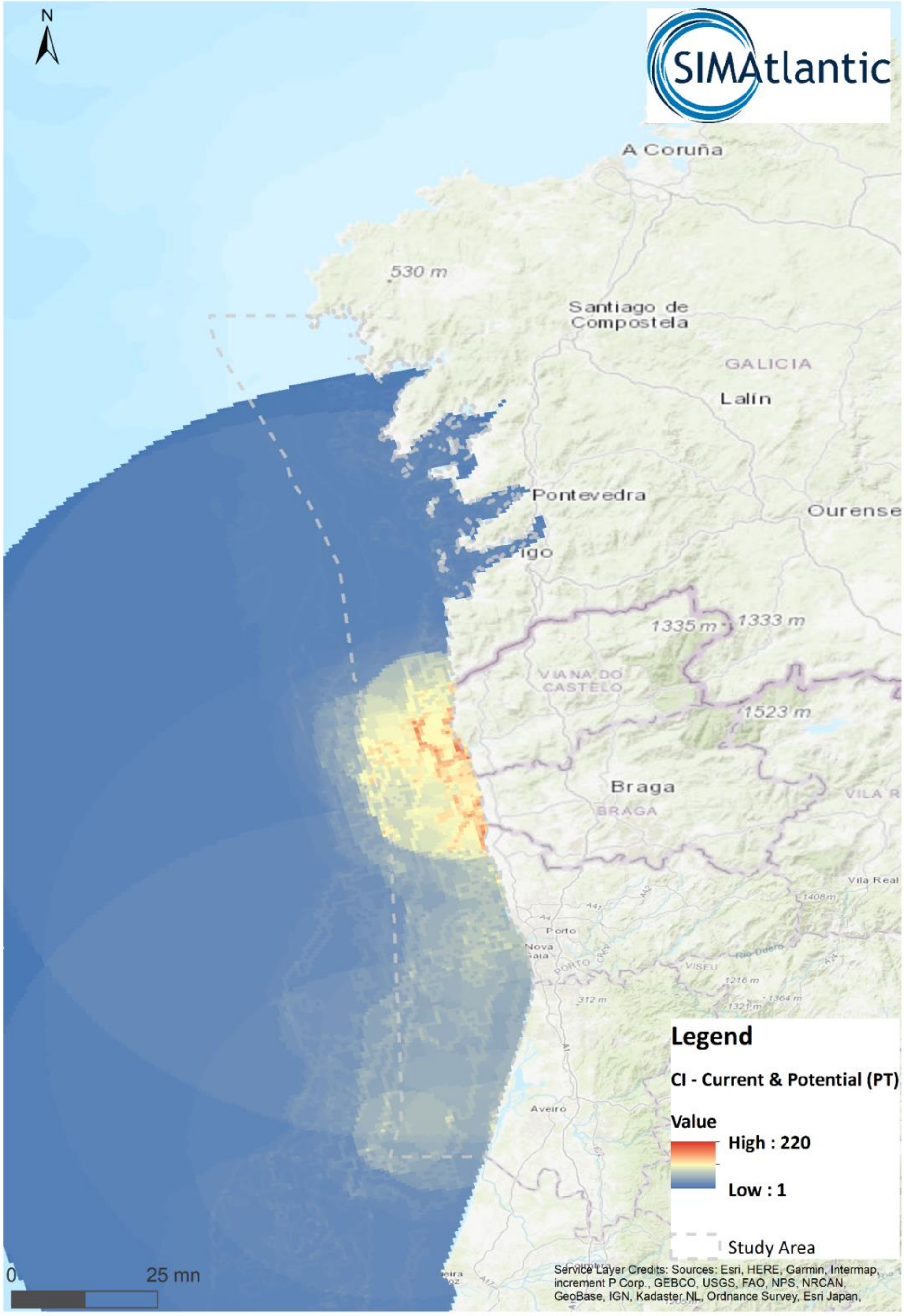

Figure 8. Cumulative impacts from current and potential activities in Portugal.

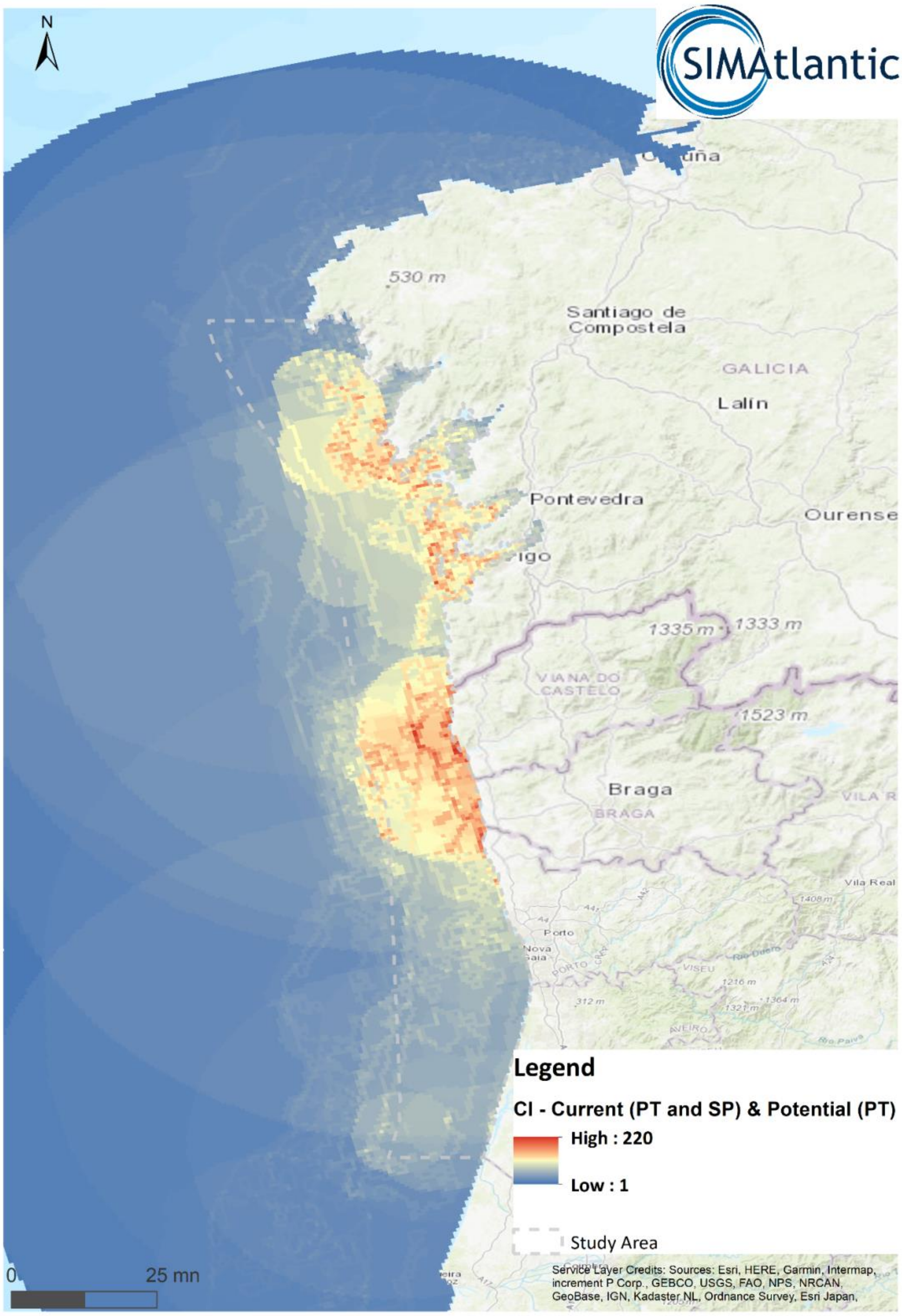

Figure 9. Cumulative impacts from current and potential activities in Portugal and current activities in Spain.

In Annex III the output maps for each Ecological component can be consulted, for:

1. Current activities in Portugal;
2. Current and potential activities in Portugal;
3. Current activities in Spain.

4.1 Cumulative impacts and Marine Protected Areas

Figures 10 and 11 show maps that illustrate that the highest intensity of impacts in the northern part of the study area (Spanish waters) overlaps with a designated Special Protected Area (SPA) and Special Areas for Conservation (SAC), included in the Natura 2000 network, accordingly to the Birds and Habitats Directive, and other protected areas such as the Atlantic Islands Maritime-Terrestrial National Park and a few Natural parks. National and Natural Parks differ in Spain with regard to the legislation that regulates them and their grade of protection, differing substantially in the activities that could take place in one or in another. In this sense, National Parks have a legal status of greater degree of protection as they are *"natural areas of high natural and cultural value, little altered by human activity which, due to their exceptional natural values, their representative character, the uniqueness of their flora, fauna or geomorphological formations, deserves preferential conservation attention and is declared of general national interest for being representative of the Spanish natural heritage"*; while Natural Parks are "*natural areas which, the landscapes, the representativeness of their ecosystems or the uniqueness of their flora, fauna or geological diversity, including their geomorphological formations, have ecological, aesthetic, educational and scientific values whose conservation deserves preferential attention*".

In Portuguese waters there is also a coincidence of higher cumulative impacts with coastal classified areas, namely a Natural Park and also a designated Site of Community Importance (SCI) in the vicinity of Viana do Castelo. In this sense, Natural Park is "*an area that contains ecosystems (natural or semi natural), where the long-term preservation of biodiversity depends on human activities, ensuring a sustainable flow of natural products and services. When they integrate marine areas, their management plans may designate Marine Parks, which aim the protection, enhancement and sustainable use of marine resources through the harmonious integration of human activities*".

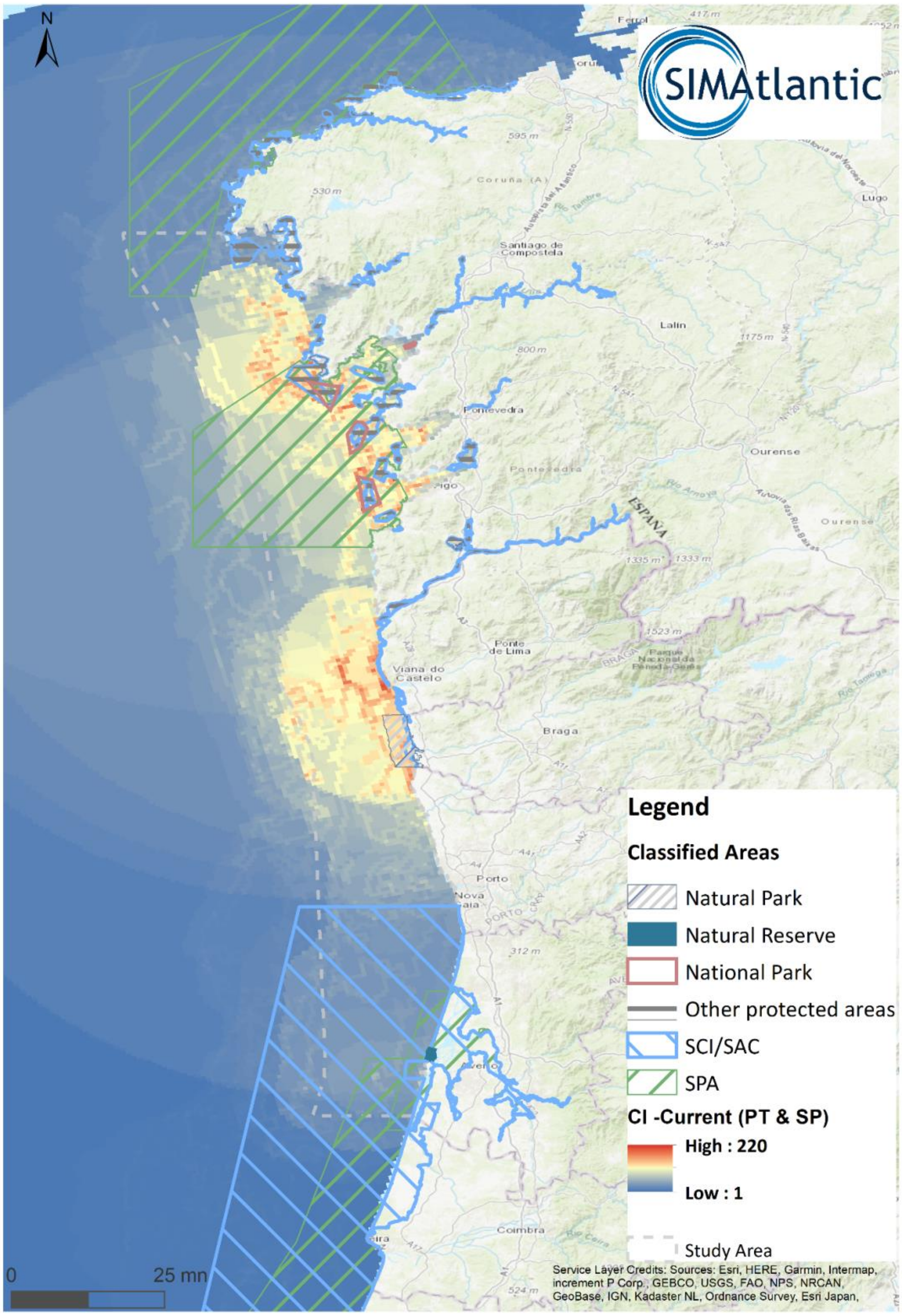

Figure 10.Cumulative Impacts from current activities in Portugal and Spain and the MPAs in the area.

