



ADRIATIC

Implementation of the ecosystem approach
in the Adriatic through marine spatial planning

Land-Sea Interactions Analysis for Montenegro



Mediterranean
Action Plan
Barcelona
Convention



Montenegro
Ministry of Ecology,
Spatial Planning and Urbanism

Impressum

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1 Introduction

Land-sea interactions in Montenegro have been analysed as part of the project “Implementation of the Ecosystem Approach in the Adriatic Sea through Marine Spatial Planning”(the GEF Adriatic Project). The GEF Adriatic Project is a subregional project carried out in Albania and Montenegro with the aim of restoring the ecological balance of the Adriatic Sea by implementing the ecosystem approach and marine spatial planning.

The project’s added value comes from ensuring the integration of two key management frameworks established by the Barcelona Convention – the ecosystem approach and marine spatial planning, by:

- Developing a methodology for the use of the ecosystem approach implementation results for the construction of marine spatial planning (MSP);
- Testing the developed methodology in the construction of marine spatial planning for selected areas;
- Building the capacity of project countries for the implementation of such an integrated approach.

In this manner, the GEF Adriatic Project is accelerating the implementation of the Integrated Coastal Zone Management Protocol and the Integrated Monitoring and Marine Ecosystem Assessment Programme (IMAP) which is crucial for the implementation of the ecosystem approach in the Mediterranean.

This study tests the methodology for assessing the impact of natural processes and activities from land to sea and from sea to land by spatialization of data that can be obtained through the implementation of integrated monitoring of the marine environment. Data obtained in this manner can, *inter alia*, be used in marine spatial planning.

2 Working Methods

2.1 Starting points

Starting points have been summarized based on the document [Relationship between LSI and ICZM](#) (Ramier E., Bocci M., Marković M., 2018 *Supporting Implementation of Maritime Spatial Planning in the Western Mediterranean region (SIMWESTMED). Priority Actions Programme Regional Activity Centre (PAP/RAC).*).

The term land-sea interactions (LSI) is usually used in the context of marine and coastal zone management and planning. Land-sea interactions can include, for example, the outflow of contaminants from a terrestrial agricultural area to a freshwater body, which is in contact with the coastal waters, as well as the laying of a submarine cable in the intertidal area to connect an offshore wind farm to the national power grid. Most activities that take place in the marine environment have a land component or connection. Coherence and integration between marine and land-based planning are important and should be achieved through consistent policies, plans and decisions.

Despite its great importance, a unique definition and conceptualization of LSI has not yet been established or formalized in professional literature. EU Directive 2014/89/EU on maritime spatial planning stipulates that the planning process should take into account land-sea interactions and promote cooperation between Member States. Although the [ICZM Protocol](#) does not explicitly contain a definition of LSI, it can be indirectly derived from Article 2 by interpreting the listed definitions for “coastal zone” and “integrated coastal zone management”. ICZM is defined as “*a dynamic process for the sustainable management and use of coastal zones, taking into account at the same time the fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interactions, the maritime orientation of certain activities and uses and their impact on both the marine and land parts.*” Furthermore, the coastal zone is defined as “*a geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socio-economic activities*” (Article 2). Thus, LSI can be defined as “*interactions in which land-based natural phenomena or human activities have an influence or an impact on the marine environment, resources and activities and interactions in which marine*

natural phenomena or human activities have an influence or an impact on the terrestrial environment, resources and activities" (CAMP Italy).

Land-sea interaction analysis is therefore a key element of the ICZM process and includes environmental processes that cross coastline boundaries, interactions between land-based and marine-based socio-economic activities, and interactions between human communities.

The literature also points out two major interactions occurring between land and sea:

- Interactions related to **land-sea natural processes**. Implications of such processes on the coastal environment and on coastal socio-economic aspects shall be identified and assessed considering their dynamic nature, in order to include them into the planning and management processes. At the same time, human activities can interfere with natural processes. The analysis of the expected impacts of land and marine activities should include the evaluation of their effects on LSI natural processes and the potential consequent effects on natural resources and ecosystem services.
- Interactions between **land and sea uses and activities**. Almost all maritime uses need support installations on land (such as the ports for shipping, marinas for yachting or grid connections for offshore wind farms), while several uses existing mostly on the land part (e.g., tourism, recreational activities, land-based transport, etc.) expand their activities to the sea as well. These interactions shall be identified and mapped, assessing their cumulative impacts and benefits.

These have been also taken into consideration in the **"Conceptual Framework for MSP in the Mediterranean"** adopted in December 2017 by the Ordinary Meeting of the Contracting Parties to the Barcelona Convention (UNEP-MAP PAP/RAC, 2017).

2.2 Methodological framework

The basis for land-sea interaction analysis is the method presented in the document **Land Sea Interactions in the framework of ICZM and MSP** (Ramieri E., Bocci M., Marković M., PAP/RAC), developed by the cross-border maritime planning projects SUPREME and SIMWESTMED. The document elaborates the procedure for including LSI in maritime planning. Key aspects concerning LSI in spatial planning (coastal and marine) are as follows:

- LSI should take into account the interactions of planning processes and plans for land and sea areas. Achieving this also requires harmonization/integration of different approaches, methodologies and instruments applied both on land and sea.
- It is important to ensure that legal, administrative, consultation and technical processes are coordinated to avoid unnecessary duplication, inconsistencies, conflicts, waste of resources and/or excessive efforts required of stakeholders.

The methodological guidelines follow a detailed approach (elaborated through 14 steps) for the analysis of land-sea interactions, which can be applied in maritime planning, but also as part of the ICZM process. The procedure is described in detail in the aforementioned document, and the synthesis is illustrated in the diagram below (Figure 1).

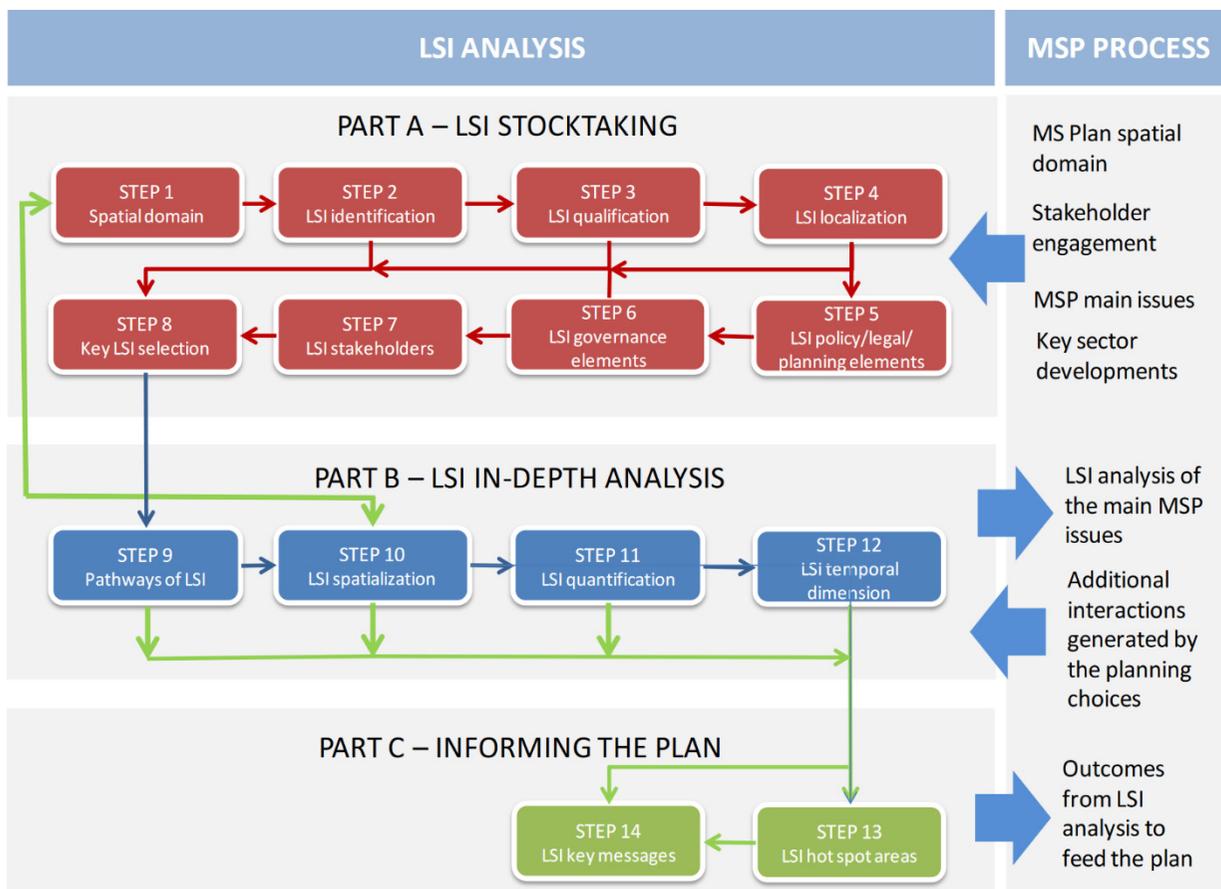


Figure 1: *Methodological guidelines for the gradual inclusion of land-sea interaction in maritime planning* (source: *Land Sea Interactions in the framework of ICZM and MSP*)

2.3 Preparing the method of analysis

The purpose of this study is to do a spatial analysis of land-sea interactions in the coastal area of Montenegro, with the aim of visualizing these interactions and using the results of the analysis in marine spatial planning. The basic idea of the analysis is to identify areas of significant existing and potential negative impacts and to remedy or prevent these impacts with a plan.

The analysis was based on the guidelines from the initial methodological document (see chapter 2.2), which are shown in Figure 1. It has been prepared at the general level and covers the entire coastline of Montenegro (step 1).

Within the scope of the baseline methodological document, initial interaction tables were prepared for:

- Natural processes;
- Use and activities: land-sea interactions;
- Uses and activities: sea-land interactions.

This analysis was prepared according to these types of interactions. In accordance with the methodological guidelines, the initial interaction tables take into account three dimensions of sustainability – environmental, economic and social. The analysis deals with the ecological and economic dimensions which, unlike the social one, can be more easily spatially distributed. A general set of natural processes, uses and activities has been predefined for them (text in black in the tables). The tables (attached) were supplemented (text in blue) with concrete/available data for the coastal area of Montenegro, i.e. data that was known to be prepared within the study the [State and Pressures of the Marine Environment in Montenegro](#) and other parts of the GEF Adriatic project.

The initial identification of interactions was based on present natural processes, uses and activities ([step 2](#)). The analysis focused on spatial influences/interactions that can also be visually represented. The availability/quality of this data has always been a problem. Attempts were made to use different sources, i.e. to suggest preparing new data as part of the project (related to maritime transport, for example).

The next step was to fill in the table based on the assessment, the potential interaction between natural processes, and the use of space/activity or the use of space/activity at sea and on land – qualification of interactions ([step 3](#)), using the following categories:

- positive impact;
- negative impact;
- no impact;
- no data;
- no land-sea or sea-land interactions.

This was the initial completion, which was confirmed/corrected by consultants during the actual analysis. According to the methodology, this step is related to the management of land-sea interactions ([step 6](#)), which does not yet exist in the right

form. Available information related to marine management (e.g. the monitoring of eutrophication and contamination) has been included in the analysis.

For some interactions, analysis tests were prepared, i.e. a localization of interactions ([step 4](#)), so that it was possible to assess what results can be expected and how to present the results of the analysis. Some interactions recorded in the table were found not to exist in reality (see notes in the tables). According to the methodology, this step is related to the policy/regulation related to land-sea interactions ([step 5](#)), which also does not yet exist. In the localization of interactions, information from planning documents and formally protected areas is used in accordance with this step.

LSI analysis is the type of analysis which requires an interdisciplinary expert team. The concept of this analysis was refined with the help of consultants. Working with consultants replaces an otherwise overlooked aspect – stakeholder involvement ([step 7](#)).

Based on the proposed corrections to the tables and interviews with the consultants, certain interactions were identified that are relevant or addressed in the following analysis ([step 8](#)). These interactions are significant and there is good enough data for them so that a meaningful spatialization can be obtained which is useful for further activities (row and column "analysed" in the tables).

The scope of interaction or the breadth of the impact of an individual activity was determined according to the analysis of the influence mechanism behind each selected interaction ([step 9](#)). The analysis is simplified/prepared in such a way that the buffer or area of activity at sea or on land which has an impact is determined, and it overlaps with the data on the land use/activity or sea affected by the activity. In natural processes, the extent of interaction usually depends on the area of that process. A 100 m buffer was used for most activities. This buffer emerges from the concept of a 100 m coastal fringe¹ (see the "scope of interaction" column in the tables).

¹ The second reason is pragmatic – visibility on maps. A buffer of less than 100 m is difficult to portray in the report, i.e. it needs to be zoomed in great detail, which

means a large number of images, and a loss of the wider impression of the spatialization of interactions.

Out of this overlap we can derive a spatialization of interactions ([step 10](#)) – the display of the interaction area in the GIS or on the maps. The analysis was prepared by recording each interaction separately and their association, according to the rule of maximum value. This means that in the event of two or more interactions overlapping in an area, the higher value is taken. For relevant uses (tourist zones and settlements), which have a large number of land-sea interactions, the frequency of interactions is also portrayed. This shows the number of different interactions in the same area.

The maps in the report do not show each interaction separately, because this would require a large number of maps, but all interactions based on uses/activities are shown together. Individual interactions are recorded in the GIS, so that for the purpose of subsequent activity planning, each interaction can be observed separately. The report presents interaction maps for the Boka Kotorska and the area where interactions for individual uses/activities are most pronounced. Attached to the report are all maps encompassing the entire area of analysis:

- Boka Kotorska Bay;
- Trašte – Platamuni;
- Budva – Čanj;
- Sutomore – Dobra voda;
- Ulcij – Bojana.

The quantification of interactions ([step 11](#)) was prepared by categories:

	positive impact
	higher negative impact
	lower negative impact
	no impact

² While discussing with the consultants, the scope of interactions (step 9) was related to the open question about interactions, for which it is very difficult to define values that would be visible on maps. The extent of the impact could be further defined through the level of economic importance of individual sectors and activities. For example, in the field of aquaculture, indicating the total

Methodological guidelines suggest four categories of interactions – low, moderate, high and very high intensity. The study used an adjusted categorization for pragmatic reasons, i.e findings, with detailed specification of intensity not possible/reliable due to the general level of processing, a lot of raw data and the lack of information on the characteristics of uses/activities (capacities, technological solutions, frequency, occurrence, emissions).² For these reasons, no time dimension analysis has been prepared ([step 12](#)).