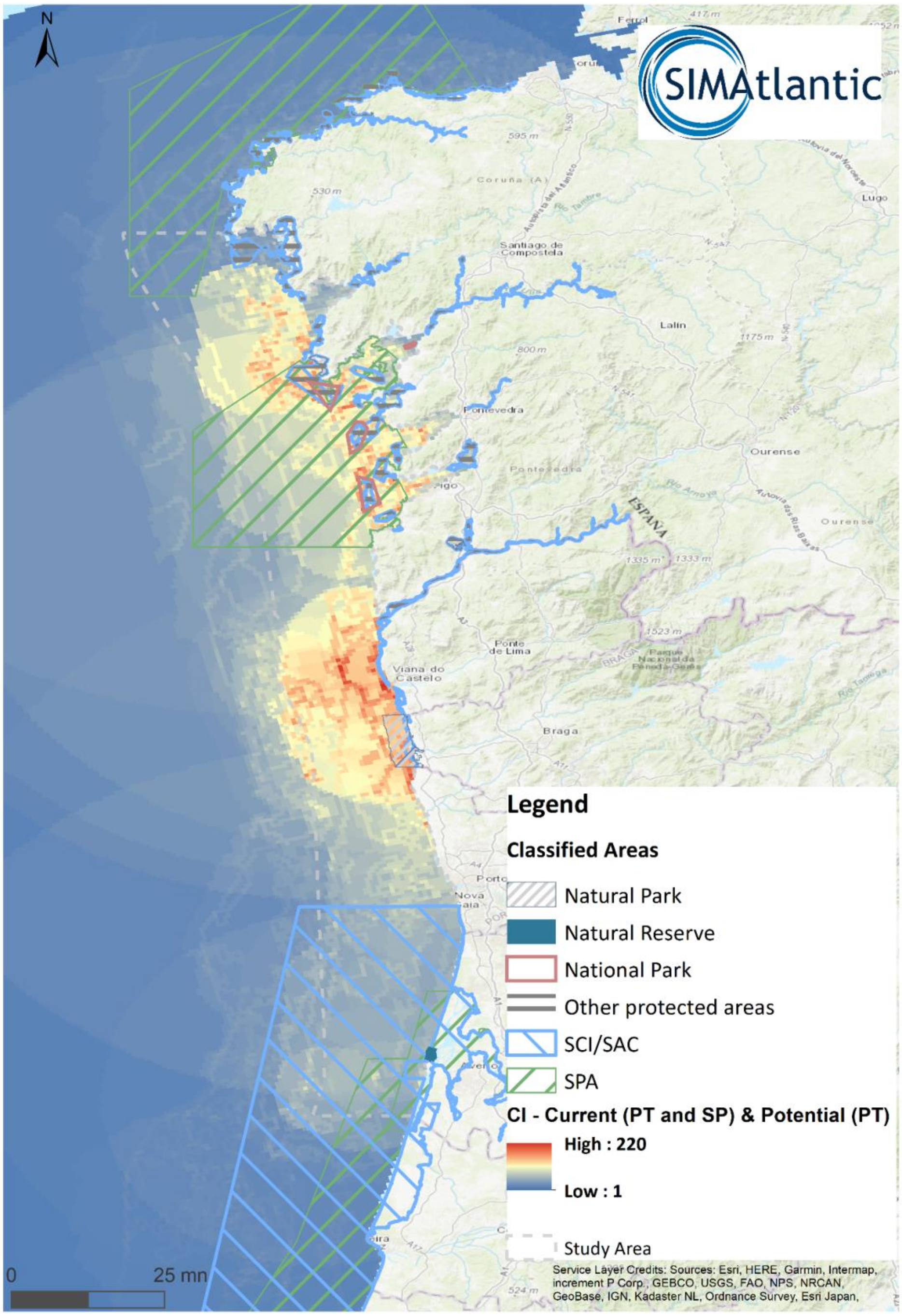

Figure 11. Cumulative impacts from current activities in Portugal and Spain, potential activities in Portugal and MPAs in the area.

5 Discussion

5.1 Limitations and lessons learnt

Limitations encountered when developing the methodology were related to different information inputs to the process, i.e., spatial data availability, the way in which spatial distribution of activities was expressed in each country, the acquisition and process of expert knowledge and the design of the method itself.

Regarding spatial data, initially difficulties to identify comparable datasets of available data in each country were found, due to the different information available, scales of data and formats, so there was the need to use European models/datasets for some specific cases (i.e., habitats, maritime transport) or to adapt the format of national data.

In the case of habitats distribution, the EUNIS model was selected in order to use a coherent dataset across borders, and then a crosswalk was designed to assign the definition of the MSFD Broad Habitat Types to the EUNIS data. The rationale behind this was that these definitions were considered to be more “familiar” for the experts involved in the consultations regarding their sensitivity. In the case of functional groups of species, no spatial data of their distribution was available, which led to the consideration of this ecological component homogeneously throughout the whole area.

Due to the unavailability of data on fishing effort for Portugal, for Spanish data only the core areas of fishing effort were considered in order to be coherent with data from the Portuguese side that represented “relevant areas for fishing”.

With regard to the experts' inputs to the different components of the methodology, there were different limitations encountered. Answers received were very limited (nine) which prevented proper statistical analysis and, therefore, the delivering of consistent results to inform a decision. In addition, participation in the experts´ workshop was too low (6 people) to obtain significant validation of the sensitivity results. The number of experts by ecological component is another element to take into account, most of the participants were habitat experts. It should be ensured that there is a relevant (and proportional) number of experts for each ecological component, which in this case was not possible. In this regard too, and in connection with the habitats definitions used, a need was found to be more specific in their definition so that expert judgments could be more precise. In the same sense, but related to the definition and identification of activities, there was found a need to specify more the connection of pressures and activities and their particular characteristics.

5.2 Proposed issues for improving the method

The application of the methodology Cumulative Effects Assessment (CEA) used in this study has demonstrated its utility and ability to contribute towards an Ecosystem Based Approach for MSP. The results also identify recommendations that would improve the method in relation to the characterization of baseline conditions of the ecological components; the evaluation of pressures and their behaviour and the uncertainty regarding different elements of the assessment.

The general methodology could be improved with a careful analysis of the baseline conditions of both ecological components and the activities taking place. Besides informing on the presence/absence of habitats, assessment of habitat's condition should be conducted to feed the analysis. Regarding activities currently taking place, it is highly advisable to gather data to support characterization of activities, in all their phases (construction, exploration and decommission). This information feeds into and improves the overall characterization of the derived pressures and their different dimensions (spatial and temporal, frequency, intensity or persistence, influence distance, etc). In this study pressures' behaviour was simplified, considering that they were distributed homogeneously through their influence distance without reducing in intensity or changing trajectory. Therefore, this approach does not take into account the reduction of intensity as it moves away from the source, or the chemical processes and/or hydrodynamics conditions, that are important aspects to assess the real distribution of pressures.

Uncertainty should be assessed, and, for that, confidence levels of the different value's variables should be measured. In Hammar et al., (2020) the approach for measuring uncertainty within the study area was reserved to the creation of a map showing the level of confidence of the ecological components, depending on the accuracy of the data (i.e., interpolation, distribution model, accurate validated model or field measurement). Gissi et al., (2017) used the Local Sensitivity Confidence Index (LSCI) defining the spatial reliability of the CI score per grid cell in relation to the knowledge level expressed by experts on the sensitivities through the confidence of each sensitivity relationship.

In this study, it was assumed that all impacts are additive, therefore interactions between them are not considered. In order to perform a relevant assessment of the significance of the impacts over an ecological component, the interaction among them needs to be considered (i.e., if they are antagonists, synergetic or just additive). When evaluating the impact, threshold and carrying capacity of the specific component should also be taken into account.

Besides these methodological aspects, overall there is a need to improve the involvement and number of experts, for habitats and species, and the way their inputs are considered. A statistically significant number of inputs by ecological component is needed to conduct an appropriate statistical analysis of the results.

Finally, for the purpose of informing a MSP process faithfully, detailed information of potential future activities as well as other coastal activities, source of Land Sea Interactions (LSI), should be also considered.

References

Andersen, J.H., Stock, A., 2013. Human Uses, Pressures and Impacts in the Eastern North Sea. Aarhus University, DCE—Danish Centre for Environment and Energy. Technical Report from DCE—Danish Centre for Environment and Energy No. 18.

Ban, N.C., Alidina, H.M., Ardron, J.., 2010. Cumulative impact mapping: Advances, relevance and limitations to marine management and conservation, using Canada's Pacific waters as a case study. Mar. Policy 34, 876–886. https://doi.org/10.1016/j.marpol.2010.01.010

Casimiro, D., Quintela, A., Matias, J., Sousa, L., Simão, A., Alves, F., 2021. D3.2 Cumulative impacts and Strategic Environmental Assessment : Literature review. Deliverable 3.2 of the SIMAtlantic project (EASME/EMFF/2018/1.2.1.5/SI2.806423) 26.

DGRM, 2019a. Volume III - A. Plano de Situação do Ordenamento do Espaço Marítimo Nacional - Espacialização de servidões, usos e atividades (Continente e Plataforma continental estendida).

DGRM, 2019b. Volume V - Plano de Situação do Ordenamento do Espaço Marítimo Nacional. Relatório Ambiental PSOEM.

EU, 2008. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). European Commission.

Fernandes, M.L., Sousa, L.P., Quintela, A., Marques, M., Reis, J., Simão, A.P., Castro, A.T., Marques, J.M., Alves, F.L., 2020. Mapping the future: Pressures and impacts in the Portuguese maritime spatial planning. Sci. Total Environ. 715, 136863. https://doi.org/10.1016/j.scitotenv.2020.136863

Halpern, B.S., Walbridge, S., Selkoe, K. a, Kappel, C. V, Micheli, F., D'Agrosa, C., Bruno, J.F., Casey, K.S., Ebert, C., Fox, H.E., Fujita, R., Heinemann, D., Lenihan, H.S., Madin, E.M.P., Perry, M.T., Selig, E.R., Spalding, M., Steneck, R., Watson, R., 2008. A global map of human impact on marine ecosystems. Science 319, 948–952. https://doi.org/10.1126/science.1149345

Hegmann, G., Cocklin, C., Creasey, S., Dupuis, S., Kennedy, A., Kingsley, L., Ross, W., Spaling, H., Stalker, D., 1999. Cumulative Effects Assessment Practitioners Guide, Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency.

OSPAR Commission, 2009. Trend analysis of maritime human activities and their collective impact on the OSPAR maritime area.

Annex I – Crosswalk between MSFD Broad Habitat types and EUNIS classification

MSFD broad habitat types	EUNIS code	EUNIS habitat description (v.2019)
Infralittoral rock and biogenic reef	MB1	Infralittoral rock includes habitats of bedrock, boulders and cobbles which occur in the shallow subtidal zone and typically support seaweed communities. The upper limit is marked by the top of the kelp zone whilst the lower limit is marked by the lower limit of kelp growth or the lower limit of dense seaweed growth. Infralittoral rock typically has an upper zone of dense kelp (forest) and a lower zone of sparse kelp (park), both with an understorey of erect seaweeds. In exposed conditions the kelp is *Laminaria hyperborea* whilst in more sheltered habitats it is usually *Laminaria saccharina*; other kelp species may dominate under certain conditions. On the extreme lower shore and in the very shallow subtidal (sublittoral fringe) there is usually a narrow band of dabberlocks *Alaria esculenta* (exposed coasts) or the kelps *Laminaria digitata* (moderately exposed) or *L. saccharina* (very sheltered). Areas of mixed ground, lacking stable rock, may lack kelps but support seaweed communities. In estuaries and other turbid-water areas the shallow subtidal may be dominated by animal communities, with only poorly developed seaweed communities.
	MB2	This complex includes polychaete reefs, bivalve reefs (e.g. mussel beds). These communities develop in a range of habitats from exposed open coasts to estuaries and marine inlets and may be found in a variety of sediment types and salinity regimes.
Infralittoral coarse and/or mixed sediment	MB3	Sedimentary habitats in the infralittoral near shore zone, typically extending from the extreme lower shore down to the lower limit for vascular plants. Sediment ranges from boulders and cobbles, through pebbles and shingle, coarse sands, sands, fine sands, muds, and mixed sediments. Those communities found in or on sediment are described within this broad habitat type.