Interaction maps by individual uses/activities have been combined into integral maps according to frequency for all three types of interactions, showing the number of different interactions in the same area. In the frequency model, the area of higher negative impact is scored with the grade 2 and the area of lower negative impact with a score of 1. From this we can determine the locations where the largest overlap of relevant interactions has occurred. These maps are the basis for defining hot spot locations ([step 13](#)). Conclusions of the land-sea interaction analysis are presented in the final chapter of the study ([step 14](#)).

It should be taken into account that due to the characteristics (deficiencies, inaccuracies) of input data and pragmatic simplification (framework buffer for the scope of interactions) specific characteristics at individual locations are not taken into account, and one should have some critical distance from the analysis results (use common sense) . Some smaller areas are highlighted in the report due to map visibility and do not express true spatial dimensions. **The illustrations are therefore informative!**

number and area of farms; the average number of cruisers that come to Boka annually; the number of professional fishing licenses; the number and size of marine protected areas, etc. This data could have contributed to a final assessment of the overall interactions but it was found that this would have significantly exceeded the analysis.

2.4 Analysed Uses and Activities

The structure of the analysed purposes and activities was drawn from the initial interaction tables. The analysis was prepared for the uses and activities for which data is available and estimated to be relevant in the preparation of the Montenegrin maritime spatial plan.

Table 1: Recorded and analysed uses and activities

Database label	Category	On land (L) and/or sea (S)	Data source	Note
Interactions with the marine environment				
Special coastal ecosystems (ICZM)				
1	Swamps and river mouths	L	CAMP, 2013	Analysed
2	Valuable marine habitats	S	GEF Adriatic, 2021	Analysed
2a	Wider areas of valuable marine habitats	S		Analysed
2b	Other areas of Posidonia meadows and coral	S		Analysed
2c	Other valuable areas (grades 4 and 5)	S		Analysed
3	Coastal forests	L	CAMP, 2013	Analysed
4	Dunes	L	CAMP, 2013	Analysed
Coastal area				
5	Exceptionally valuable areas	L/S		Analysed
5a	Extremely valuable landscapes	L	PPPNOB, 2018	Analysed
5b	Exceptionally valuable marine areas	S	GEF Adriatic, 2021	Analysed
6	Intersections – strict regime	L	PPPNOB, 2018	Analysed
ECONOMIC INTERACTIONS (ACTIVITIES)				
Professional fishing				
7	Fishing posts	L/S	IBM, GEF Adriatic, 2021	Analysed
Recreational fishing				
-	/			no data
Aquaculture				
8	Mariculture locations	S	IBM, GEF Adriatic, 2021	analysed

Database label	Category	On land (L) and/or sea (S)	Data source	Note
Maritime transport				
-	Shipping routes	S	GEF Adriatic, 2021	No relevant interactions, lines not along the coast
9	Port system: aquatorium of large ports and areas of smaller ports	L/S	GEF Adriatic, 2021	
Energetics				
-	Submarine pipelines and cables	S	HMZ	Impacts are not relevant, and are limited to smaller areas
-	Wind farms	L	PPPNOB, 2018	No interactions, lines not along the coast
-	Oil and gas exploration area	S	PPPNOB, 2018	Interactions are difficult to reliably represent due to complexity
Coastal tourism				
10	Tourist zones	L	PPPNOB, 2018 and GEF Adriatic, 2021	Analysed
11	Settlements	L	PPPNOB, 2018	Analysed
12	Bathing areas and aquatorium	L/S	MEPG, 2020	Analysed
Marine tourism				
	Recreational nautical infrastructure	L/S	GEF Adriatic, 2021	No available data at the time of the analysis
Protected areas				
13	Natural protected areas – existing and planned: land protected areas, marine protected areas – designation process (nature park), marine protected areas – preliminary protection (special nature reserve)	L/S	AZZS, 2020	Analysed
-	Natural and cultural historical area of Kotor	L/S	CAMP, 2013	Due to the area being so large, information about other interactions has been lost and therefore not taken into account
14	Cultural goods	L/S	CAMP, 2013	Analysed

3 Natural processes

The analysis was prepared for natural processes at sea which impact land:

- sea level rise
- coastal erosion
- trophic impact.

For GIS analysis, usable data for extreme weather events and salinization is not available. There is no special data only on sea floods and the area affected by high tides. Flooding areas have been recorded (and should be taken into account in spatial planning) in Tivat Saline, Buljarica, along Bojana and occasional streams. Regarding tectonic activities, there is data for seismic categorization, but interactions due to the complexity of such analysis would be difficult to represent reliably.

The identified interactions of natural processes and impact assessments are laid out in the supporting excel file of this report.

3.1 Sea-level rise

The data prepared through the CAMP project (Assessment of sea-level rise for the coastal area of Montenegro, Harpha Sea d.o.o., 2013) is used for sea growth. The area of interaction is taken to be the area of increase up to 0.96 m according to the digital terrain model. This area corresponds to the estimate of a global sea-level rise of 54 cm until 2100³ based on the principle: 0,96 m at DMT (digital terrain model) = 0,27 m (altitude correction) + 0,15 m (sea rise 1978-2013) + 0,54 m (sea rise up to 2100).

Sea-level rise has a great impact on beaches/bathing areas, and on special habitat types and valuable areas in the lower parts of the coast, which would disappear due to the sea-level rise. These are primarily the areas of Ulcinj salt flats, Ada Bojana and the southern part of Velika plaža (Figures 5 and 8). In the Boka Kotorska Bay (Figure 7) there is great impact in the area of Morinj (Figure 4) and Tivat salt flats (Figure 5). The analysis shows that along the entire coast

³ Based on the IPPC (2000) forecast for scenarios A1B and A2. The 0,54 m rise scenario is significant because it also corresponds to current extreme weather events. Such an increase is in the size of the class of the current forecast

according to the scenario RCP8.5 for the Adriatic Sea up to 2100. (EEA, 2021, <https://www.eea.europa.eu/data-and-maps/figures/past-trend-at-selected-tide>).

(Figure 6), in the areas threatened by sea rise, we have individual parts of settlements, tourist zones and nautical infrastructure, such as Kotor (Figure 2).



Figure 2: *Sea-level rise: Kotor* (Harpha Sea, 2013)

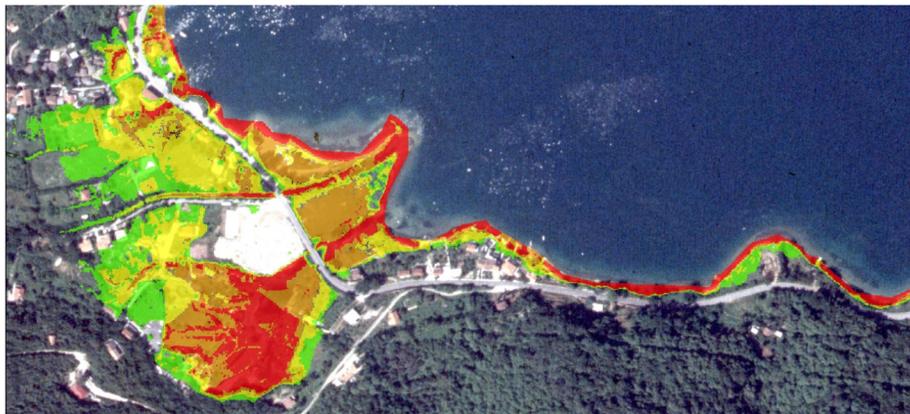


Figure 3: *Sea-level rise: Morinj* (Harpha Sea, 2013)



Figure 4: *Sea-level rise: Tivat salt flats* (Harpha Sea, 2013)

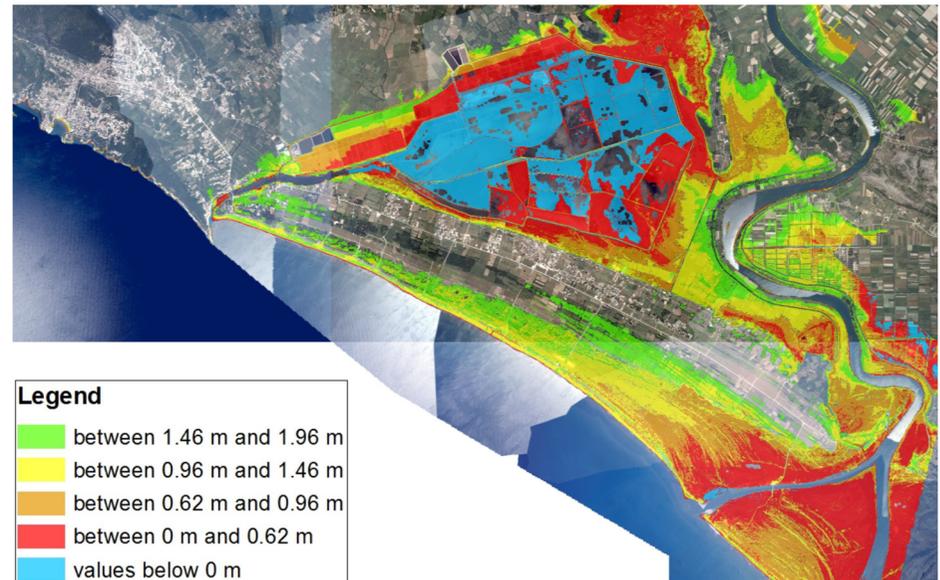


Figure 5: *Sea-level rise: Ulcinj salt flats – Ada Bojana* (Harpha Sea, 2013)

Figure 6: Impact of sea-level rise on land

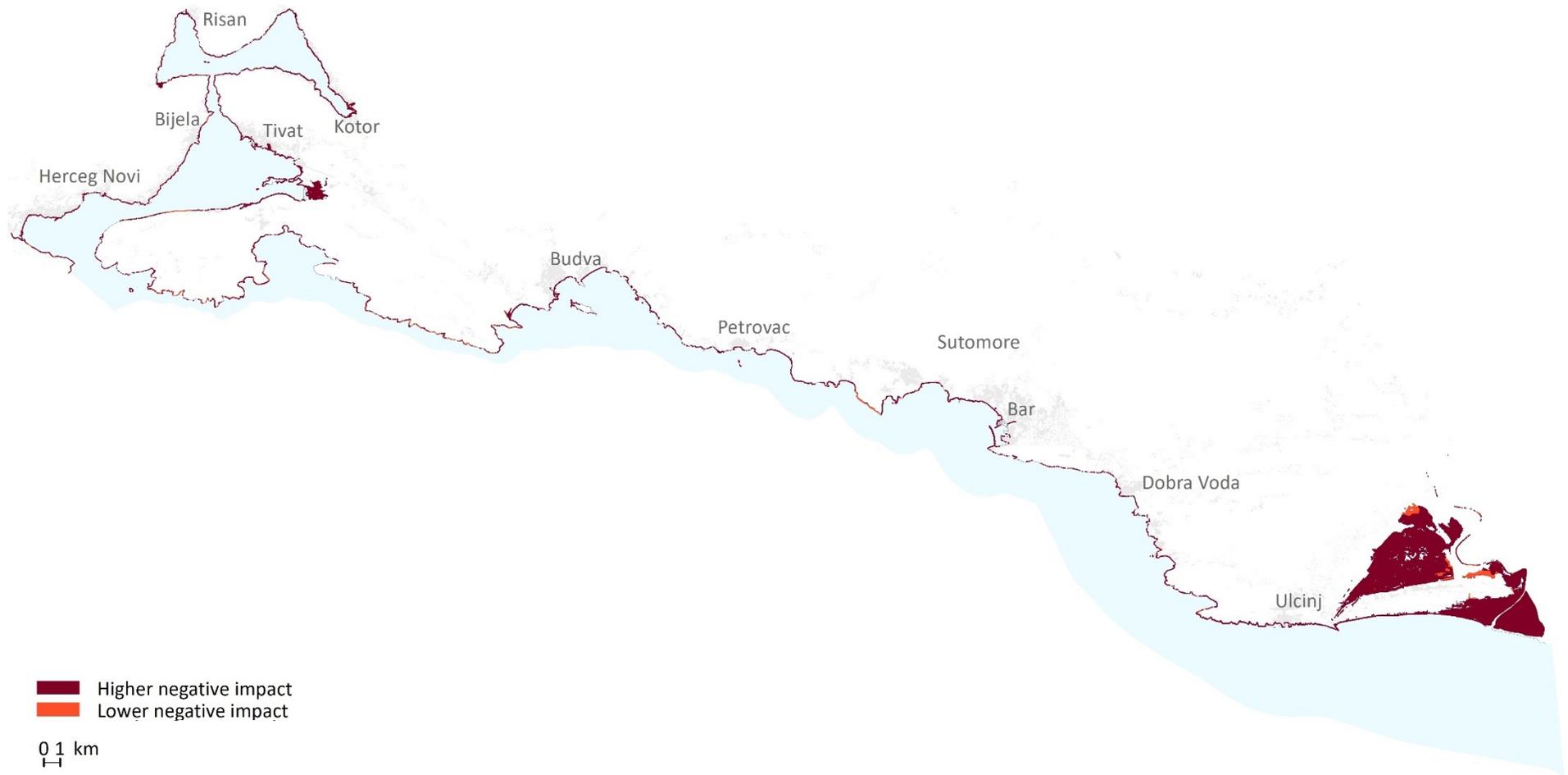


Figure 7: Impact of sea-level rise on land: Boka Kotorska Bay

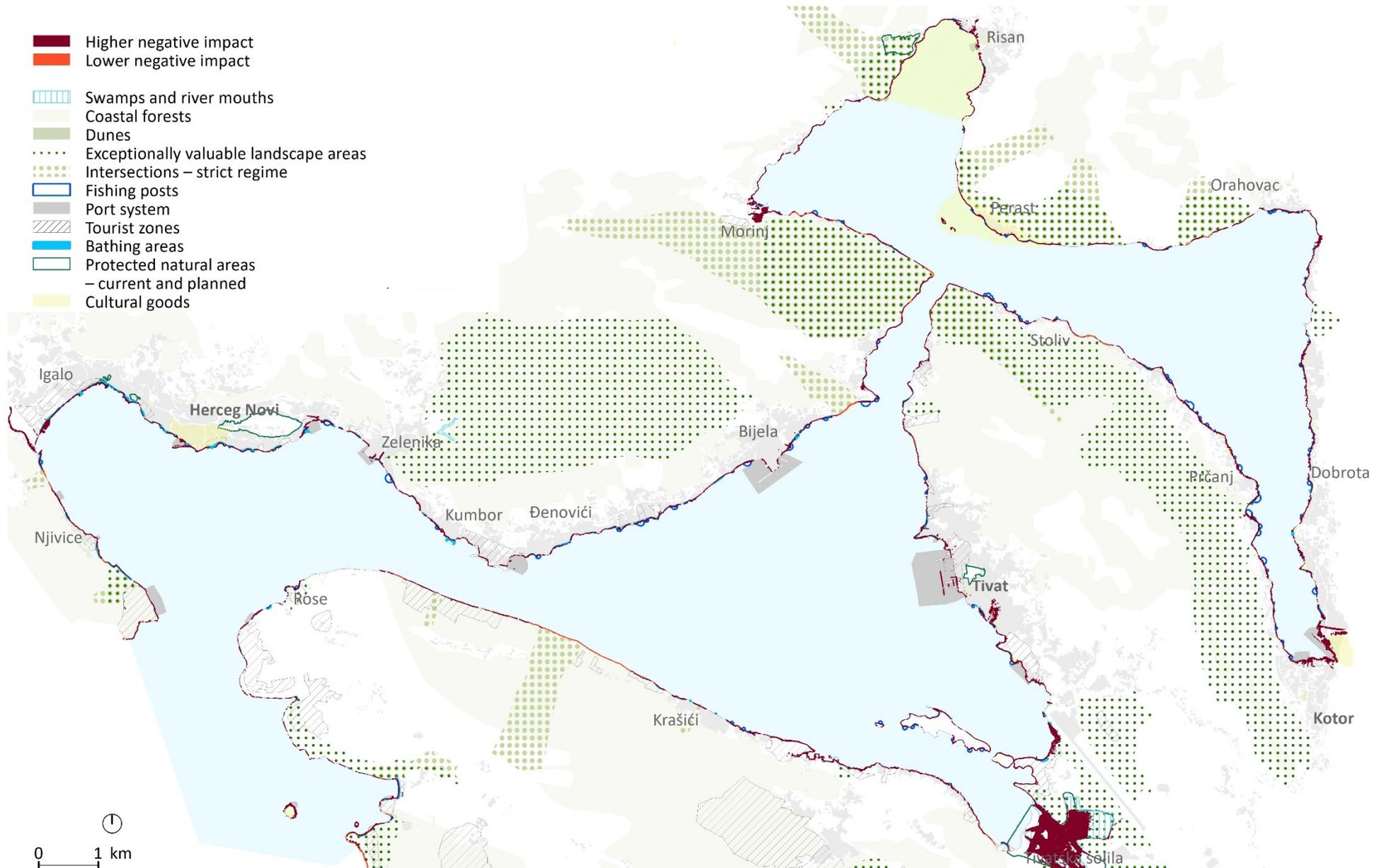
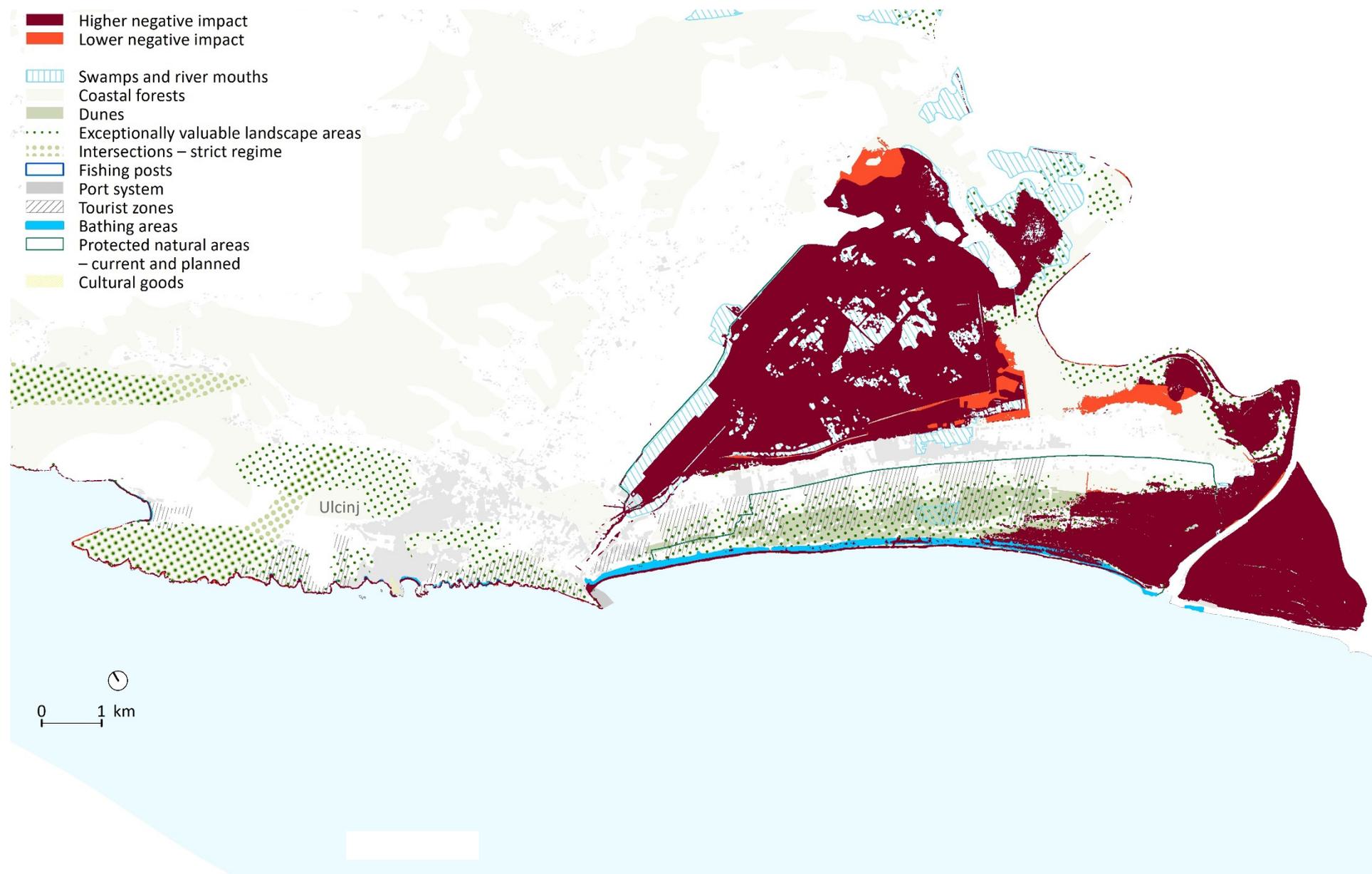
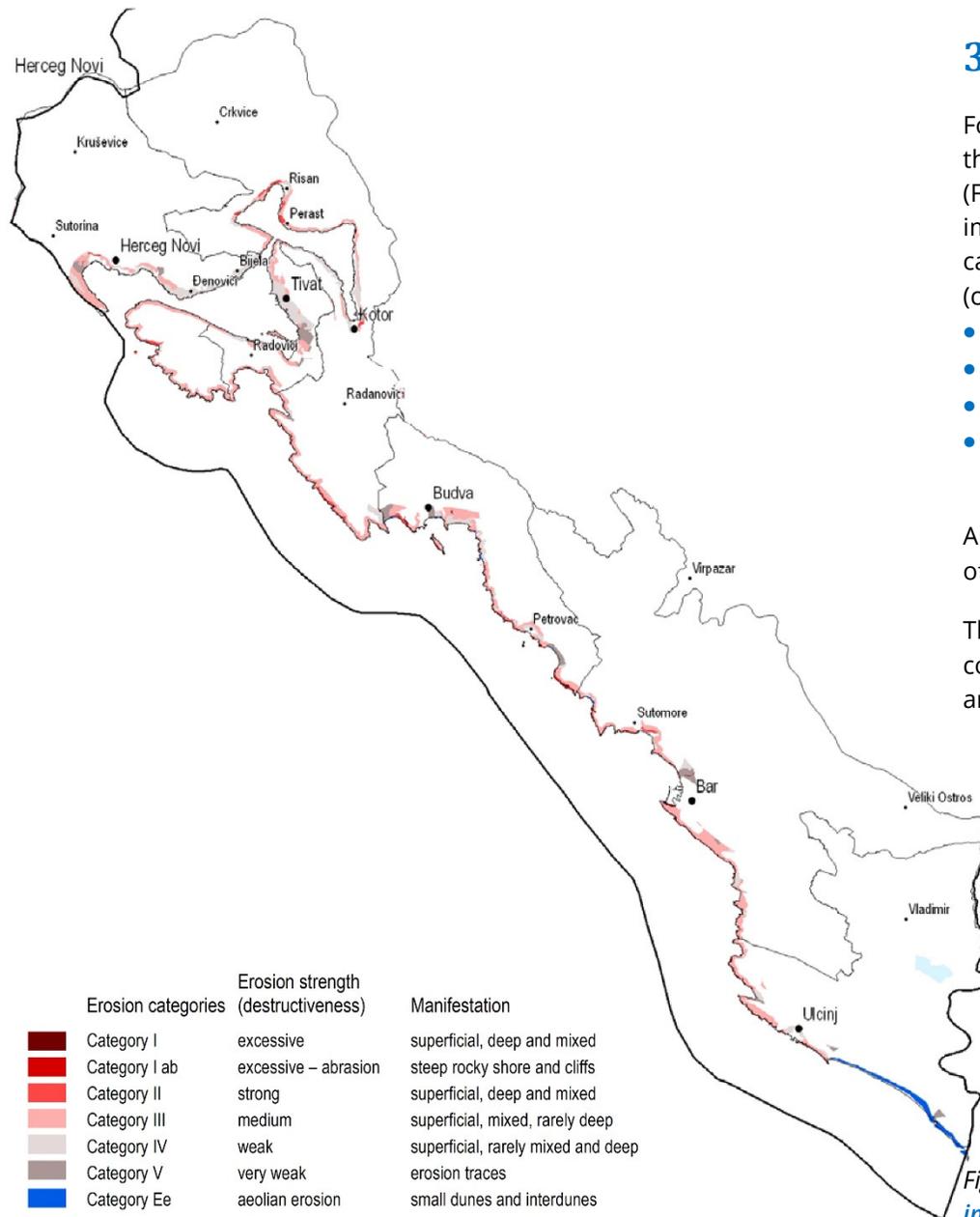


Figure 8: Impact of sea-level rise on land: Ulcinj – Bojana





3.2 Coastal erosion

For the analysis of the impact of coastal erosion on the mainland, the data on the erosion of the immediate sea coast prepared through the CAMP project (Fuštić B., Erosion map of selected basins of the Montenegrin coast and the immediate sea coast, 2013) have been used (Figure 10). The categories which can be considered as an approximation of the relevant impact of the sea (coastal erosion) on land, are assumed to be the following:

- Category I: excessive, superficial, deep and mixed,
- Category I ab: excessive – abrasion, steep rocky shore and cliffs,
- Category II: strong – surface, deep and mixed,
- Ea category: aeolian erosion, refers to the area of Velika plaža and Ada Bojana, which is also under the influence of sea erosion.

Areas of categories I and Ea are considered as areas of interaction regardless of the overlap with activities/uses on land.

The impact of coastal erosion on habitats and areas can in principle be considered negative, but in fact such an impact was decisive on its occurrence and value.

Figure 9: Erosion map of selected basins of the Montenegrin coast and the immediate sea coast (CAMP, Fuštić B., 2013)