	MB4	Infralittoral mixed (heterogeneous) sediments found from the extreme low water mark to down to the lower limit for vascular plants. These habitats incorporate a range of sediments including heterogeneous muddy gravelly sands and also mosaics of cobbles and pebbles embedded in or lying upon sand, gravel or mud. There is a degree of confusion with regard to nomenclature within this complex as many habitats could be defined as containing mixed sediments, in part depending on the scale of the survey and the sampling method employed. The BGS trigon can be used to define truly mixed or heterogeneous sites with surficial sediments which are a mixture of mud, gravel and sand. However, another 'form' of mixed sediment includes mosaic habitats such as superficial waves or ribbons of sand on a gravel bed or areas of lag deposits with cobbles/pebbles embedded in sand or mud and these are less well defined and may overlap into other habitat or biological subtypes. These habitats may support a wide range of infauna and epibiota including polychaetes, bivalves, echinoderms, anemones, hydroids and Bryozoa. Mixed sediments with biogenic reefs classified separately as MB2.
Infralittoral mud	MB6	Sublittoral mud and cohesive sandy mud extending from the extreme lower shore to the lower limit of vascular plants. This biotope is predominantly found in sheltered harbours, sealochs, bays, marine inlets and estuaries and stable deeper/offshore areas where the reduced influence of wave action and/or tidal streams allow fine sediments to settle. Such habitats are often dominated by polychaetes and echinoderms, in particular brittlestars such as Amphiura spp. Estuarine muds tend to be characterised by infaunal polychaetes and oligochaetes.
Infralittoral sand	MB5	Clean medium to fine sands or non-cohesive slightly muddy sands on open coasts, offshore or in estuaries and marine inlets. Such habitats are often subject to a degree of wave action or tidal currents which restrict the silt and clay content to less than 15%. This habitat is characterised by a range of taxa including polychaetes, bivalve molluscs and amphipod crustacea.
Circalittoral sand	MC5	Circalittoral clean fine sands with less than 5% silt/clay in deeper water, or either on the open coast or in tide-swept channels of marine inlets in depths of over 15-20 m or non-cohesive muddy sands with the silt content of the substratum typically ranging from 5% to 20% generally found in water depths of over 15-20 m. This habitat is generally more stable than shallower, infralittoral sands and consequently supports a more diverse community. This habitat extends offshore, while very little information is available on these they are likely to be more stable than their shallower counterparts. This habitat is characterised by a range of taxa including polychaetes, bivalve molluscs and amphipod crustacea.

Circalittoral mud	MC6	Circalittoral mud and sandy mud typically with over 20% silt/clay, generally in water depths of over 10 m. Sea pens such as *Virgularia mirabilis* and brittlestars such as Amphiura spp. are particularly characteristic of this habitat
Circalittoral rock and biogenic reef	MC1	Circalittoral rock is characterised by animal dominated communities (a departure from the algae dominated communities in the infralittoral zone). The circalittoral zone can itself be split into two sub-zones; upper circalittoral (foliose red algae present but not dominant) and lower circalittoral (foliose red algae absent). The depth at which the circalittoral zone begins is directly dependent on the intensity of light reaching the seabed; in highly turbid conditions, the circalittoral zone may begin just below water level at mean low water springs (MLWS). The biotopes identified in the field can be broadly assigned to one of three energy level categories: high, moderate and low energy circalittoral rock (used to define the habitat complex level). The character of the fauna varies enormously and is affected mainly by wave action, tidal stream strength, salinity, turbidity, the degree of scouring and rock topography. It is typical for the community not to be dominated by single species, as is common in shore and infralittoral habitats, but rather comprise a mosaic of species. This, coupled with the range of influencing factors, makes circalittoral rock a difficult area to satisfactorily classify; particular care should therefore be taken in matching species and habitat data to the classification.
	MC2	Biogenic reefs in the circalittoral zone formed by a variety of organisms, includes polychaete reefs, bivalve reefs (e.g. mussel beds) and cold water coral reefs in the circalittoral zone. These communities develop in a range of habitats from exposed open coasts to estuaries, marine inlets and deeper offshore habitats and may be found in a variety of sediment types and salinity regimes.
Offshore circalittoral rock and biogenic reef	MD1	Offshore (deep) circalittoral habitats on rocky substrates, these habitats are not affected by wave action.
	MD2	Offshore (deep) circalittoral habitats formed by organisms such as cold water corals and bivalves, these habitats are not affected by wave action.

Offshore circalittoral coarse and/or mixed sediment	MD3	Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little quantitative data available. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore mixed sediments and in some areas settlement of *Modiolus modiolus* larvae may occur and consequently these habitats may occasionally have large numbers of juvenile *M. modiolus*. In areas where the mussels reach maturity their byssus threads bind the sediment together, increasing stability and allowing an increased deposition of silt leading to the development of the biotope *Modiolus modiolus* beds with *Chlamys varia*, sponges, hydroids and bryozoans on slightly tide-swept very sheltered Atlantic circalittoral mixed substrata.
	MD4	Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to offshore gravels and coarse sands and, in some areas, populations of the horse mussel *Modiolus modiolus* may develop in these habitats.
Offshore circalittoral sand	MD5	Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.
Offshore circalittoral mud	MD6	In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70 m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. Communities are typically dominated by polychaetes but often with high numbers of bivalves such as Thyasira spp., echinoderms and foraminifera.
Upper bathyal rock and biogenic reef	ME1	Upper bathyal benthic habitats with substrates predominantly of bedrock, immobile boulders or artificial hard substrates.
	ME2	Biogenic habitats formed by organisms such as cold water corals in the upper bathyal zone

Upper bathyal sediment	ME3	Deep-sea coarse sediment has not been sampled widely for infauna so little is currently known about infaunal community structure. Epifauna tend to be sparse mobile species or burrowing fauna such as anemones visible at the surface. In the absence of ecological data, coarse sediment habitat can be defined according to Long (2006), which describes the classification's broad sediment types according to the relative proportion of mud, sand and gravel (see p3 of UKSeaMap 2010 technical report 3 http://jncc.defra.gov.uk/pdf/UKSeaMap2010_TechnicalReport_3_Substrate2.pdf). It can be difficult to reliably distinguish between coarse sediment and mixed sediment using video data only. Note that mixed sediment has a greater mud content than coarse sediment. If sediment particles are large enough to be classed as gravel using the Folk classification then sediment would be classed as coarse sediment rather than sand. If sand contains a high enough percentage of gravel it is also classed as coarse sediment. Coral rubble is classed as coarse sediment. Stable pebbles, cobbles and boulders are classed as rock; any rock present on coarse sediment is considered a separate habitat within a mosaic.
	ME4	Upper bathyal benthic habitats with substrates predominantly of mixed particle size or gravel. Includes habitats with mobile substrates of biogenic origin but no longer living, and of allochthonous material such as macrophyte debris.
	ME5	Sandy sediments in the upper bathyal zone
	ME6	Mud and cohesive sandy mud in the upper bathyal zone

Annex II – Questionnaire sent to experts

<u>Questions and criteria for defining sensitivity scores -</u> *based on Hammar et al.,(2020)*

Assessment confidence

Denote your assessment confidence by one of the three levels:

1. high confidence
2. some confidence
3. low confidence

Assessment criteria

Individual taxa (marine mammals, turtles or seabirds)		**Habitats**	
0.0	No response or negligible effect	0.0	No change or negligible effect
0.2	Low stress	0.2	Low disturbance
0.4	Stress with implications for survival or reproduction	0.4	Disturbance with implications for long term persistence
0.6	Very severe stress or occasional direct mortality	0.6	Very severe disturbance or occasional direct destruction/change
0.8	Frequent mortality	0.8	Partial destruction/change
1.0	Very high mortality	1	Permanent destruction/change

Ecosystem component	Pelagic species						Habitats																											
	Marine mammals	*Confidence*	Turtles	*Confidence*	Seabirds	*Confidence*	Circalitoral coarse and/or mixed sediment	*Confidence*	Circalittoral mud	*Confidence*	Circalittoral rock and biogenic reef	*Confidence*	Circalittoral sand	*Confidence*	Infralittoral coarse and/or mixed sediment	*Confidence*	Infralittoral mud	*Confidence*	Infralittoral rock and biogenic reef	*Confidence*	Infralittoral sand	*Confidence*	Offshore Circalittoral coarse and/or mixed sediment	*Confidence*	Offshore Circalittoral mud	*Confidence*	reef	*Confidence*	Offshore Circalittoral sand	*Confidence*	Upper bathyal rock and biogenic reef	*Confidence*	Upper bathyal sediment	*Confidence*
Pressures	**Physical**																																	
Physical disturbance to seabed (temporary or reversible)																																		
Physical loss (due to permanent change of seabed substrate																																		
Changes to hydrological conditions																																		
	Substances, litter and energy																																	
Input of nutrients — diffuse sources, point sources,																																		
Input of organic matter — diffuse sources and point sources																																		
Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events																																		
Input of litter (solid waste matter, including micro-sized																																		
Input of anthropogenic sound (impulsive, continuous)																																		
Input of other forms of energy (including electromagnetic																																		
	Biological																																	
Input of microbial pathogens																																		
Input or spread of non-indigenous species																																		
Input of genetically modified species and translocation of																																		
Loss of, or change to, natural biological communities due to																																		
Disturbance of species (e.g. where they breed, rest and																																		
Extraction of, or mortality/injury to, wild species (by																																		

Annex III – Maps

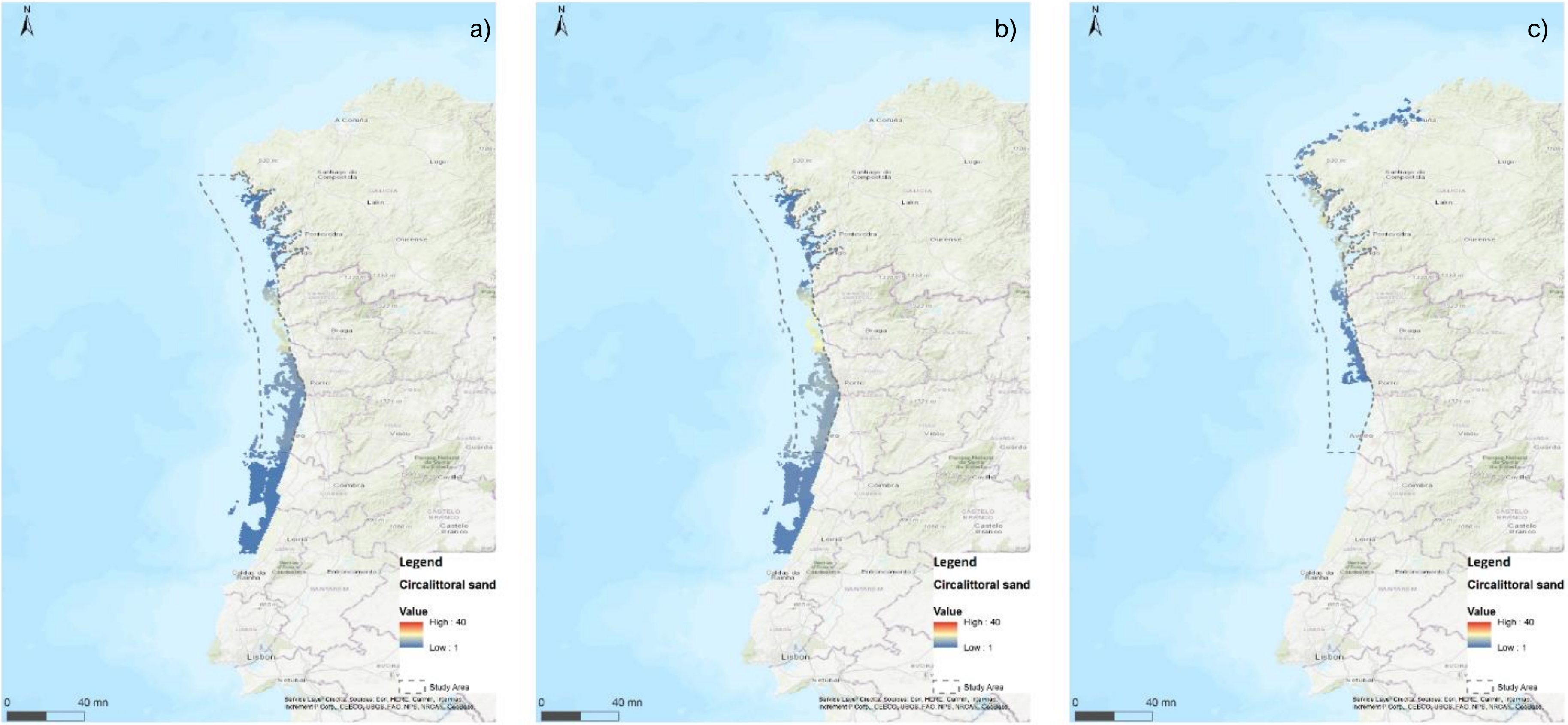

Figure III – 1. Cumulative Impacts for **Circalittoral Sand**. a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