Figure 10: Impact of coastal erosion on land: Boka Kotorska Bay

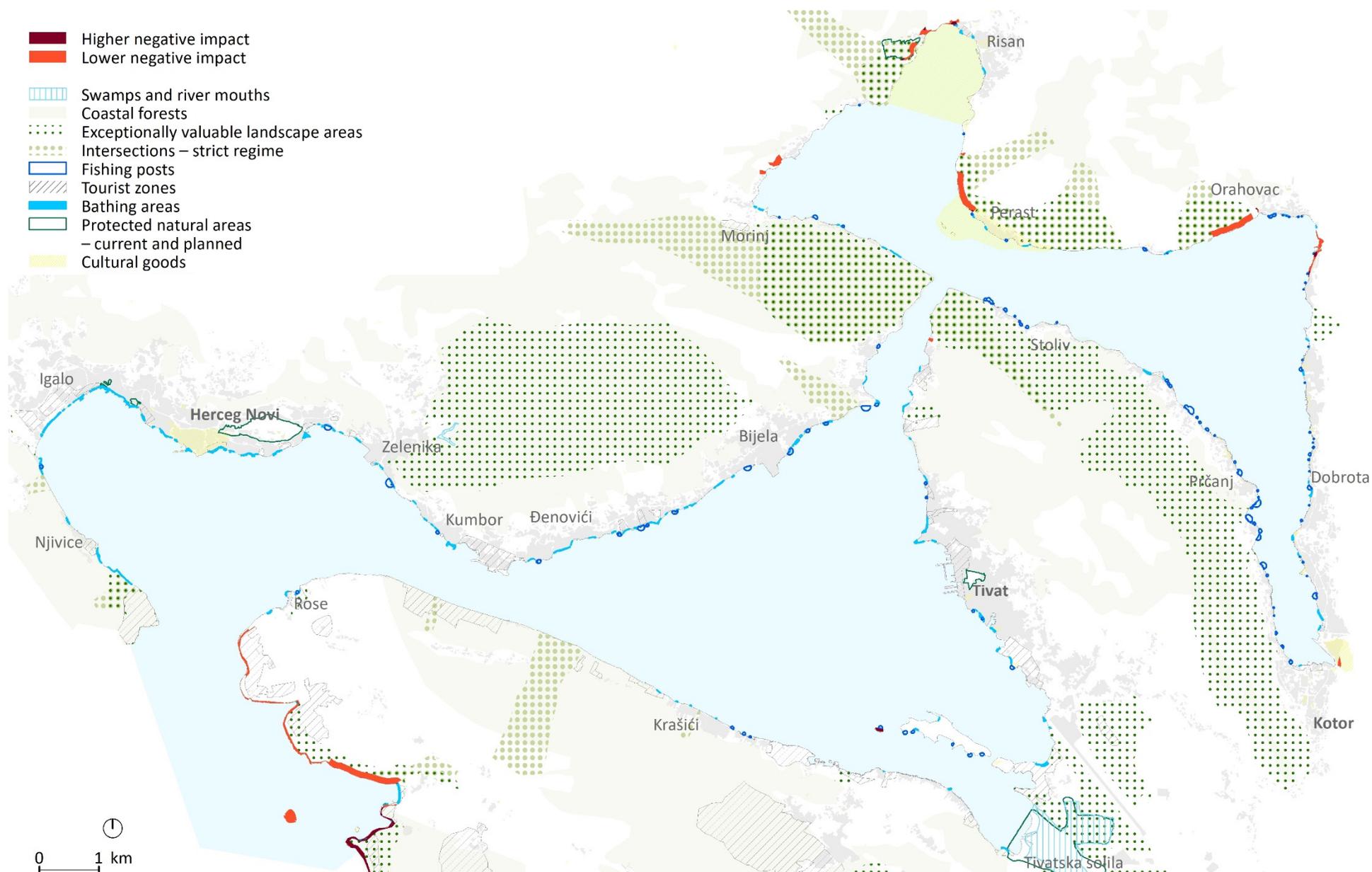


Figure 11: *Impact of coastal erosion on land: Budva – Čanj*

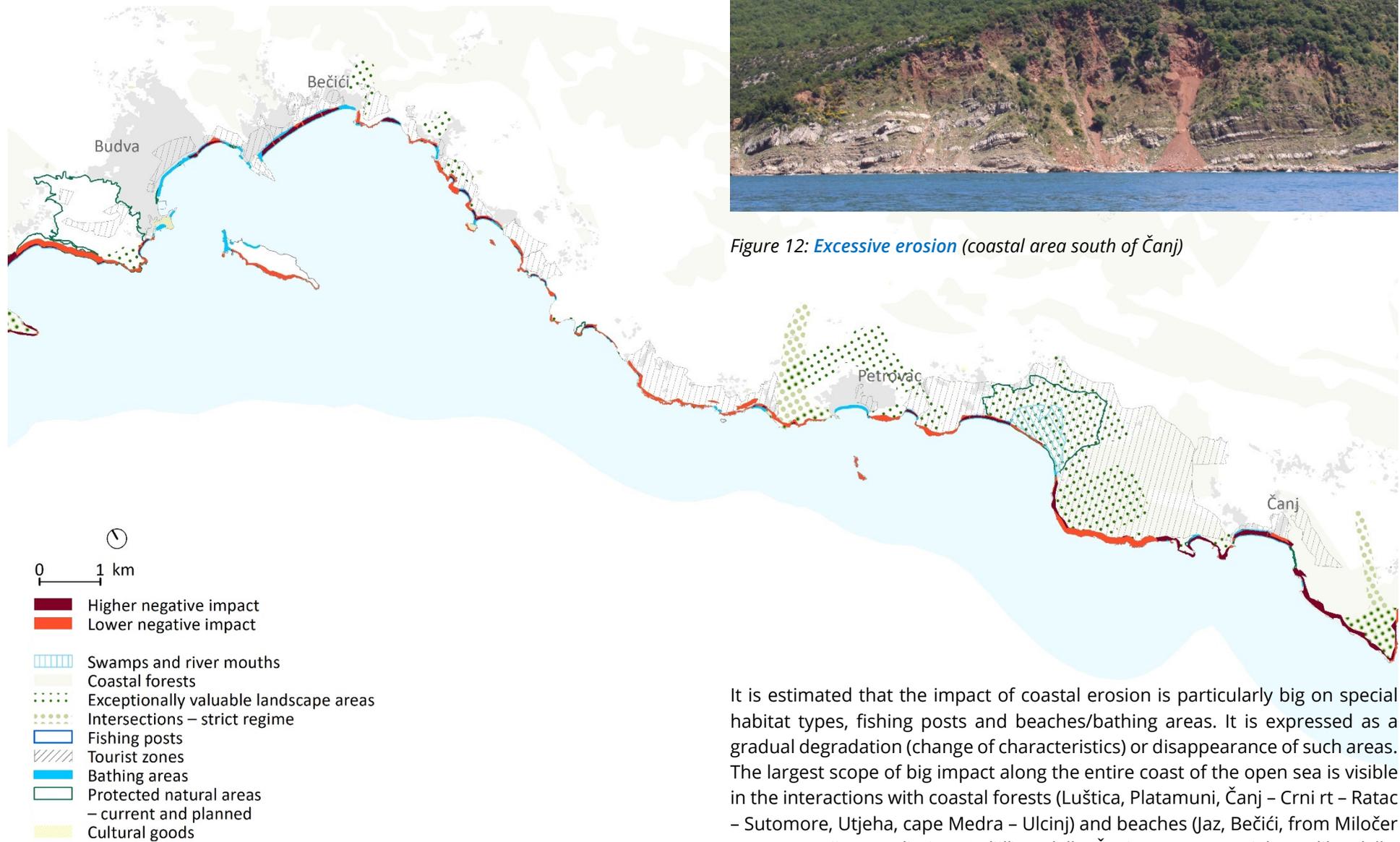
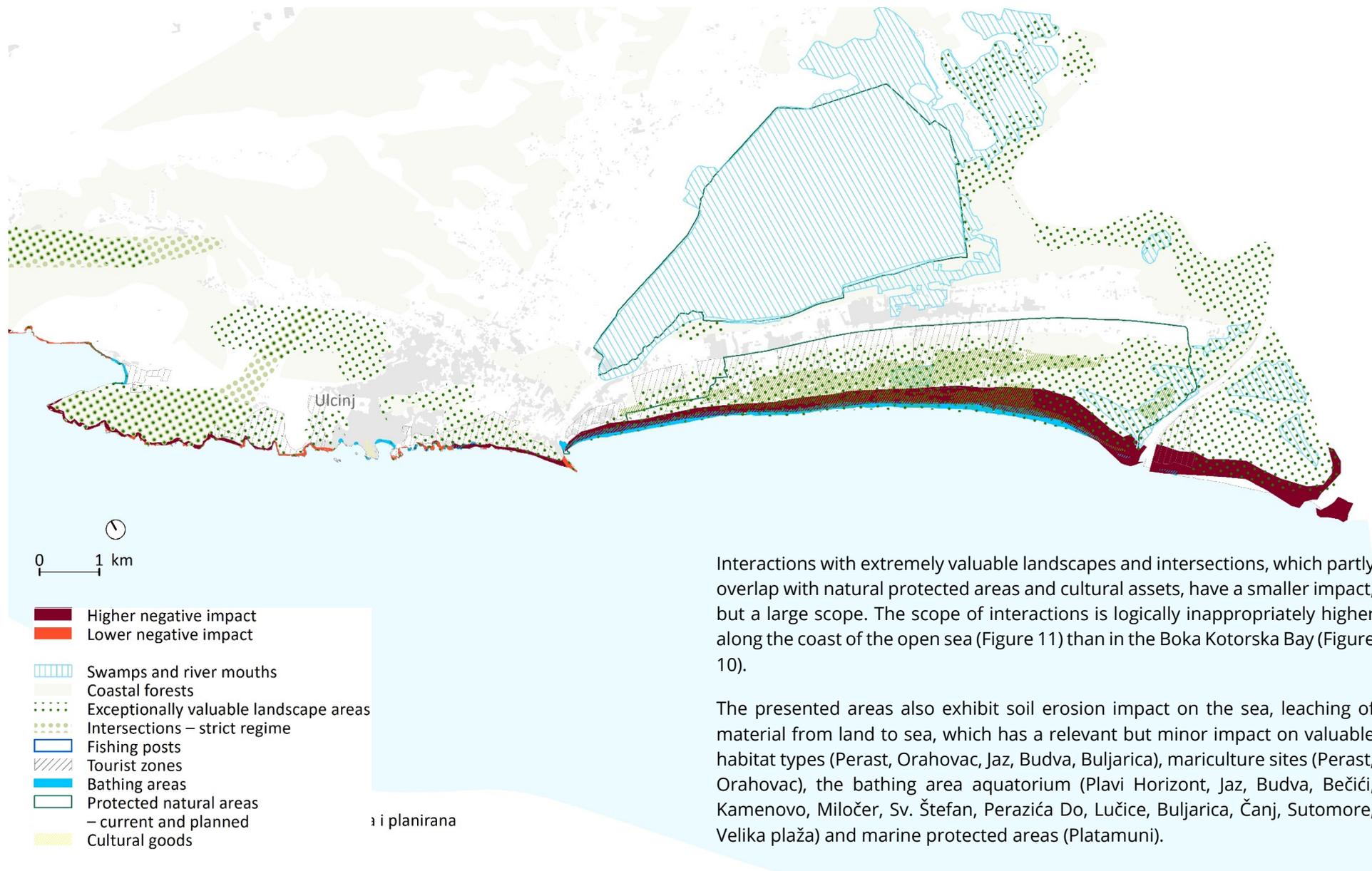


Figure 12: *Excessive erosion* (coastal area south of Čanj)

It is estimated that the impact of coastal erosion is particularly big on special habitat types, fishing posts and beaches/bathing areas. It is expressed as a gradual degradation (change of characteristics) or disappearance of such areas. The largest scope of big impact along the entire coast of the open sea is visible in the interactions with coastal forests (Luštica, Platamuni, Čanj – Crni rt – Ratac – Sutomore, Utjeha, cape Medra – Ulcinj) and beaches (Jaz, Bečići, from Miločer to Crvena stijena, Buljarica, Kraljičina plaža, Čanj, Sutomore, Utjeha, Velika plaža, Ada Bojana).

Figure 13: *Impact of coastal erosion on land: Ulcinj – Bojana*



Interactions with extremely valuable landscapes and intersections, which partly overlap with natural protected areas and cultural assets, have a smaller impact, but a large scope. The scope of interactions is logically inappropriately higher along the coast of the open sea (Figure 11) than in the Boka Kotorska Bay (Figure 10).

The presented areas also exhibit soil erosion impact on the sea, leaching of material from land to sea, which has a relevant but minor impact on valuable habitat types (Perast, Orahovac, Jaz, Budva, Buljarica), mariculture sites (Perast, Orahovac), the bathing area aquatorium (Plavi Horizont, Jaz, Budva, Bečići, Kamenovo, Miločer, Sv. Štefan, Perazića Do, Lučice, Buljarica, Čanj, Sutomore, Velika plaža) and marine protected areas (Platamuni).

3.3 Trophic impact

The analysis uses the assessment of the level of impact related to the trophic nature of the marine environment of Montenegro prepared through the GEF Adriatic project – State and Pressures of the Marine Environment in Montenegro (2021). Categories 4 – high pressure, and 5 – very high pressure, are taken into account (Figure 14).

Eutrophication has the biggest negative impact on bathing areas and affects the sanitary suitability of water and the attractiveness of the sea. It has a relatively smaller negative impact on settlements and tourist zones outside the beach area. Trophic impact is big in all major urban areas – Kotor, Tivat, Igalo (Figure 15), Budva, Sutomore and Bar (Figure 16) and the area of Port Milena.

Figure 14:
Assessment of the level of impacts related to the trophic status of the marine environment of Montenegro

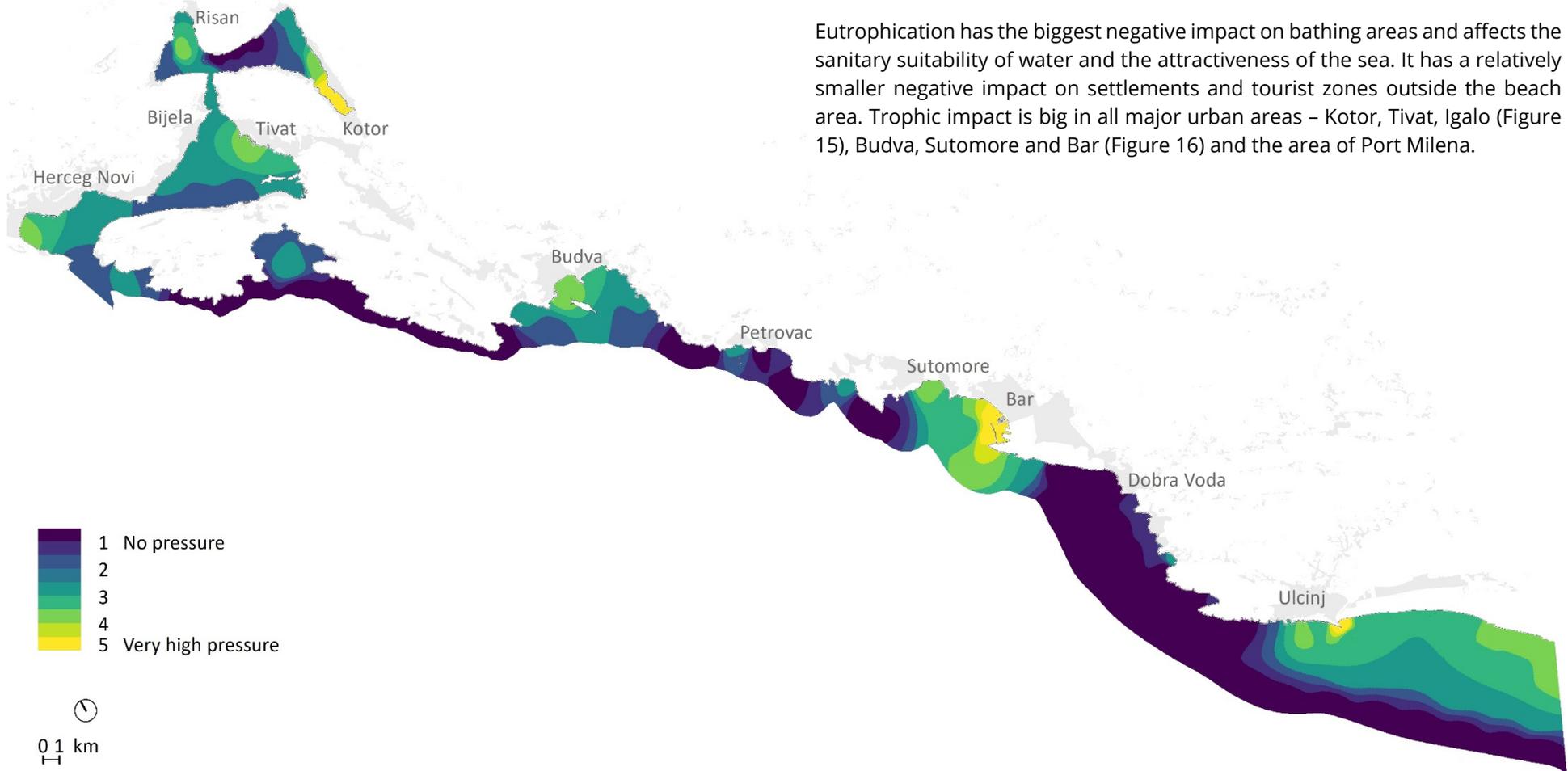


Figure 15: Trophic impact on land: Boka Kotorska Bay

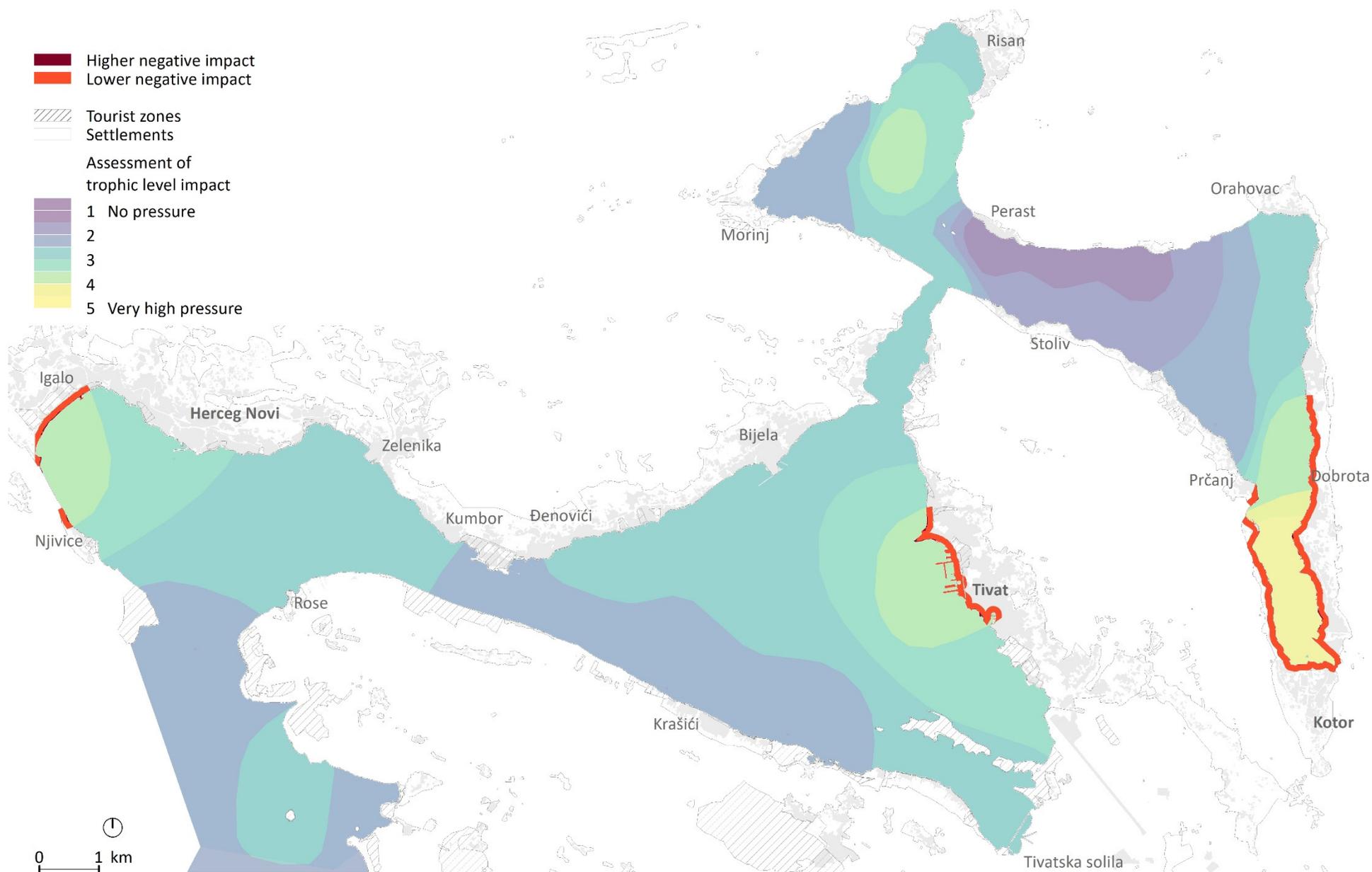
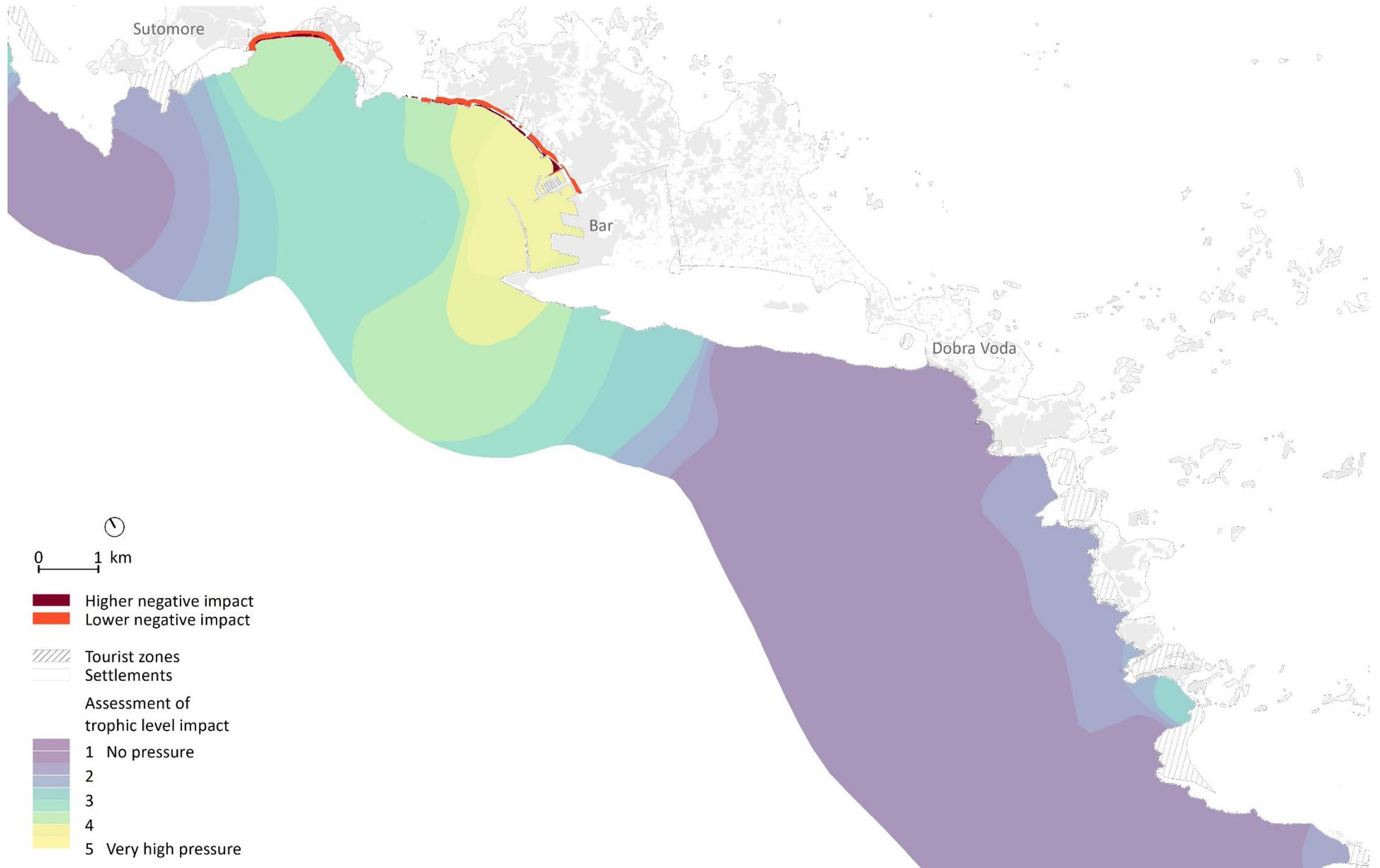
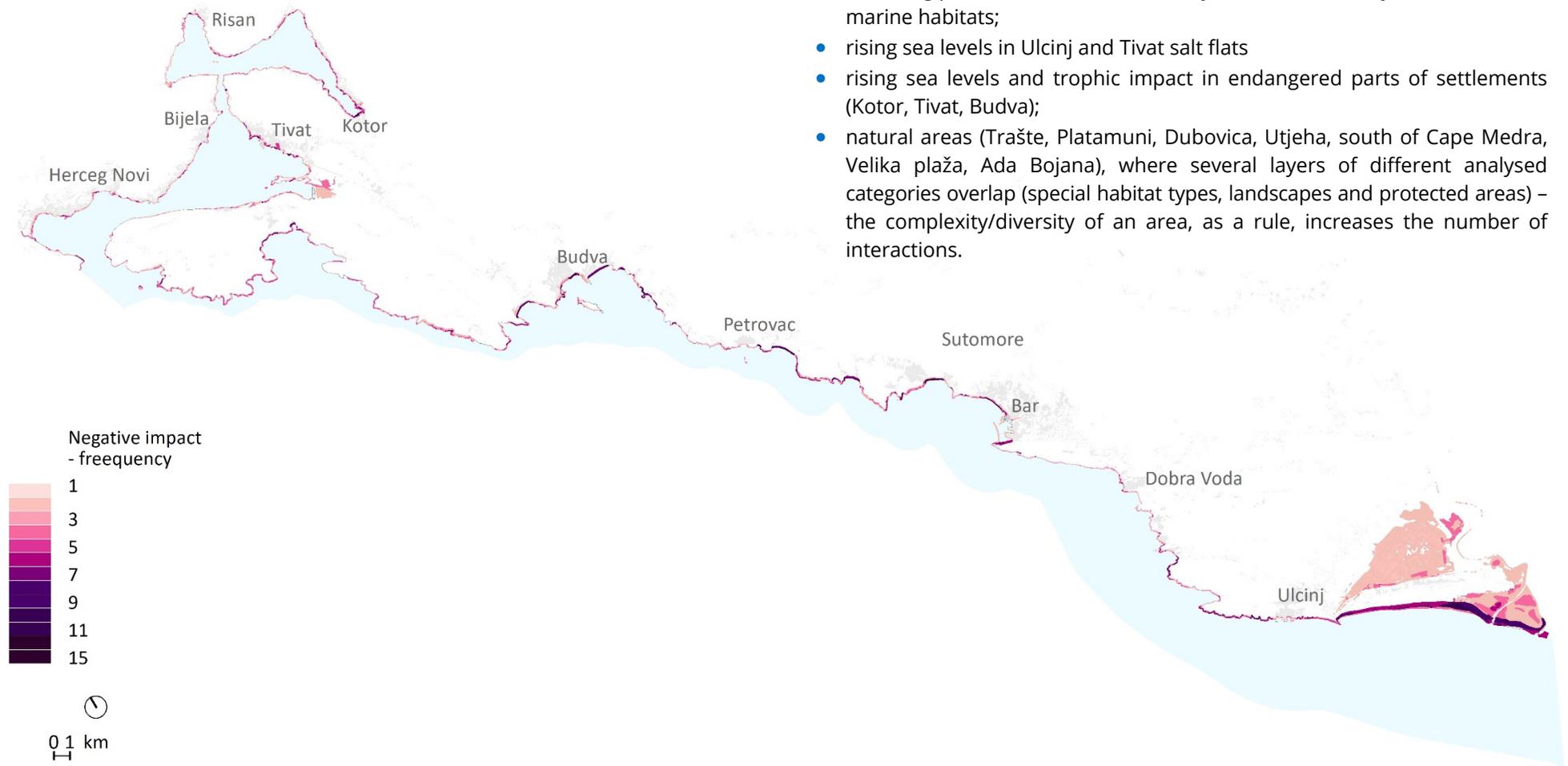


Figure 16: *Trophic impact on land: Sutomore – Dobra Voda*



3.4 Total interactions of natural processes at sea with land

Figure 17: *Total interactions of natural processes at sea with land – frequency*



The areas with the greatest overlap of the impact of natural processes, i.e. greatest volume of interactions, are in Kotor, Tivat, from Platamun to Sv. Štefan, Buljarice to Bar, Utjeha, from Cape Medra to Bojana. They are:

- beaches/bathing areas along the entire coast, which are subject to the effects of erosion and rising sea levels, especially those that are also used as fishing posts (the Boka Kotorska Bay) and which are adjacent to valuable marine habitats;
- rising sea levels in Ulcinj and Tivat salt flats
- rising sea levels and trophic impact in endangered parts of settlements (Kotor, Tivat, Budva);
- natural areas (Trašte, Platamuni, Dubovica, Utjeha, south of Cape Medra, Velika plaža, Ada Bojana), where several layers of different analysed categories overlap (special habitat types, landscapes and protected areas) – the complexity/diversity of an area, as a rule, increases the number of interactions.

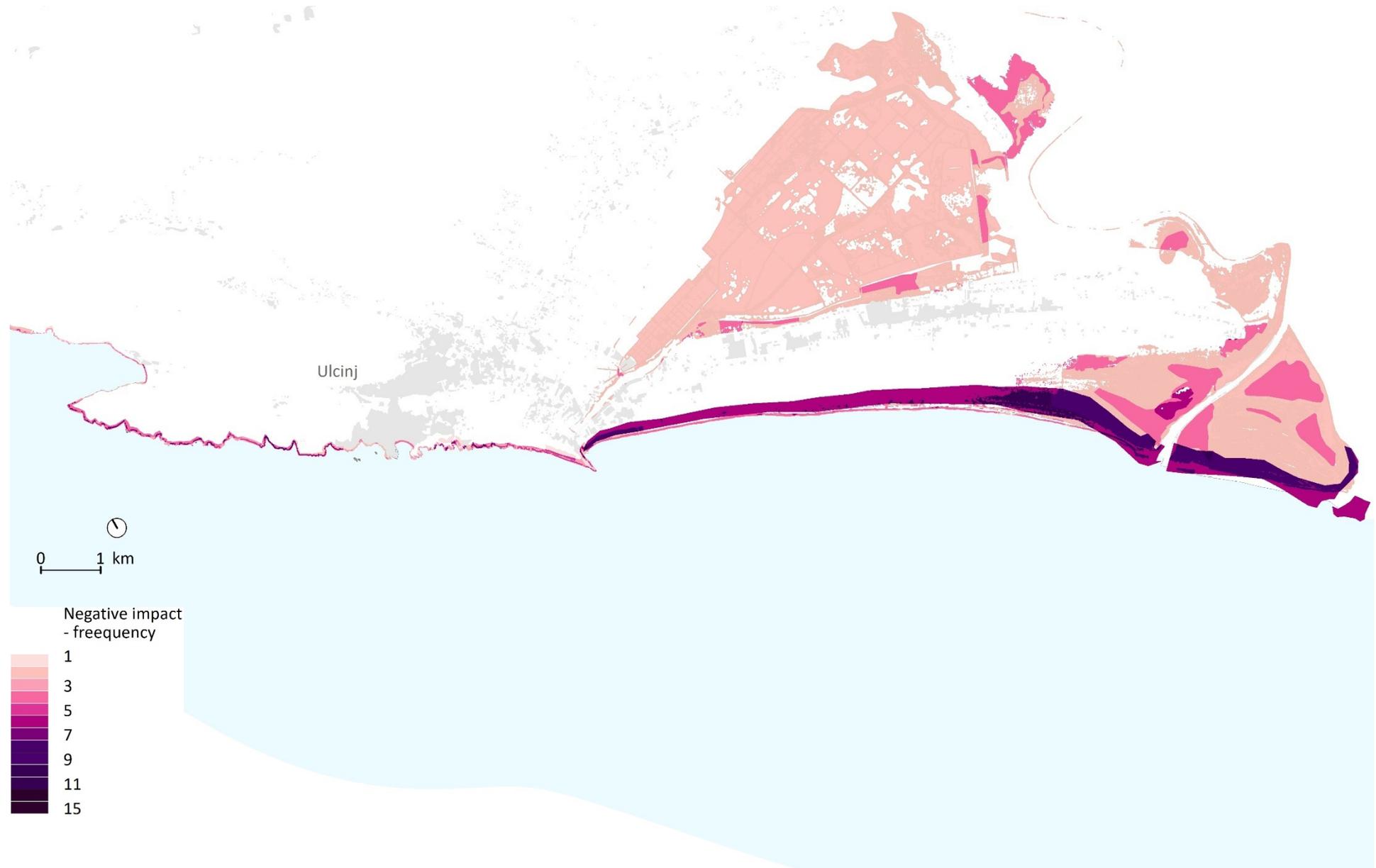
Figure 18: Total interactions of natural processes at sea with land – frequency: Boka Kotorska Bay



Figure 19: Total interactions of natural processes at sea with land – frequency: Budva – Čanj



Figure 20: Total interactions of natural processes at sea with land – frequency: Ulcinj – Bojana



4 Uses and activities: sea-land interactions

The analysis was prepared for the following uses and activities concerning sea-land interactions:

- mariculture sites,
- fishing posts,
- natural protected areas.