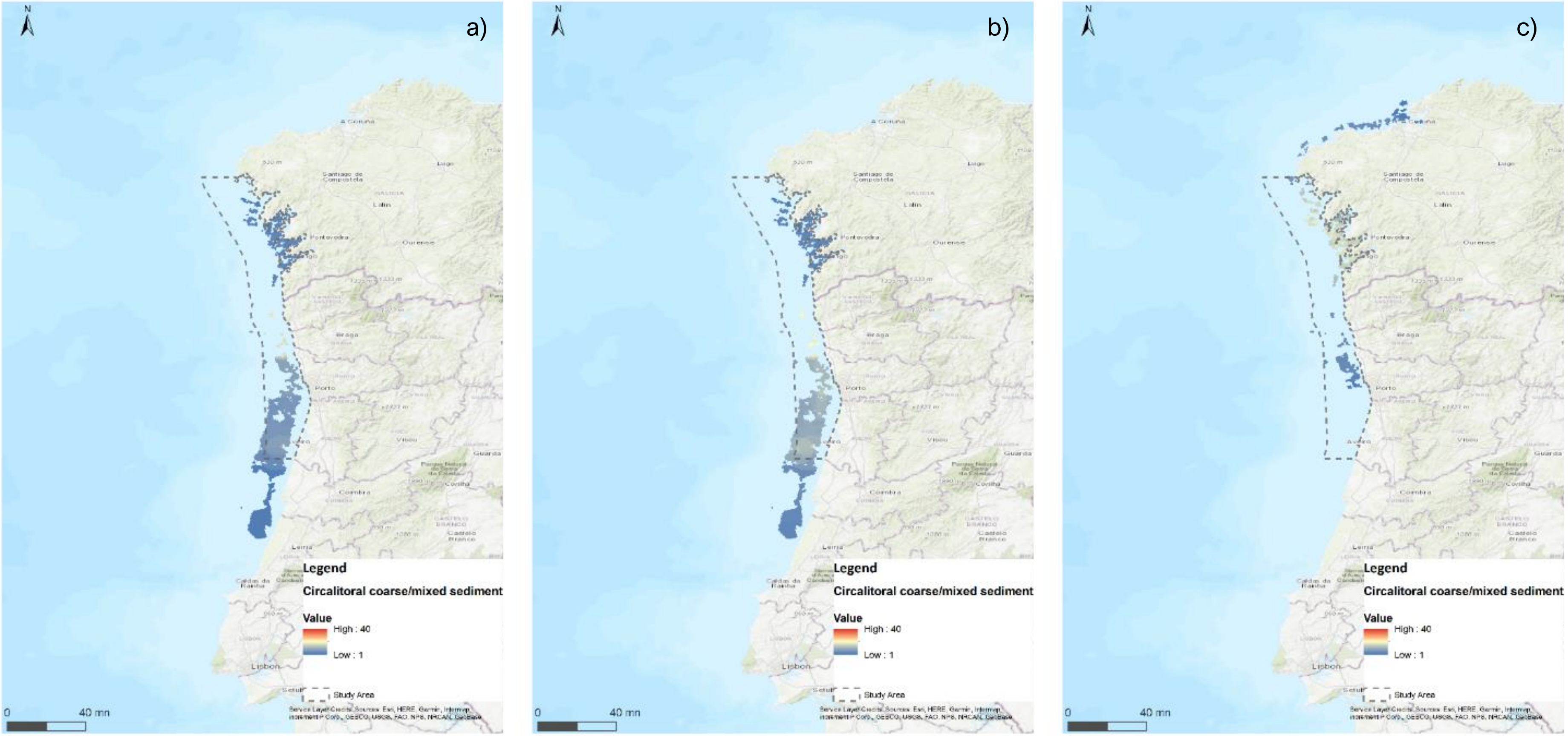

Figure III – 2. Cumulative Impacts for **Circalittoral Coarse and Mixed Sediment** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

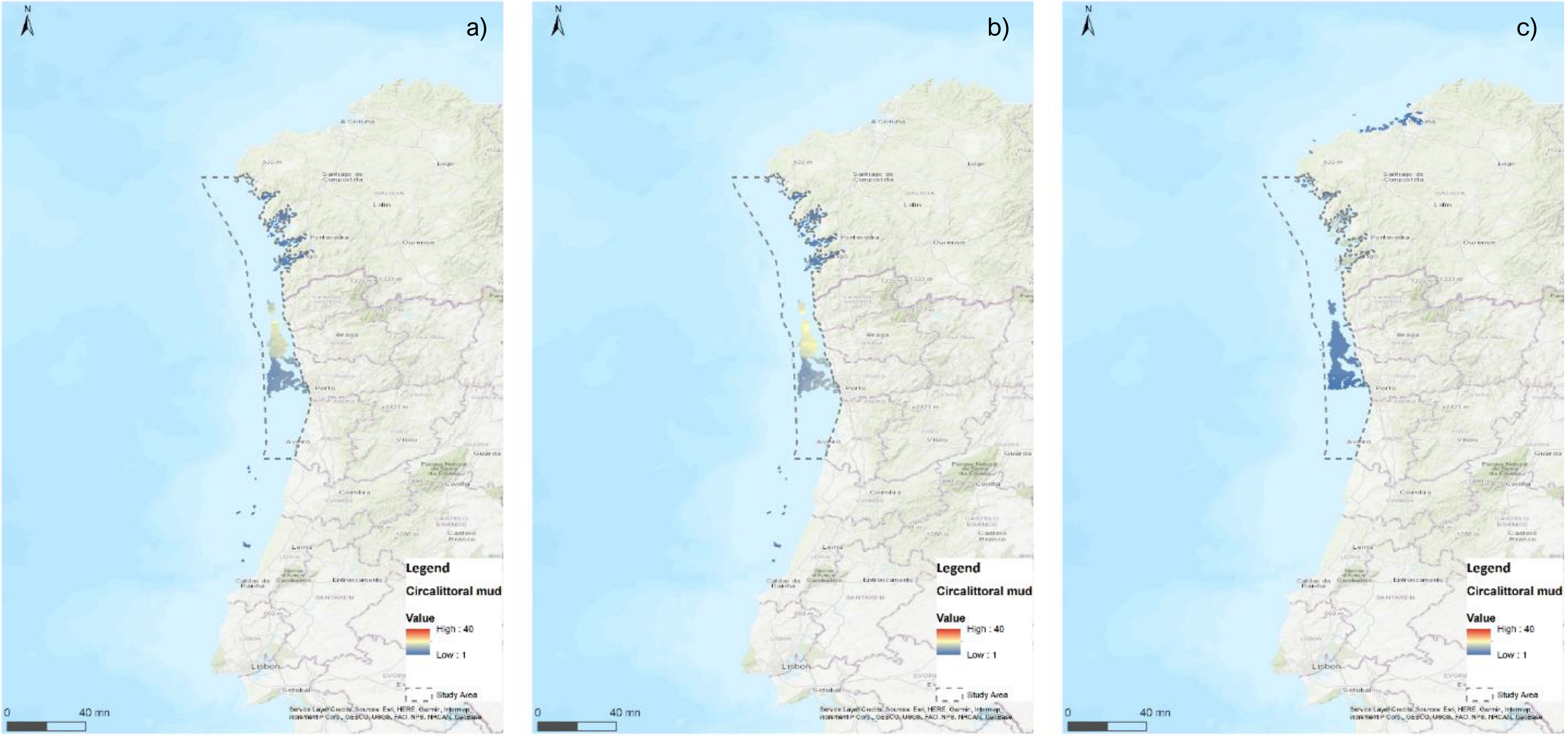

Figure III – 3. Cumulative Impacts for **Circalittoral Mud** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

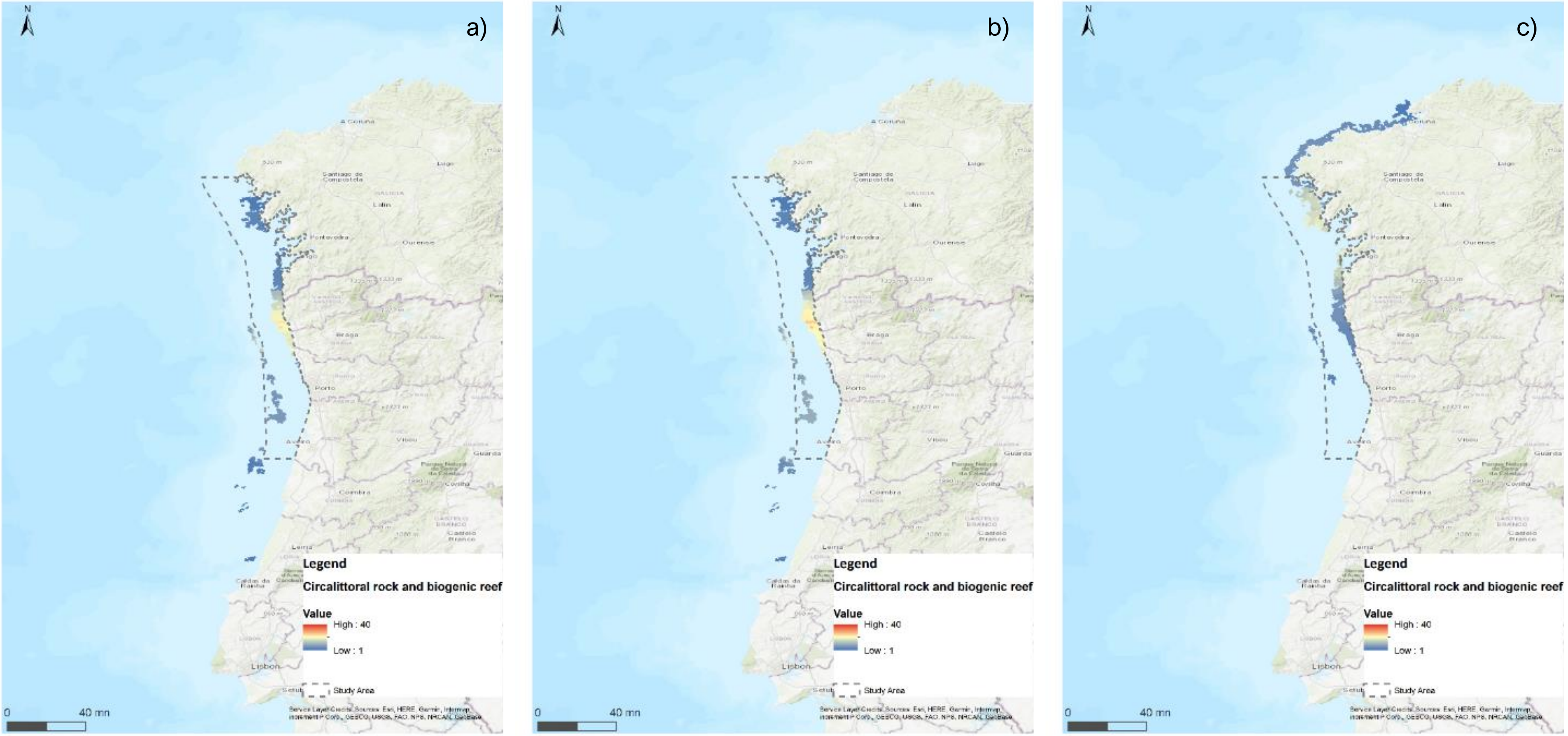

Figure III – 4. Cumulative Impacts for **Circalittoral Rock and Biogenic Reef** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

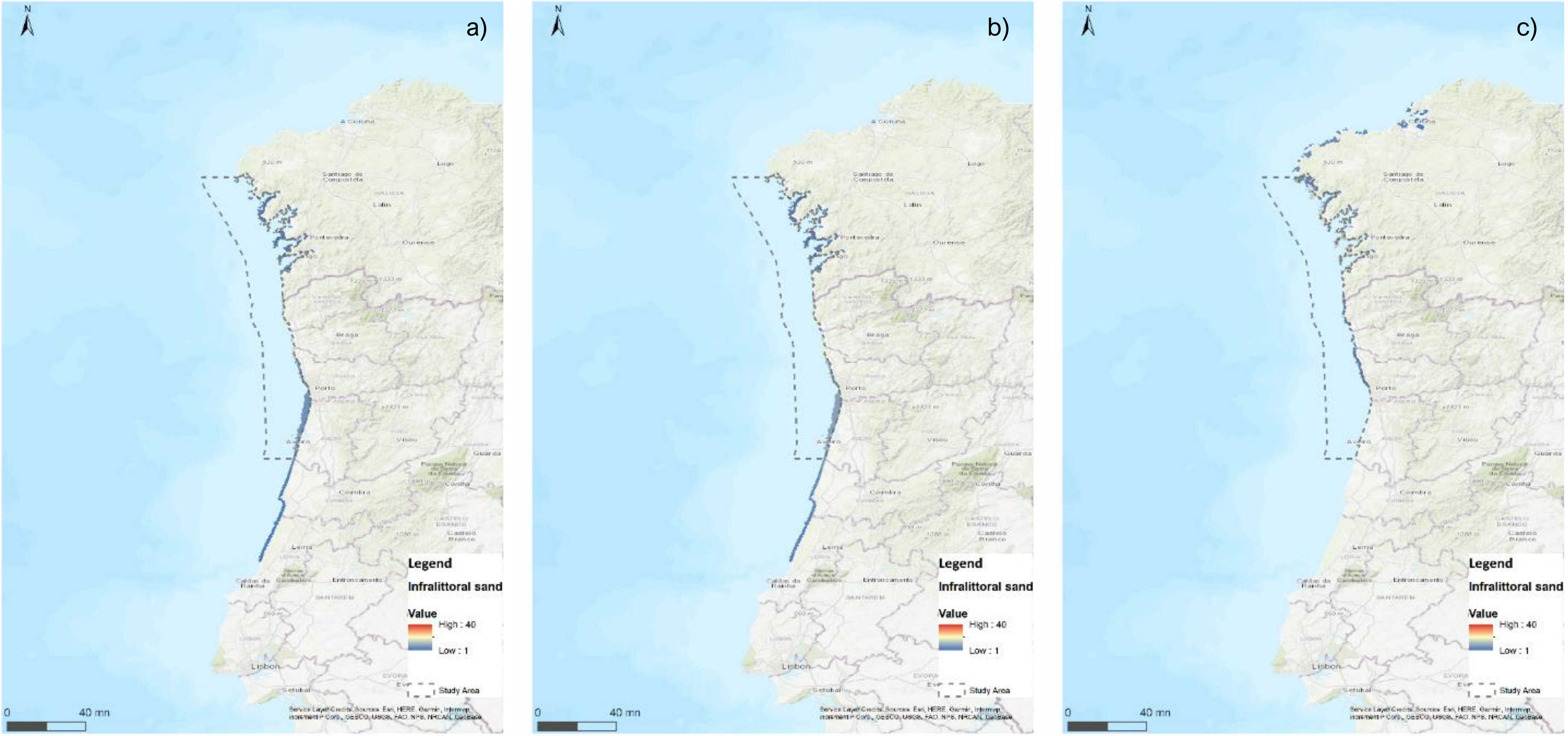

Figure III – 5. Cumulative Impacts for **Infralittoral Sand** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

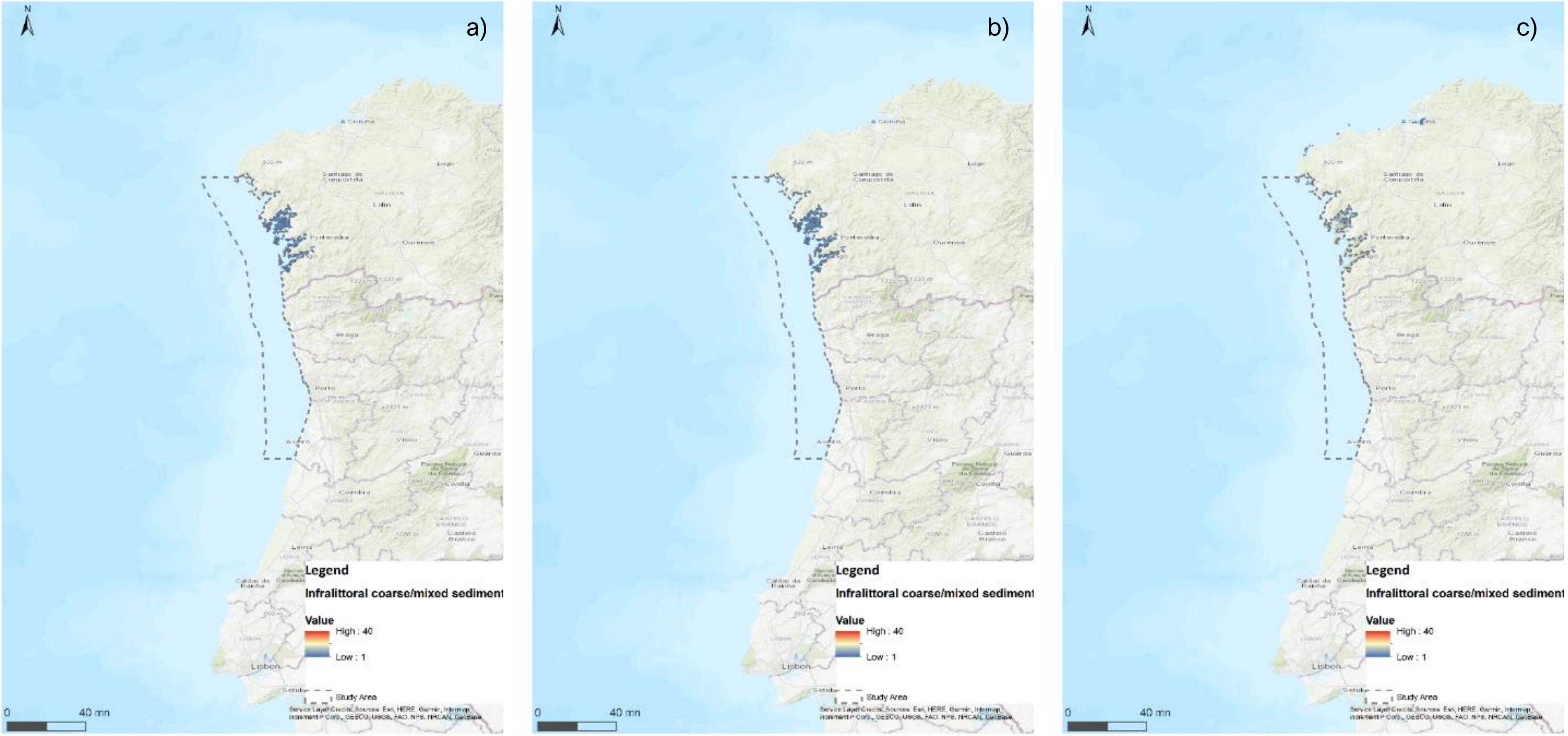

Figure III – 6. Cumulative Impacts for **Infralittoral Coarse and Mixed Sediment** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

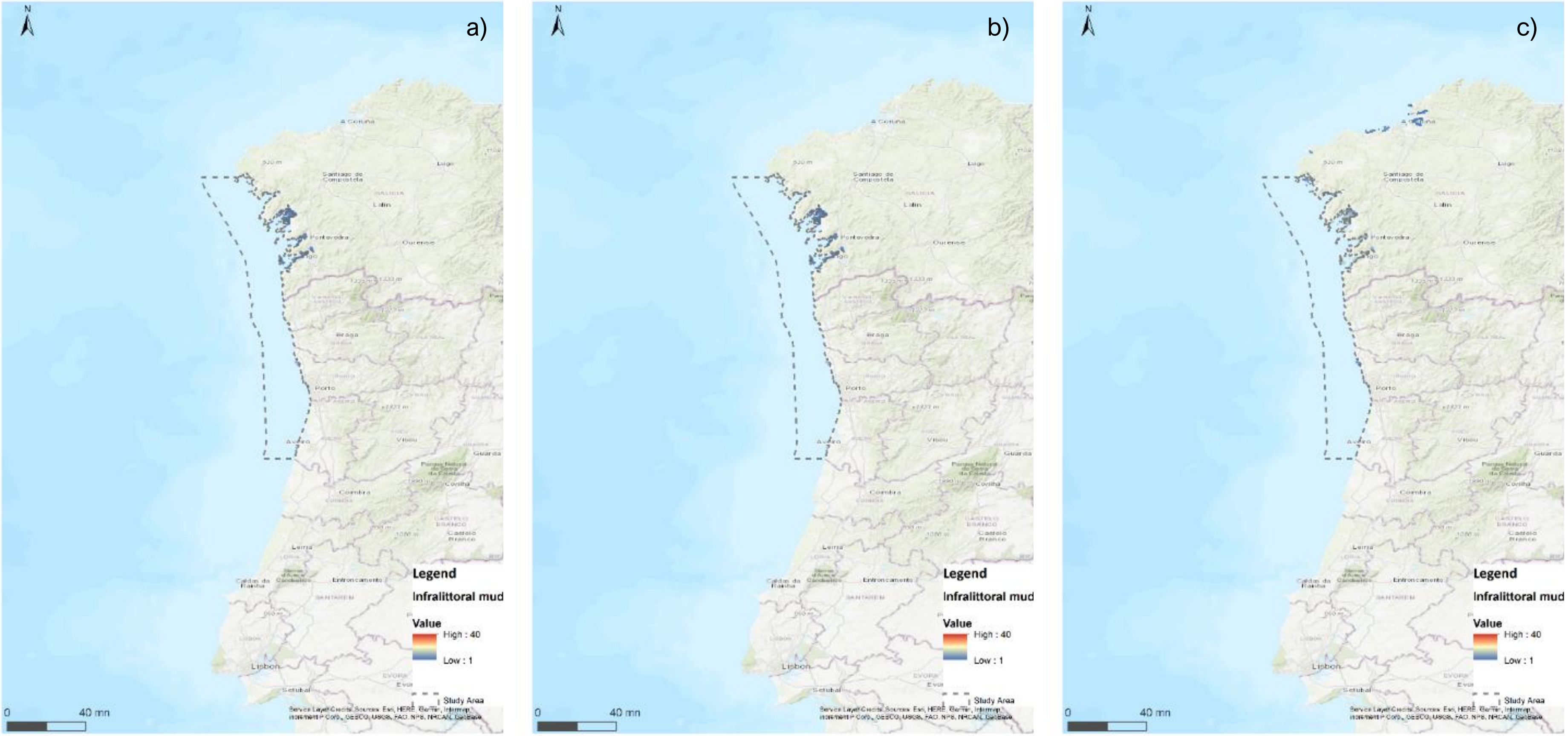

Figure III – 7. Cumulative Impacts for **Infralittoral Mud** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