Other uses and activities at sea were not taken into account because at the time of analysis no satisfactory data was available (recreational nautical tourism infrastructure) or impacts were not relevant (submarine infrastructure, waterways) or interactions were difficult to present reliably due to many complexities (oil and gas exploration area). The identified land-sea interactions and impact assessments are laid out in the supporting excel file of this report .

4.1 Mariculture locations

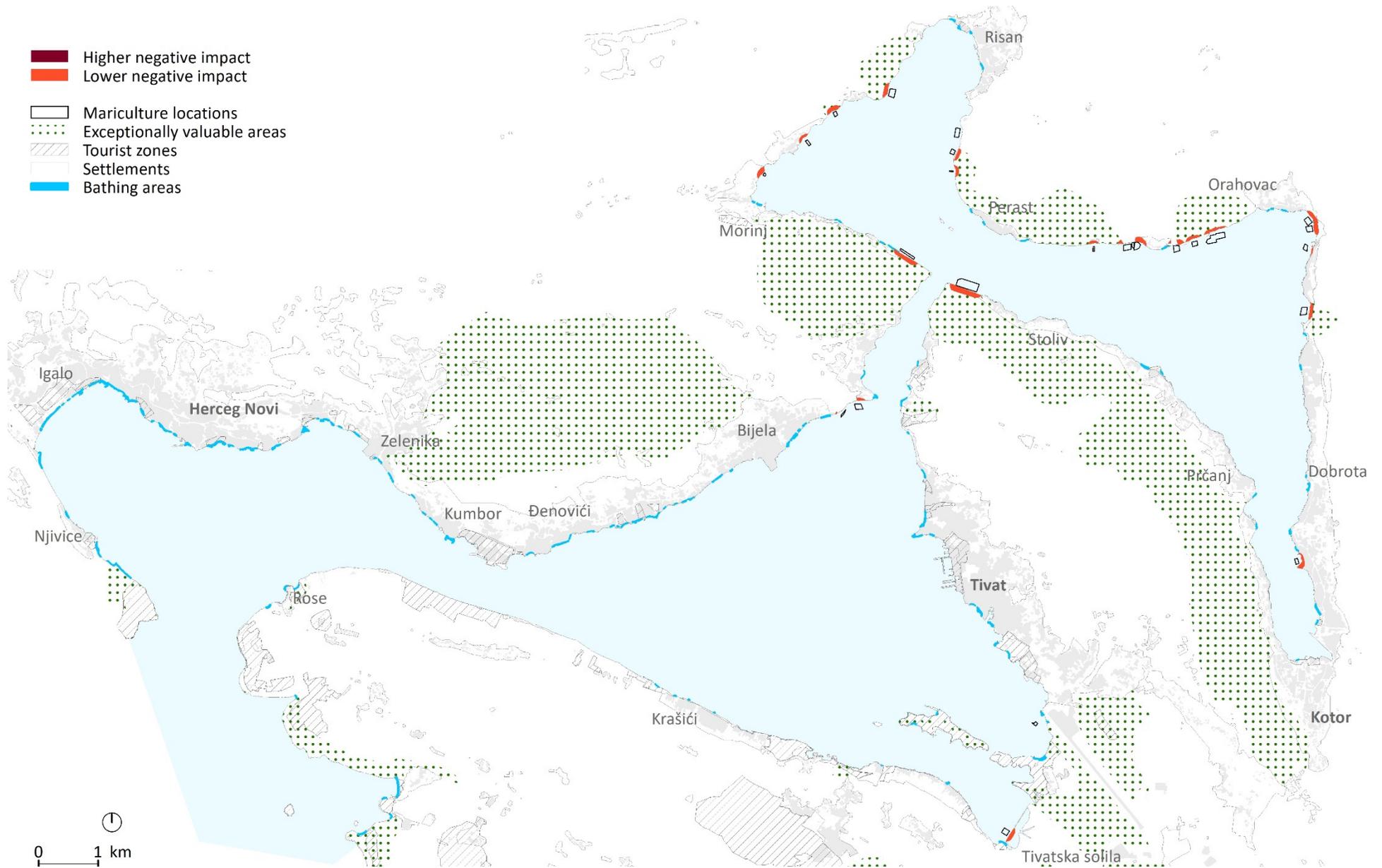
Mariculture sites can interact with areas of extremely valuable landscapes and natural protected areas – less impact due to visible disruption. This type of interaction is typical of practically all locations in the Risan and Kotor bays (Figure 22).

The second type of interaction is restrictions, i.e. conflict with bathing areas and other activities at sea, along the coast, tourist zones and settlements. The scope of such interaction is small or non-existent, because such potentially conflicting areas are avoided when determining locations for mariculture.



Figure 21: *Mariculture location* (Dražin vrt)

Figure 22: *Mariculture location land interactions: Boka Kotorska Bay*



All mariculture sites are defined (i.e. permits are issued) on the basis of existing mariculture zones that form an integral part of the Spatial Plan of the Special Purpose Area for the Maritime Property of Montenegro (2007) and the Spatial Plan of Special Purpose for the Coastal Area of Montenegro (2018). What is very important to mention is that all shellfish farming locations (based on the agreements signed annually with Morsko Dobro) can use only 20 m² of coastal land, while fish farming allows for a maximum of 100 m² of coastal land. So the level of interaction with the mainland, i.e. valuable areas on the mainland is realistically very low. Also, due to the characteristics of the high-way along the coast, the land used by farms is right below the highway, i.e. right by the sea, while valuable areas on land are above the highway, making it possible for the highway to act as a "barrier" between the farms and valuable landscapes.

4.2 Fishing posts

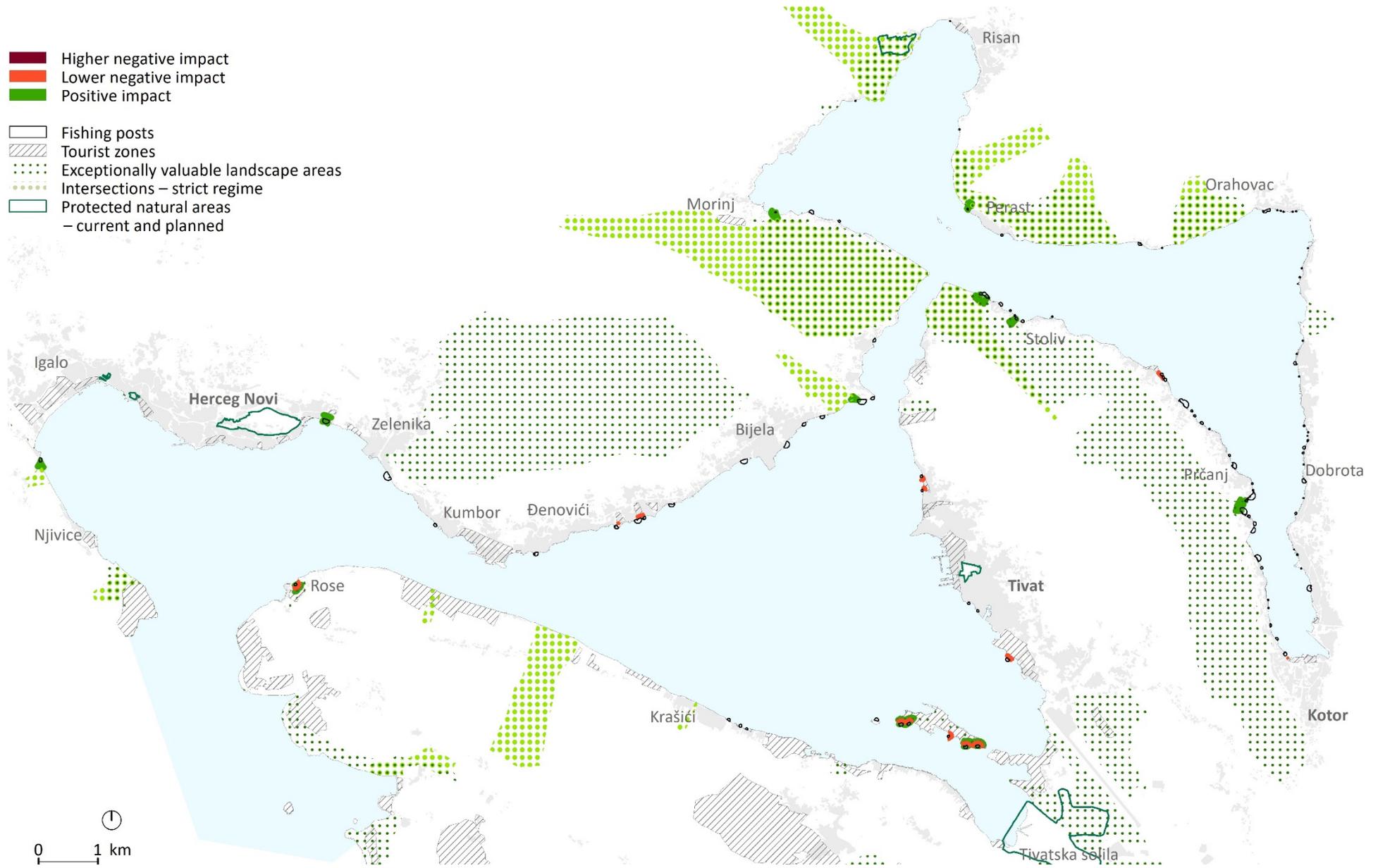
Fishing posts are places on the coast, but for the purposes of this analysis they are considered as an activity at sea. Figure 24 shows the areas at sea where trawls are usually towed. They may interact with bathing areas or tourist zones due to the shared use of space. The extent of these interactions is not significant or problematic, and is limited to a few posts. There is no conflict of use, because fishing posts are used exclusively at night and in the early morning hours, when fishing is done. For the rest of the day, they can be used as bathing areas.

The posts are traditional fishing zones in the Boka Kotorska Bay. These are places where smaller trawls are being towed, which cannot have a negative impact on valuable areas on land, and in particular cannot lead to physical damage to protected areas on land. In essence, the posts have a positive impact on the mainland (landscapes, natural protected areas) because they "protect" a significant part of the coast from additional construction, because within 100 meters of the post the disposal of rubble, stones, fencing and construction are prohibited.



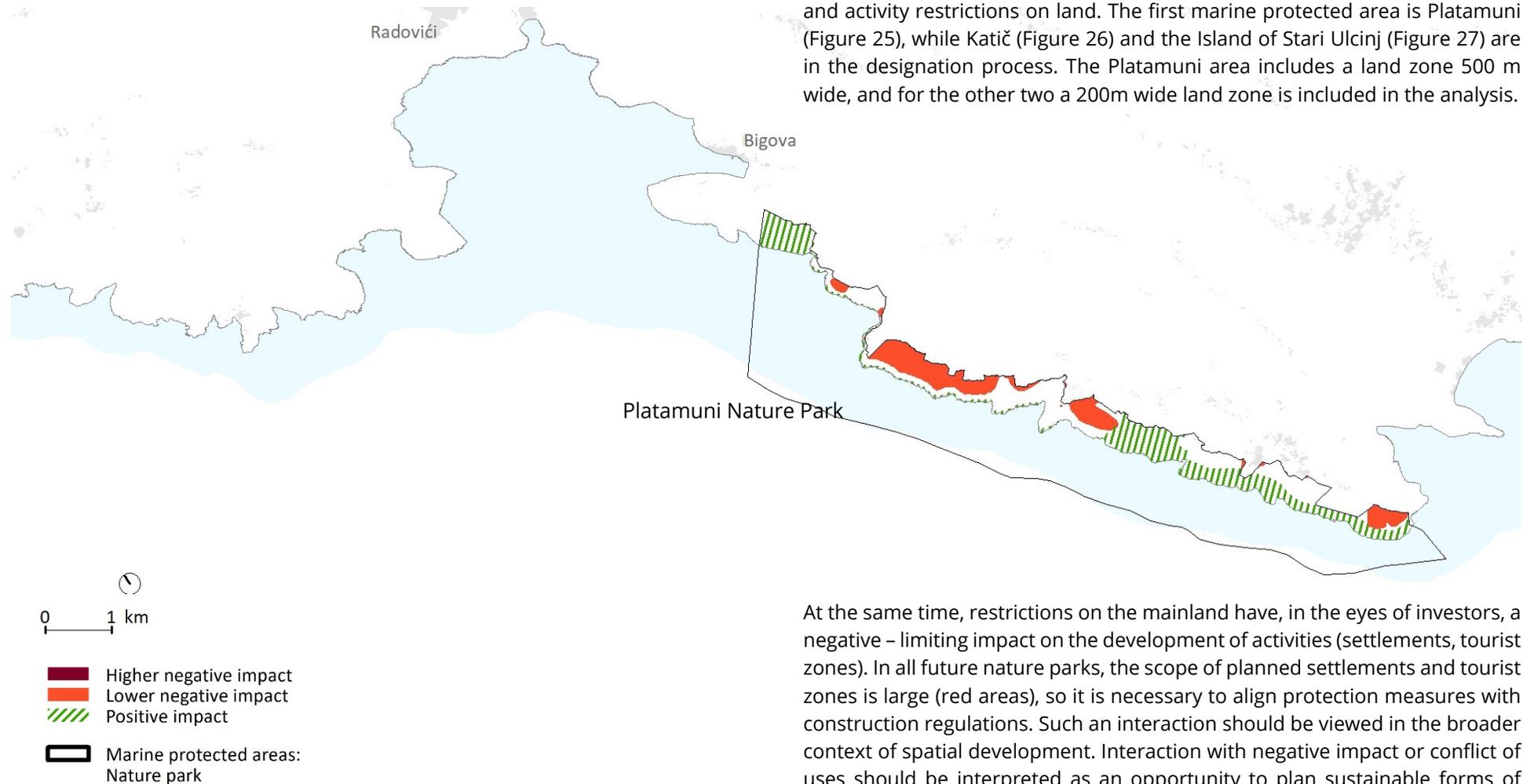
Figure 23. *Fishing at fishing posts* (A. Joksimovic)

Figure 24. Interactions of fishing posts with land: Boka Kotorska Bay



4.3 Marine protected areas

Figure 25. Interactions of marine protected areas with land: Trašte – Platamuni



The protection of marine areas has a positive impact on the land characteristics as well (habitats, landscapes, cultural assets) because, as a rule, it includes uses and activity restrictions on land. The first marine protected area is Platamuni (Figure 25), while Katič (Figure 26) and the Island of Stari Ulcinj (Figure 27) are in the designation process. The Platamuni area includes a land zone 500 m wide, and for the other two a 200m wide land zone is included in the analysis.