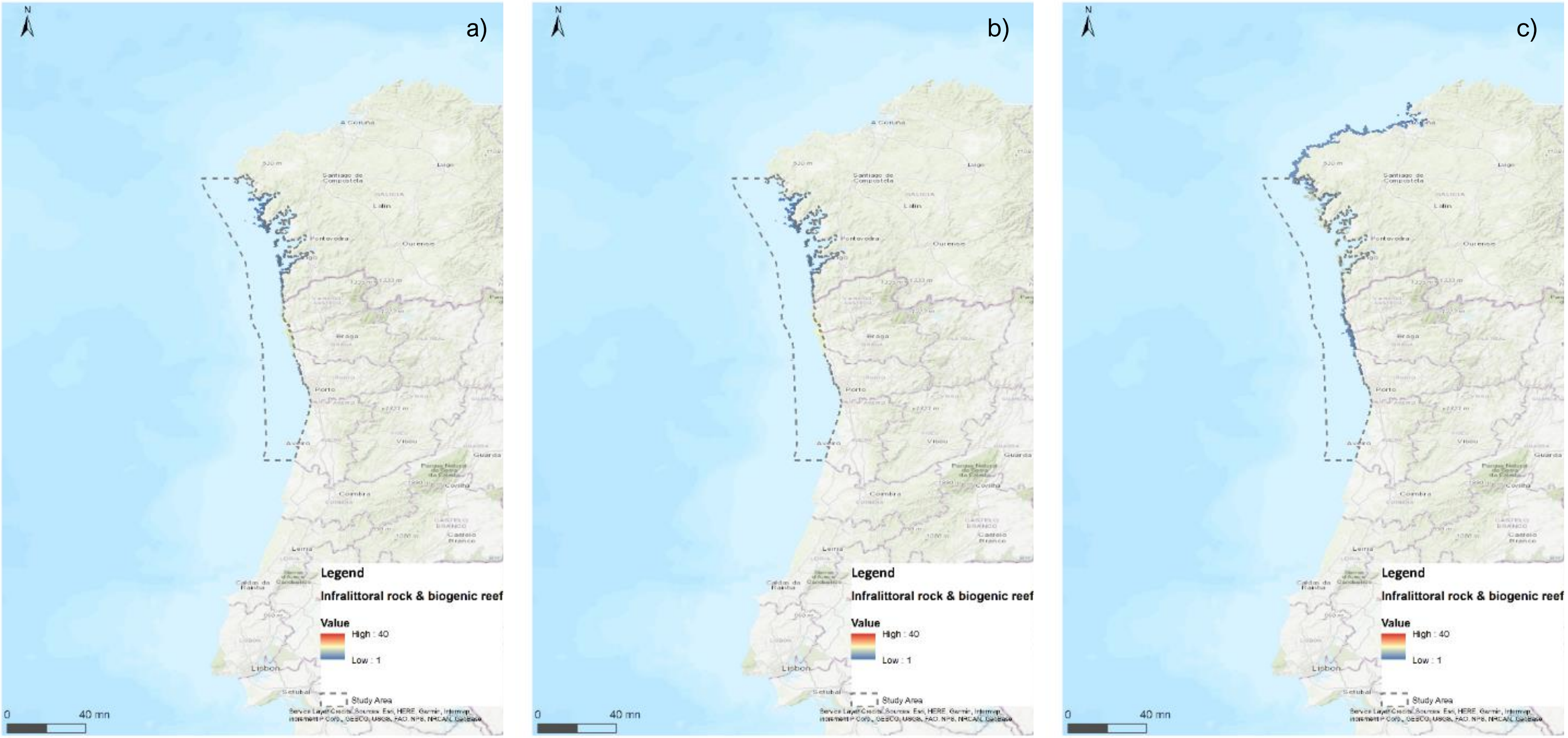

Figure III – 8. Cumulative Impacts for **Infralittoral Rock and Biogenic Reef** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

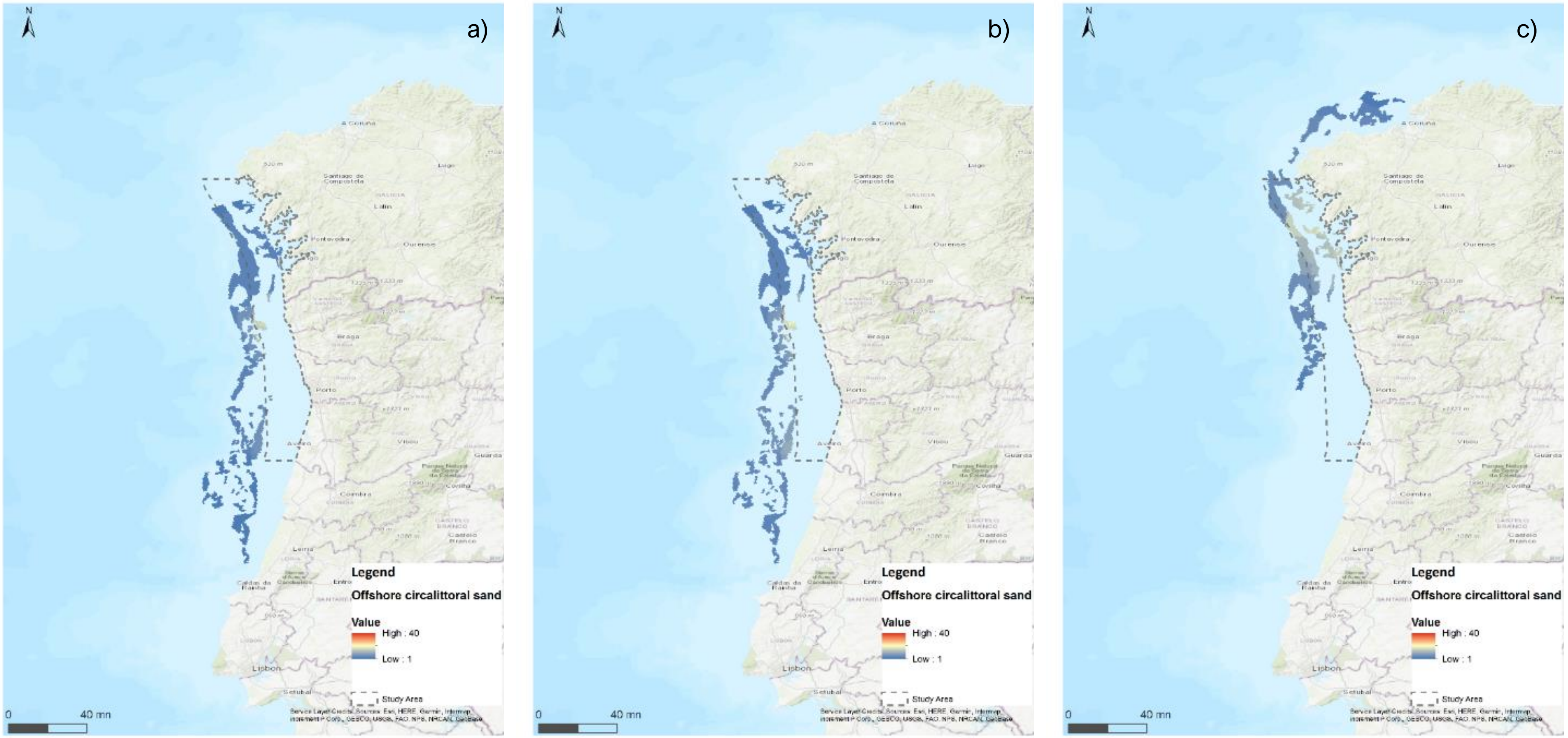

Figure III – 9. Cumulative Impacts for **Offshore Circalittoral Sand** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

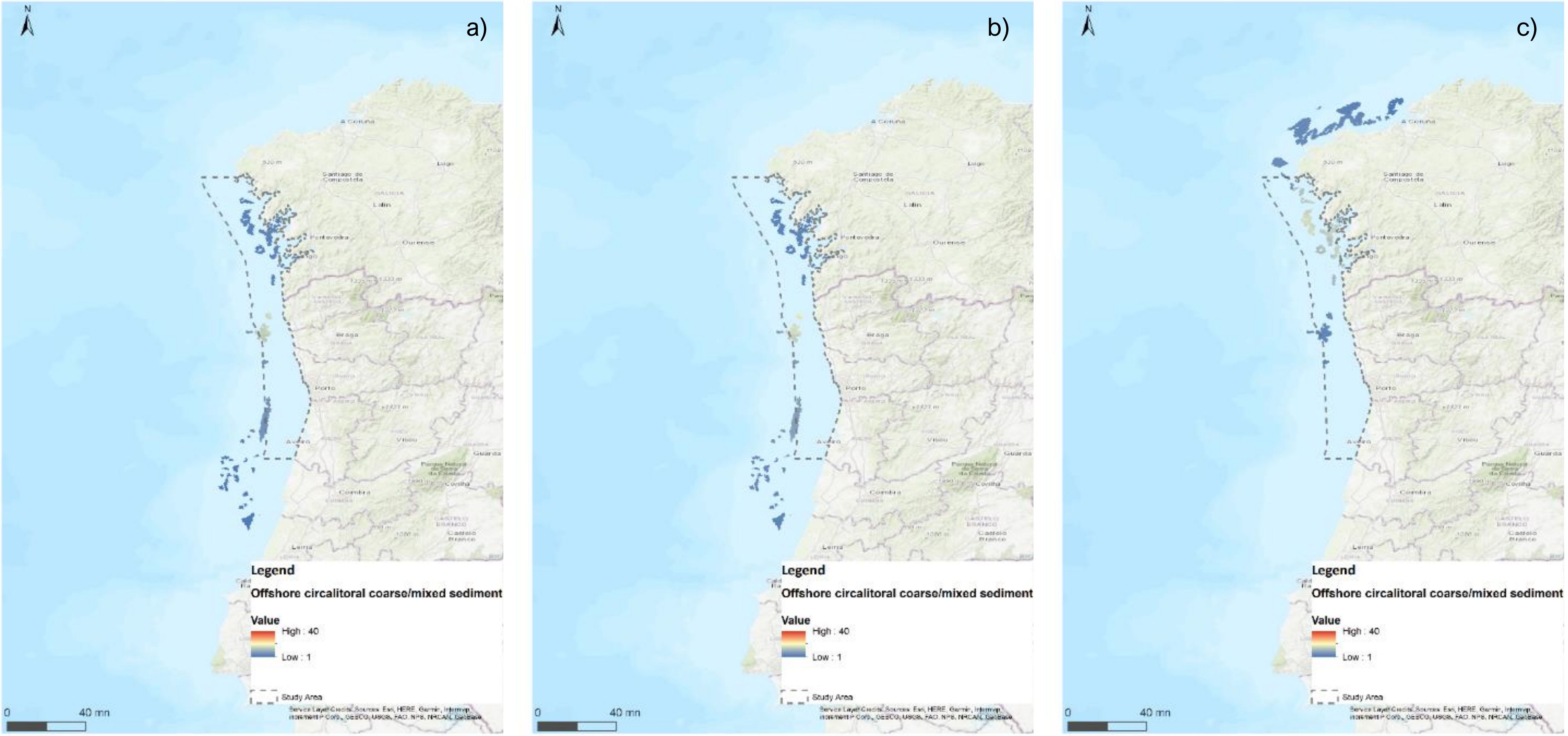

Figure III – 10. Cumulative Impacts for **Offshore Circalittoral Coarse and Mixed Sediment** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

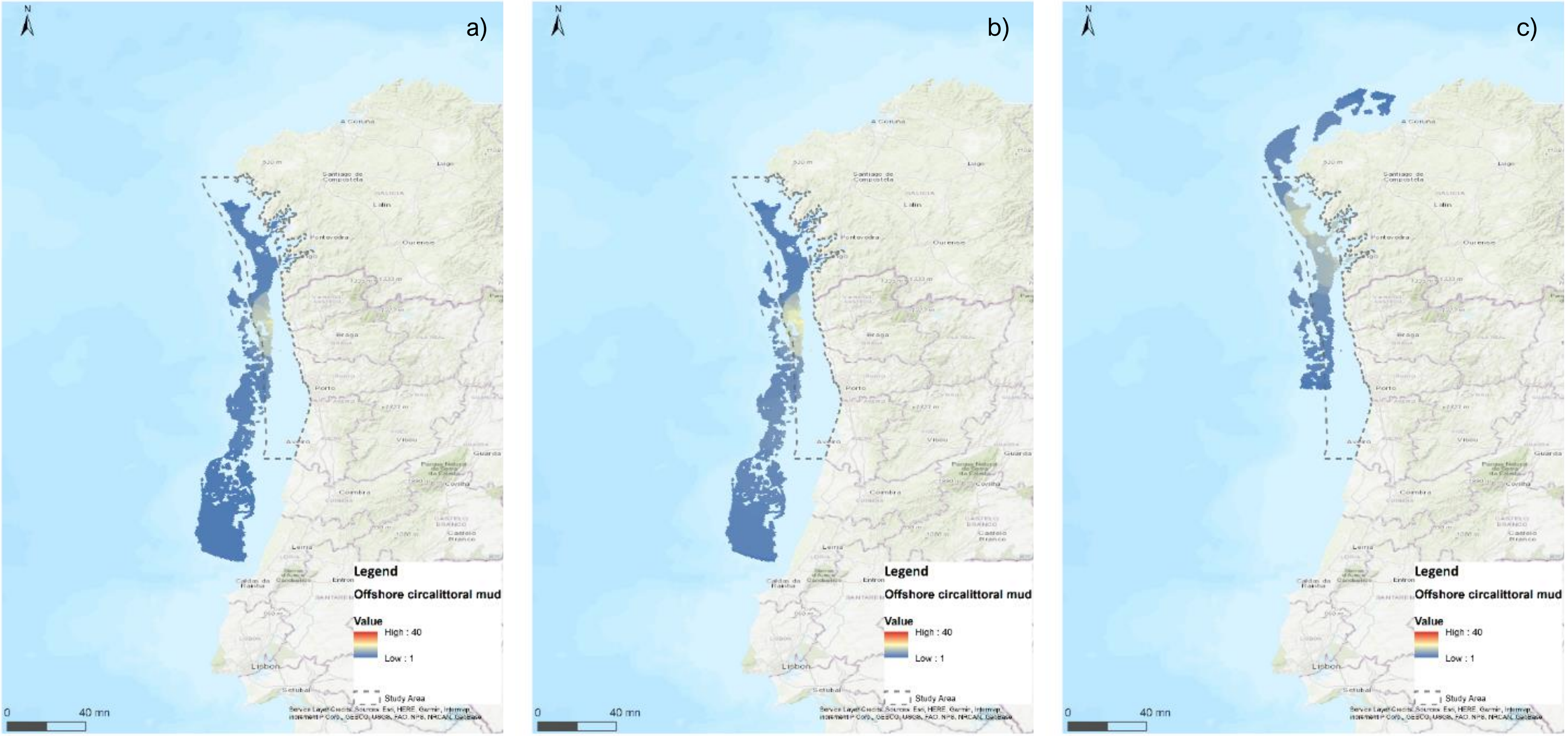

Figure III – 11. Cumulative Impacts for **Offshore Circalittoral Mud** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

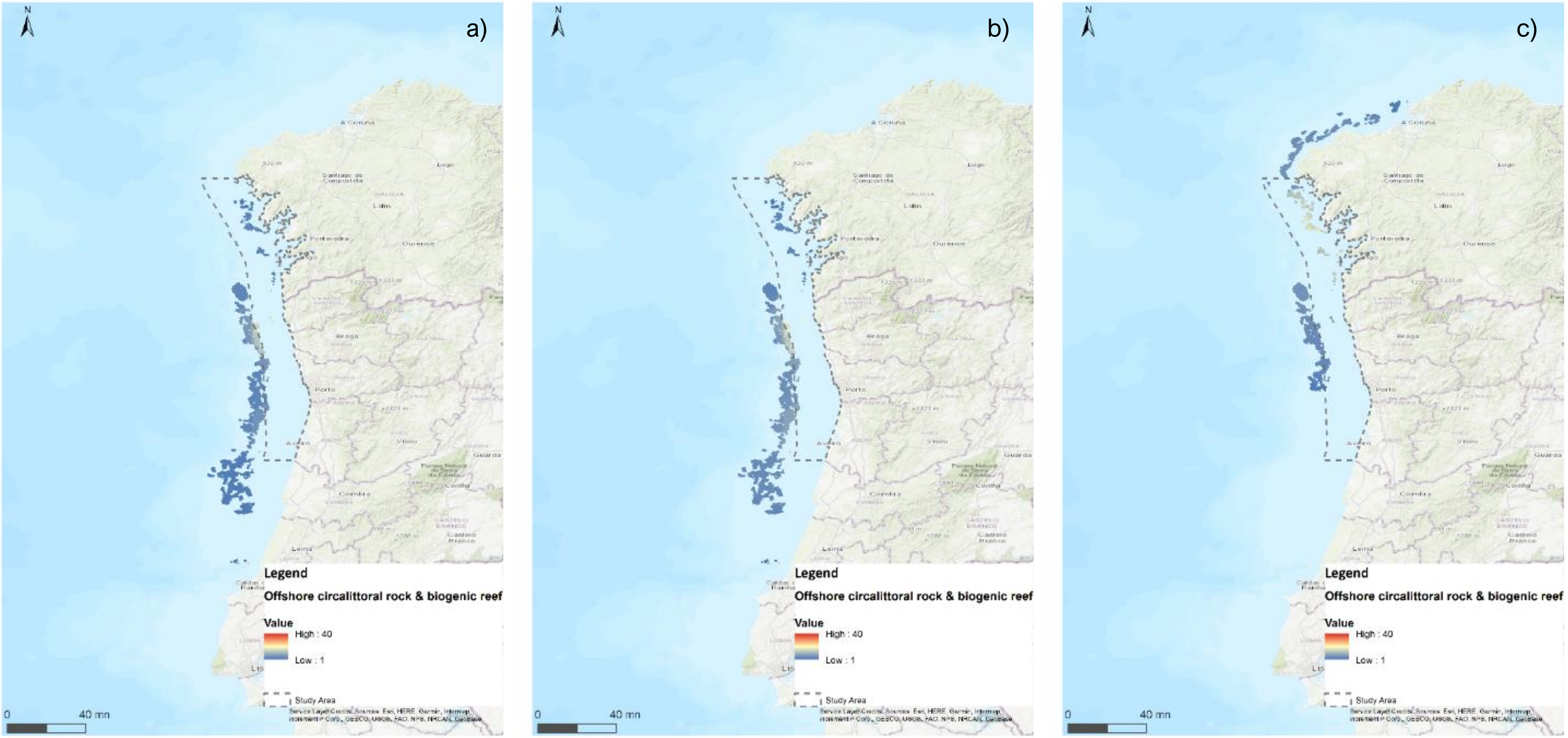

Figure III – 12. Cumulative Impacts for **Offshore Circalittoral Rock and Biogenic Reef** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

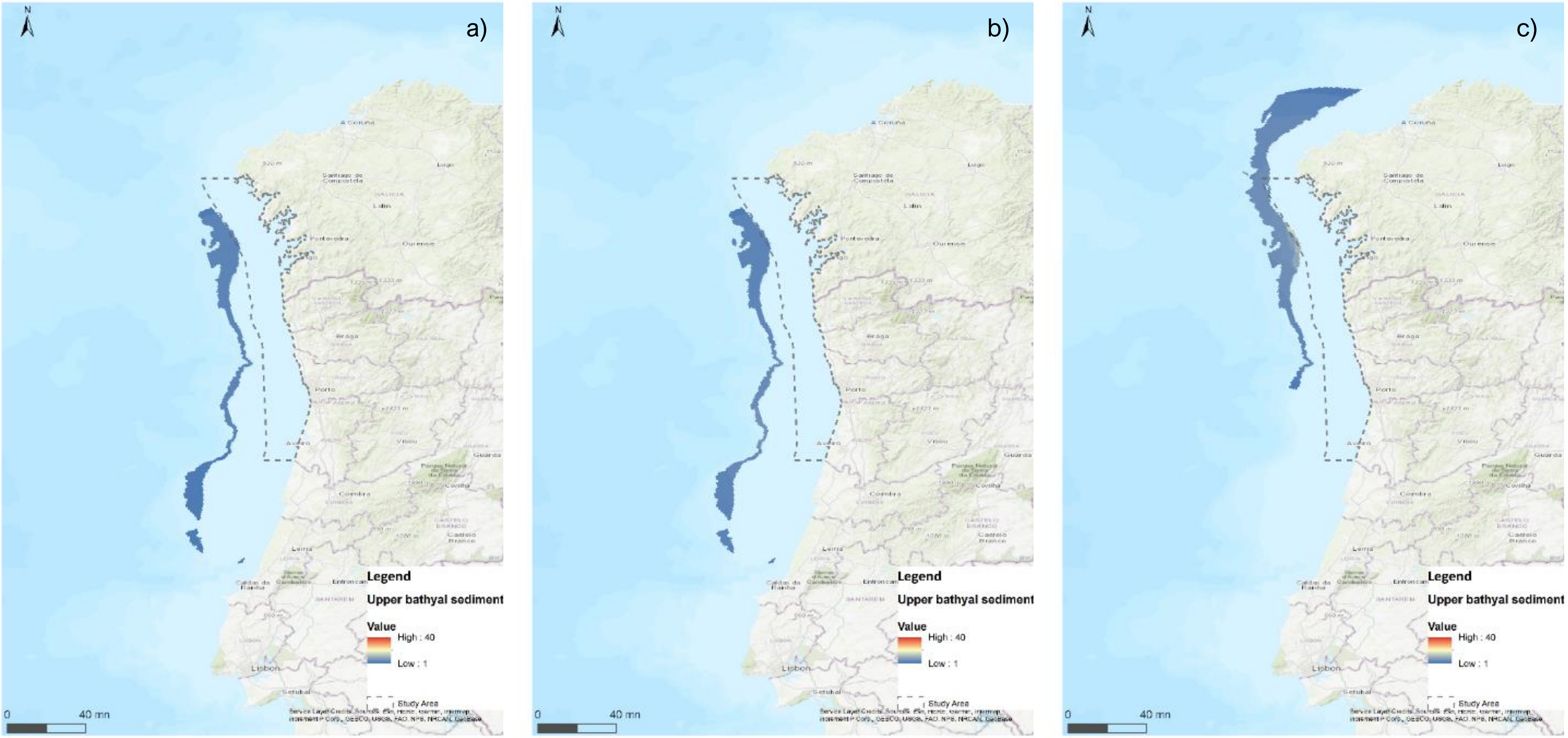

Figure III – 13. Cumulative Impacts for **Upper bathyal Sediment** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

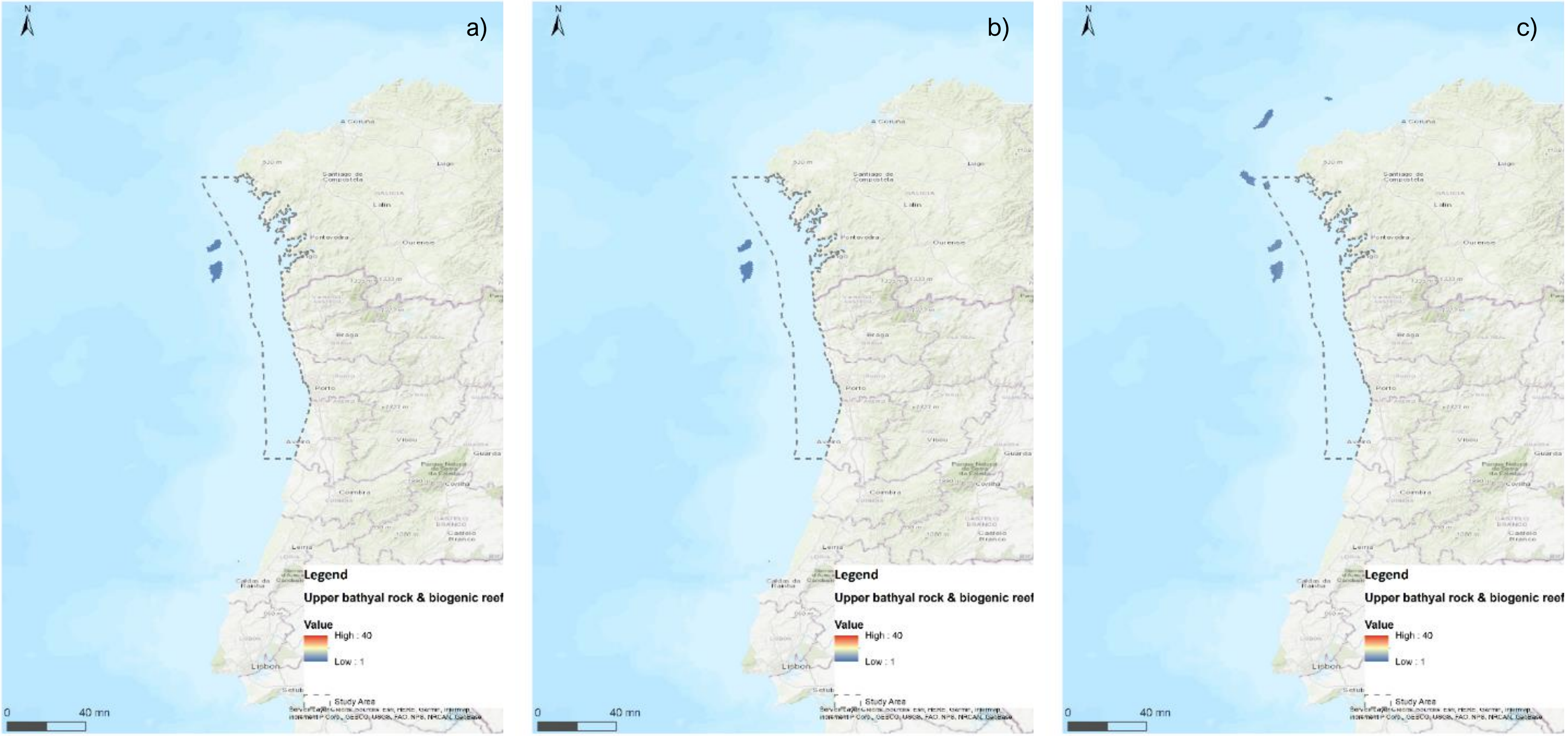

Figure III – 14. Cumulative Impacts for **Upper bathyal Rock and Biogenic Reef** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