At the same time, restrictions on the mainland have, in the eyes of investors, a negative – limiting impact on the development of activities (settlements, tourist zones). In all future nature parks, the scope of planned settlements and tourist zones is large (red areas), so it is necessary to align protection measures with construction regulations. Such an interaction should be viewed in the broader context of spatial development. Interaction with negative impact or conflict of uses should be interpreted as an opportunity to plan sustainable forms of urbanization.

Figure 26: Interactions of marine protected areas with land: Budva – Čanj



Figure 27: Interactions of marine protected areas with land: Sutomore – Dobra voda



4.4 Uses and activities: total sea-land interactions

Due to the smaller number of analysed uses/activities and their meaningful location (fishing posts are not or cannot be in the same area as mariculture sites) there is no overlap of different interactions. The map of total sea-land interactions in the Boka Kotorska Bay (Figure 28) is thus merely the sum of all areas of interaction – fishing posts and locations for mariculture. It is estimated that these sea-land interactions are not significant.

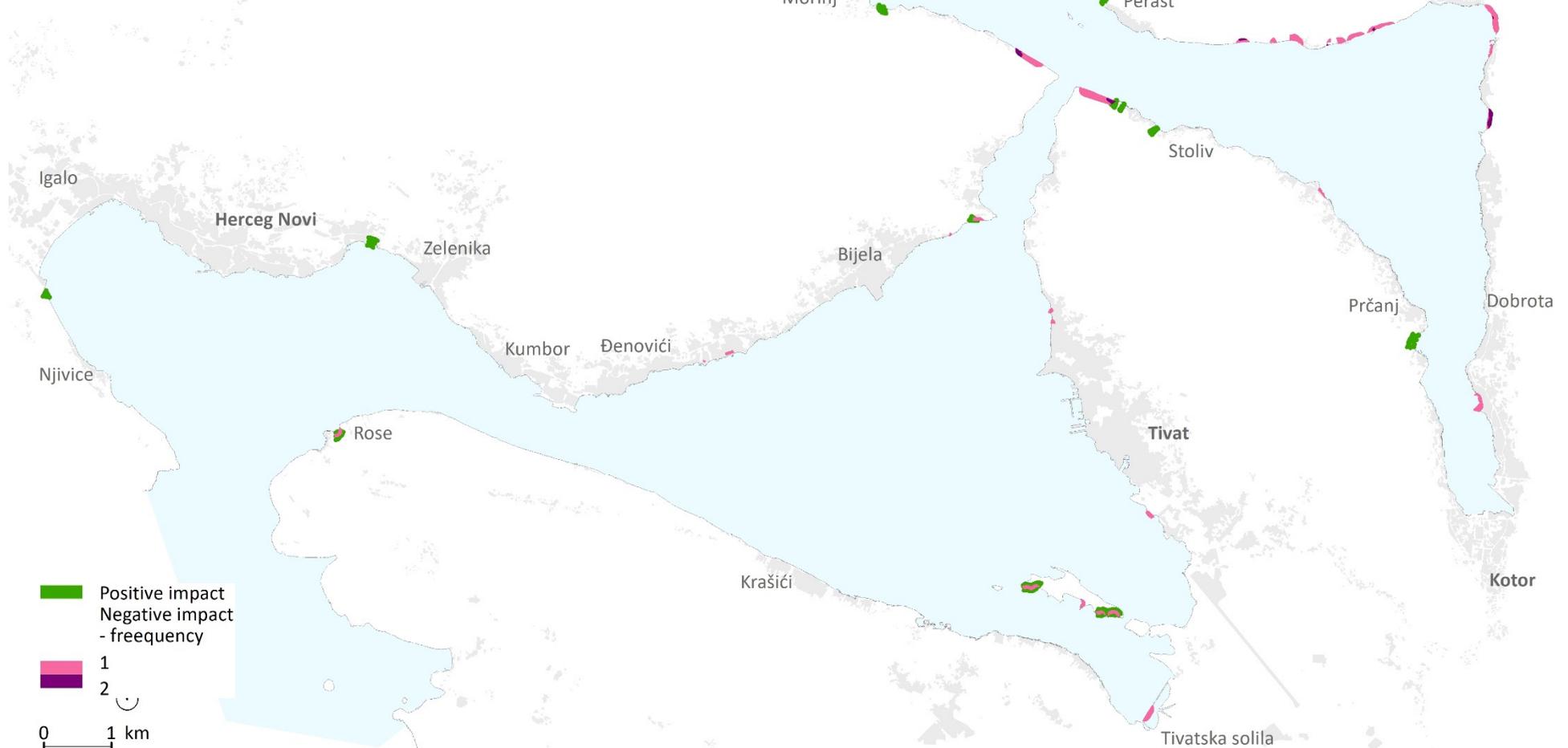


Figure 28: Total sea-land interactions – frequency: Boka Kotorska Bay

5 Uses and activities: land-sea interactions

The analysis was prepared for the following uses and activities concerning land-sea interactions:

- mineral deposits and areas of exploitation fields;
- port system;
- tourist zones;
- settlements;
- bathing areas;
- natural protected areas;
- cultural goods;
- areas for waste treatment, remediation and storage.

The interactions of agricultural areas, areas for industry and production, and wind farms, which are in principle significant, have not been analysed, because they are not located or are not planned in the narrower coastal area. Discharges were not analysed because their impact had already been analysed in the assessment of impact levels related to the trophic nature of the marine environment. Other uses and activity at sea were not considered because at the time of the analysis there was no satisfactory data, the impacts were not relevant or the interactions were difficult to express due to complexity.

The identified land – sea interactions and impact assessments are available in the supporting excel file of this report.

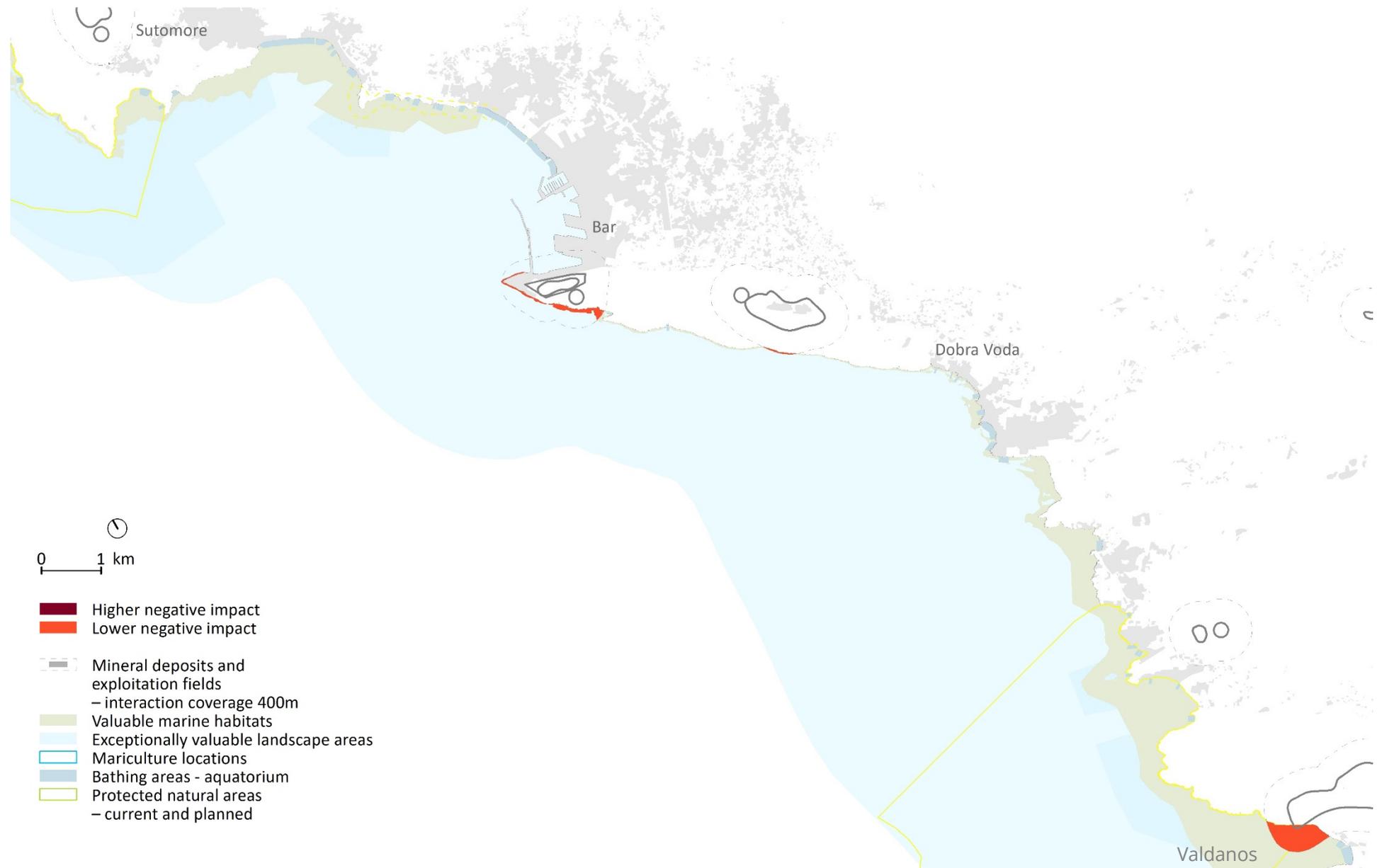
5.1 Mineral deposits and areas of exploitation fields

Figure 29:
Interactions of mineral deposits and areas of exploitation fields with the sea



Mineral deposits and areas of exploitation fields near the coast are problematic due to leaching and aeolian transport of materials into the sea, as well as visual degradation of the sea area. In this sense, the locations at Volujica and north of Valdanos, defined by the SPSPCA, can be problematic (Figure 30), especially because this location is located in a protected natural area.

Figure 30: Interactions of mineral deposits and areas of exploitation fields with the sea: Sutomore – Dobra Voda



5.2 Port system

The analysed port system takes into account existing and planned ports. Ports have a greater negative impact on virtually all elements of the sea due to physical damage and pollution of the marine environment, conflict with other uses and in some places visual degradation. The analysis shows that larger ports/marinas – Porto Montenegro, Bijela, Kumbor, Zelenika, Bar – do not have such interactions. The reason is that the areas of these ports/marinas are degraded or artificially altered marine environments, in which there are no valuable elements (habitats, landscapes, protected areas) or activities such as bathing.

The ports/docks of Kotor, Risan, Meljine, Herceg Novi (Figure 32) and Budva (Figure 33) interact with areas of exceptional sea landscape, which is defined as a wider area of cultural property on land. A number of (envisaged) smaller docks (in the areas of Njivice, Rose, Mamula, Žanjice (Figure 32), Trašta, Čanja (Figure 33), Sutomore (Ratac) are in areas of valuable marine habitats and/or extremely valuable marine areas). Some of the planned docks are in locations that do not have existing access to the sea. The new roads bring additional negative impacts, especially in steep and visibly exposed areas, for example above the planned dock of Kobilja at the entrance to the Boka Kotorska Bay. Due to high impact, it was recommended that the planned docks of Kobilja and Ratac not be included in the marine spatial plan.