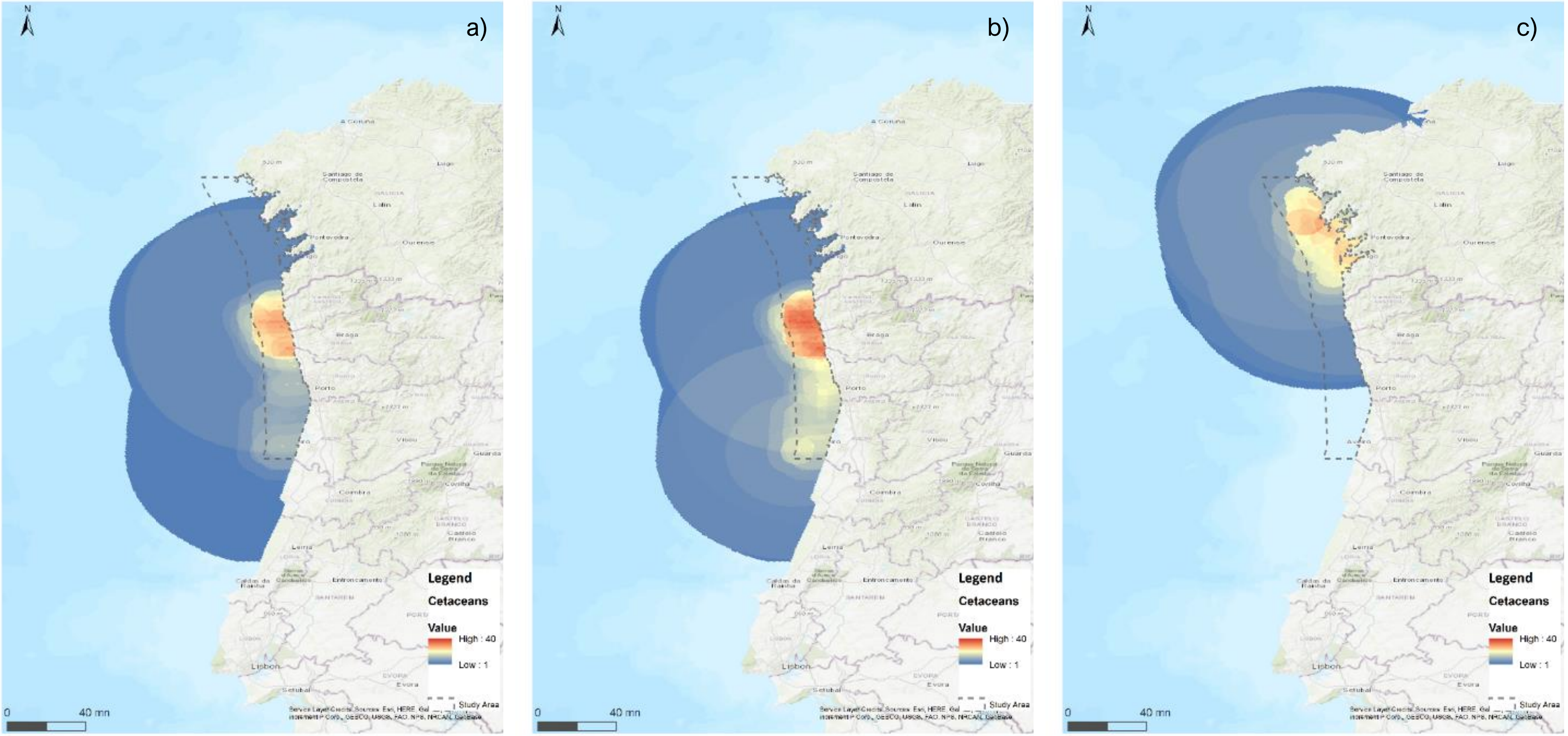

Figure III – 15. Cumulative Impacts for **Marine Mammals** a) Current *a*ctivities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

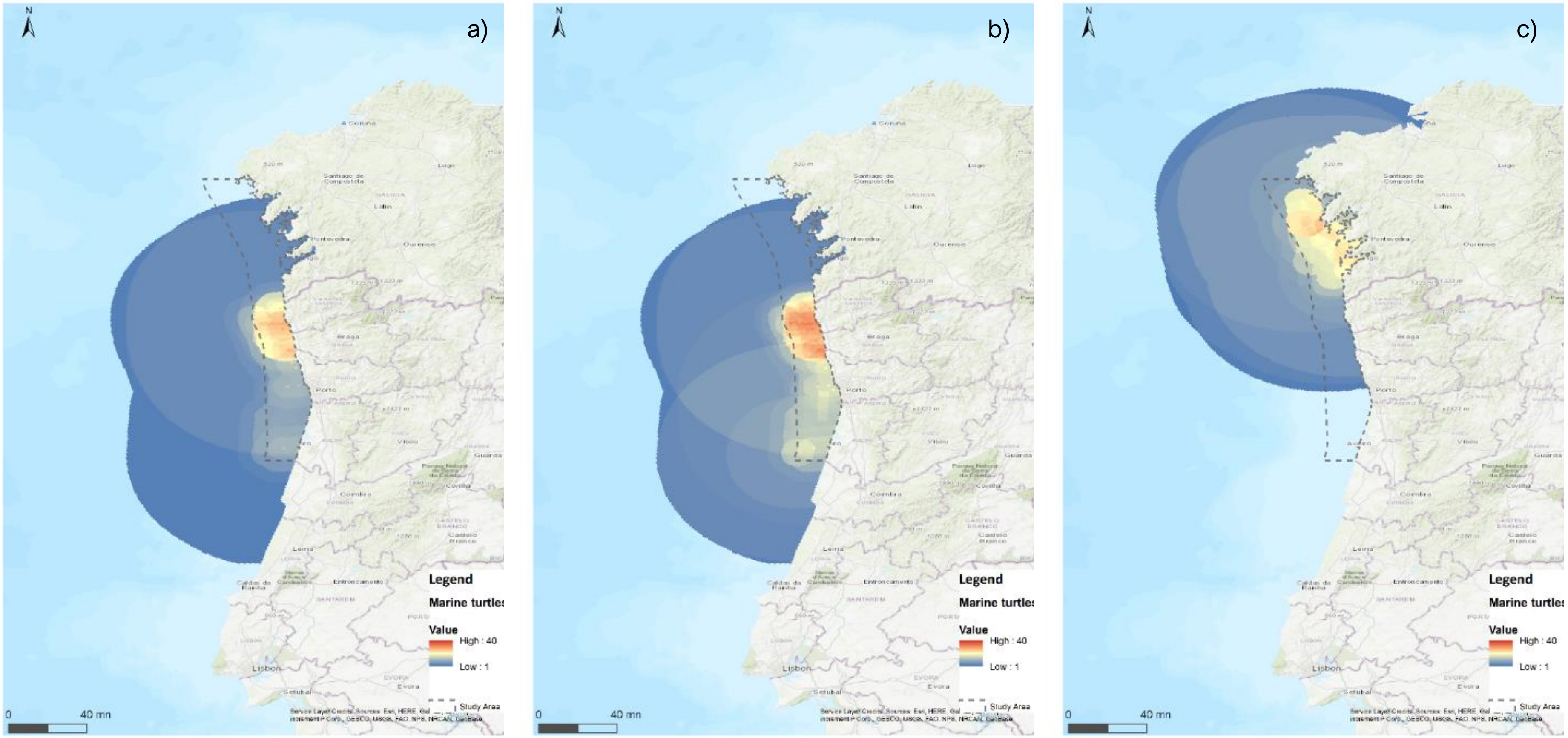

Figure III – 16. Cumulative Impacts for **Marine Turtles** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.

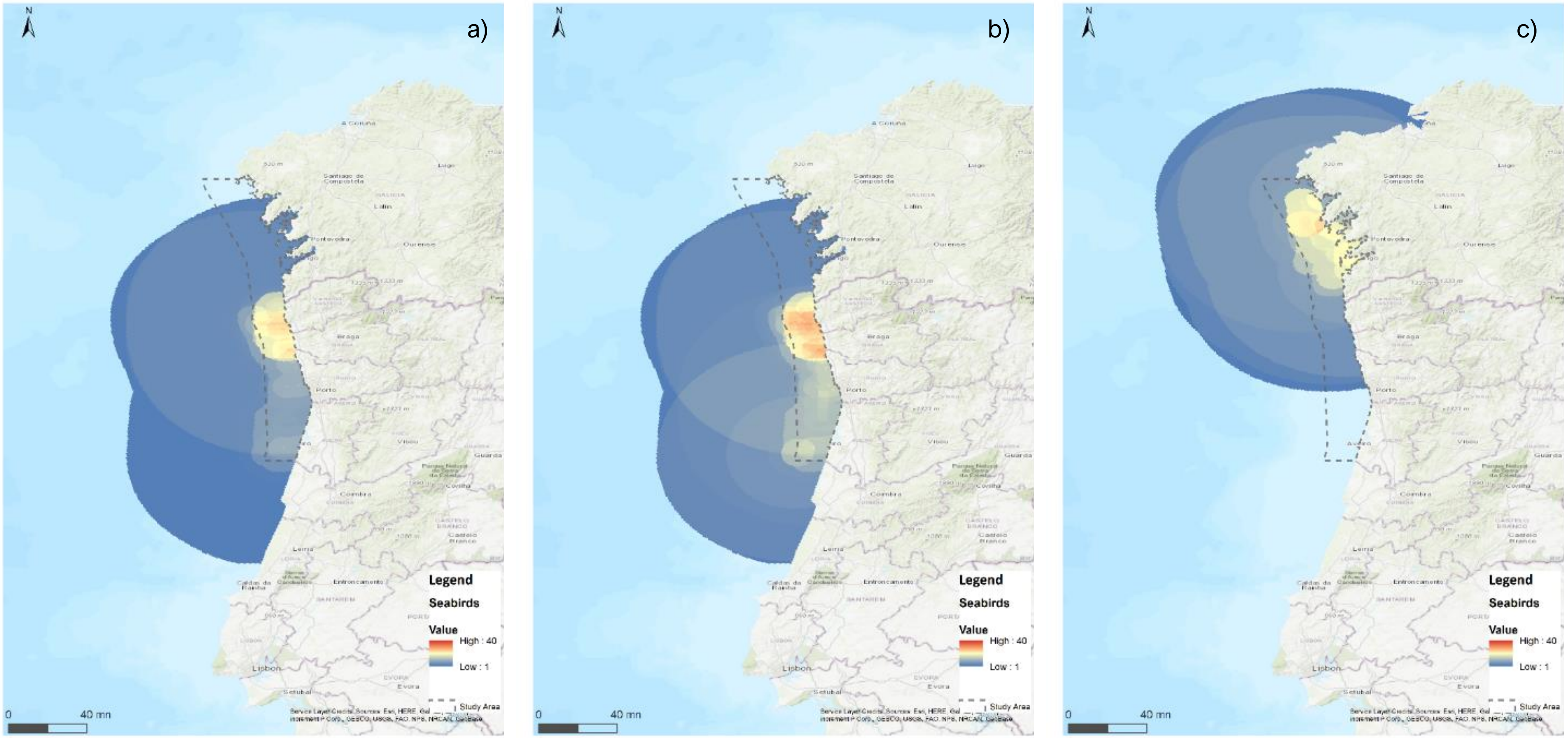

Figure III – 17. Cumulative Impacts for **Seabirds** a) Current activities in Portugal. b) Current and potential activities in Portugal. c) Current activities in Spain.