Figure 31: *Interactions of port systems with the sea*

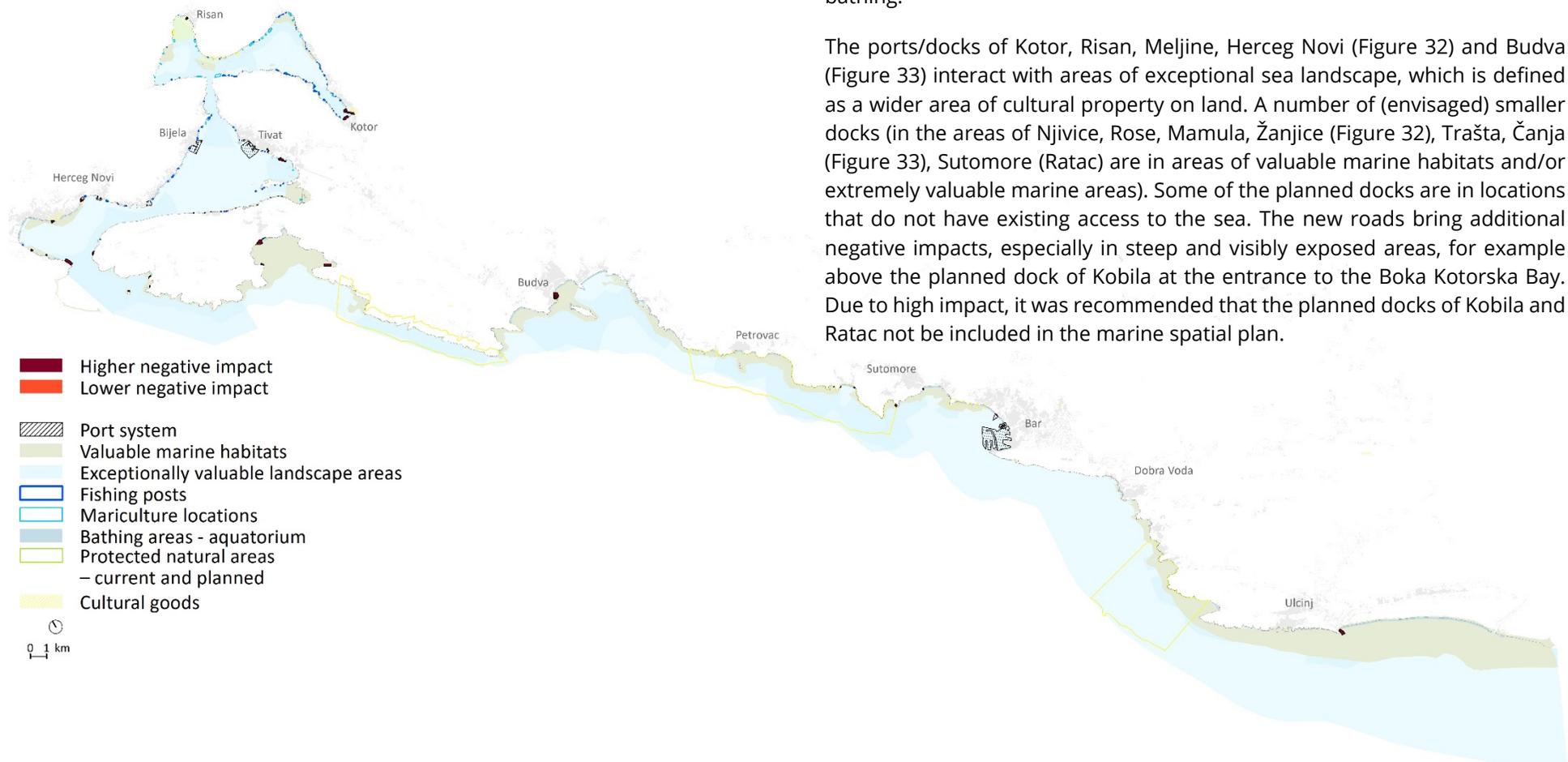


Figure 32: Interactions of port systems with the sea: Boka Kotorska Bay

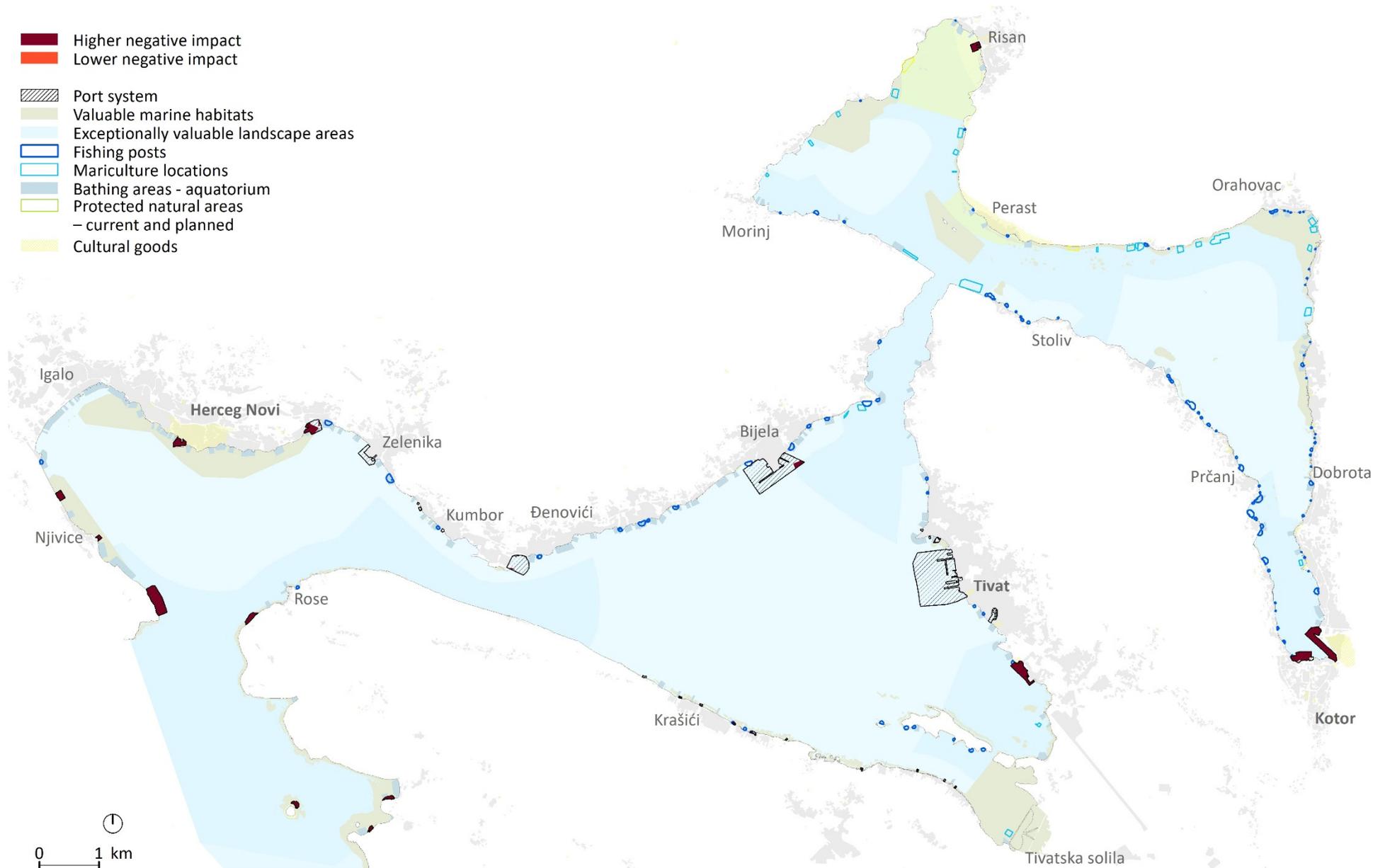
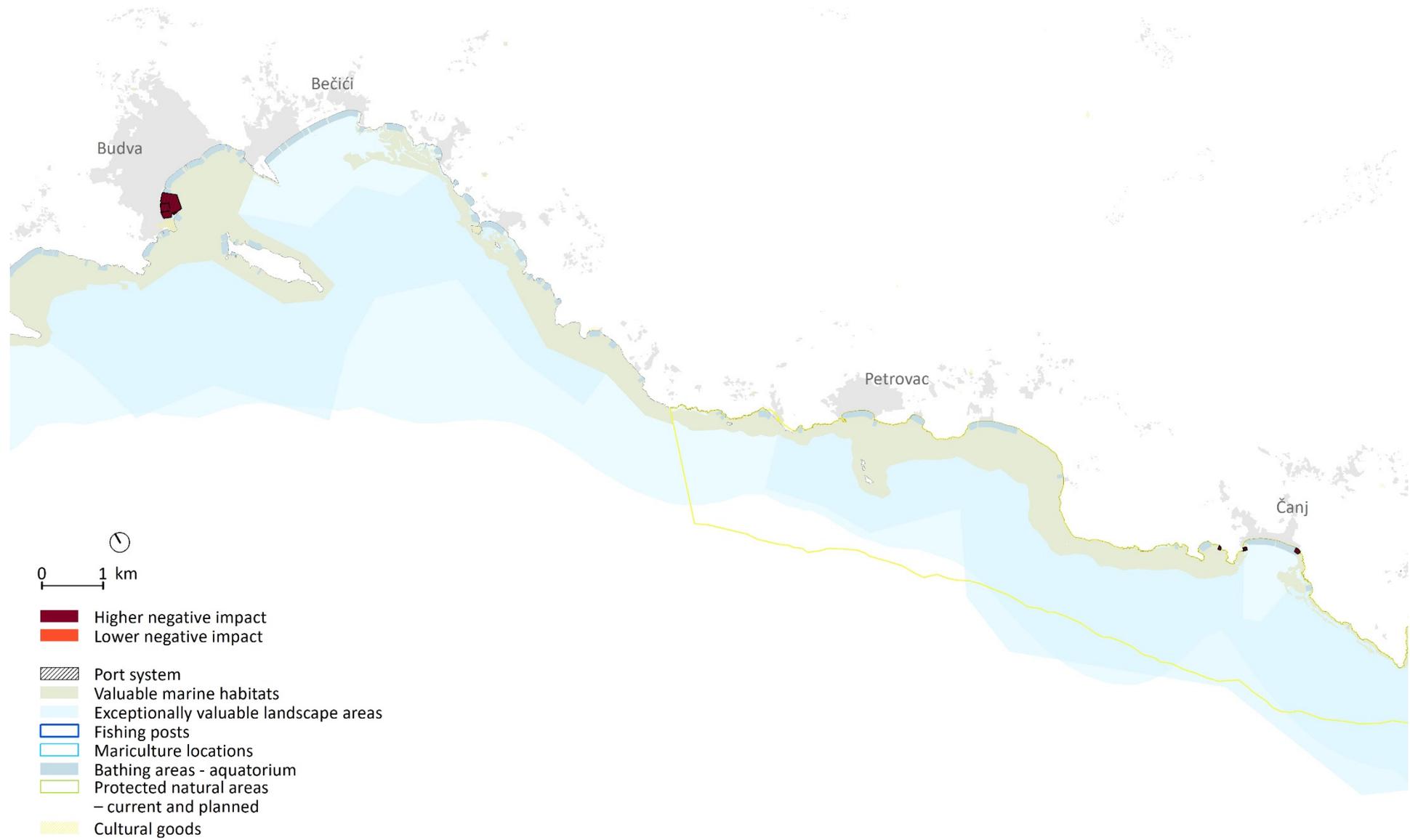


Figure 33: Interactions of port systems with the sea: Budva – Čanj



5.3 Tourist zones and settlements

The basis for the analysis are areas that include both existing and planned areas of tourist zones and settlements. Means and potential interactions are illustrated. The planned areas and their interactions are visible from the maps as areas without created zones that are used for cartographic purposes.

Tourist zones and settlements have similar interactions. The temporal dimension of interactions related to tourist zones is different. These are more pronounced but limited to the tourist season. Similar to ports, they affect practically all characteristics of the sea (due to physical damage and pollution of the marine environment, conflict with protection measures, and visual degradation), but the intensity and scope of interactions is usually lower.

Figure 34: *Interactions of tourist zones with the sea*

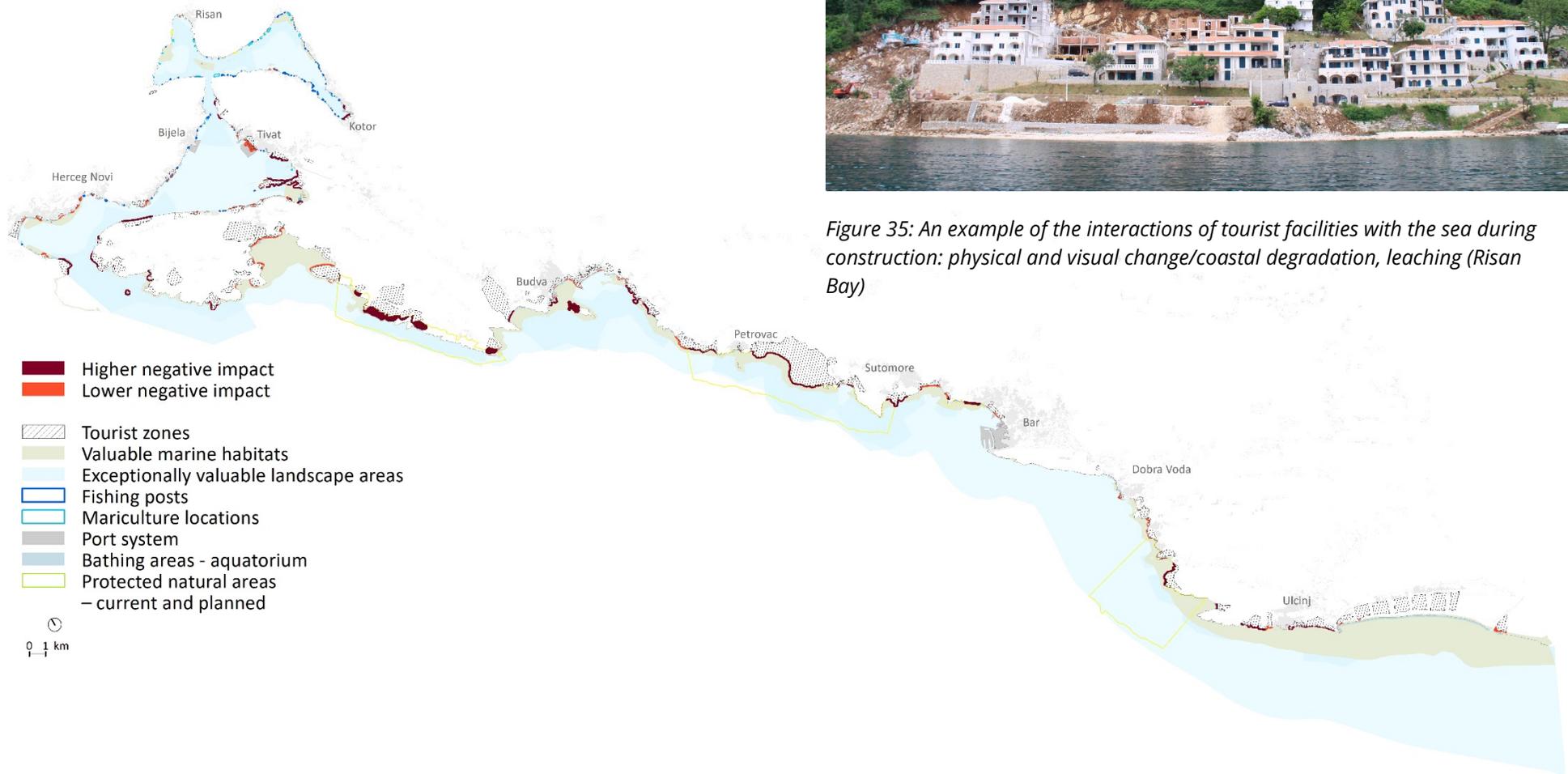


Figure 35: *An example of the interactions of tourist facilities with the sea during construction: physical and visual change/coastal degradation, leaching (Risan Bay)*

Figure 36: Interactions of tourist zones with the sea – maximum values: Boka Kotorska Bay

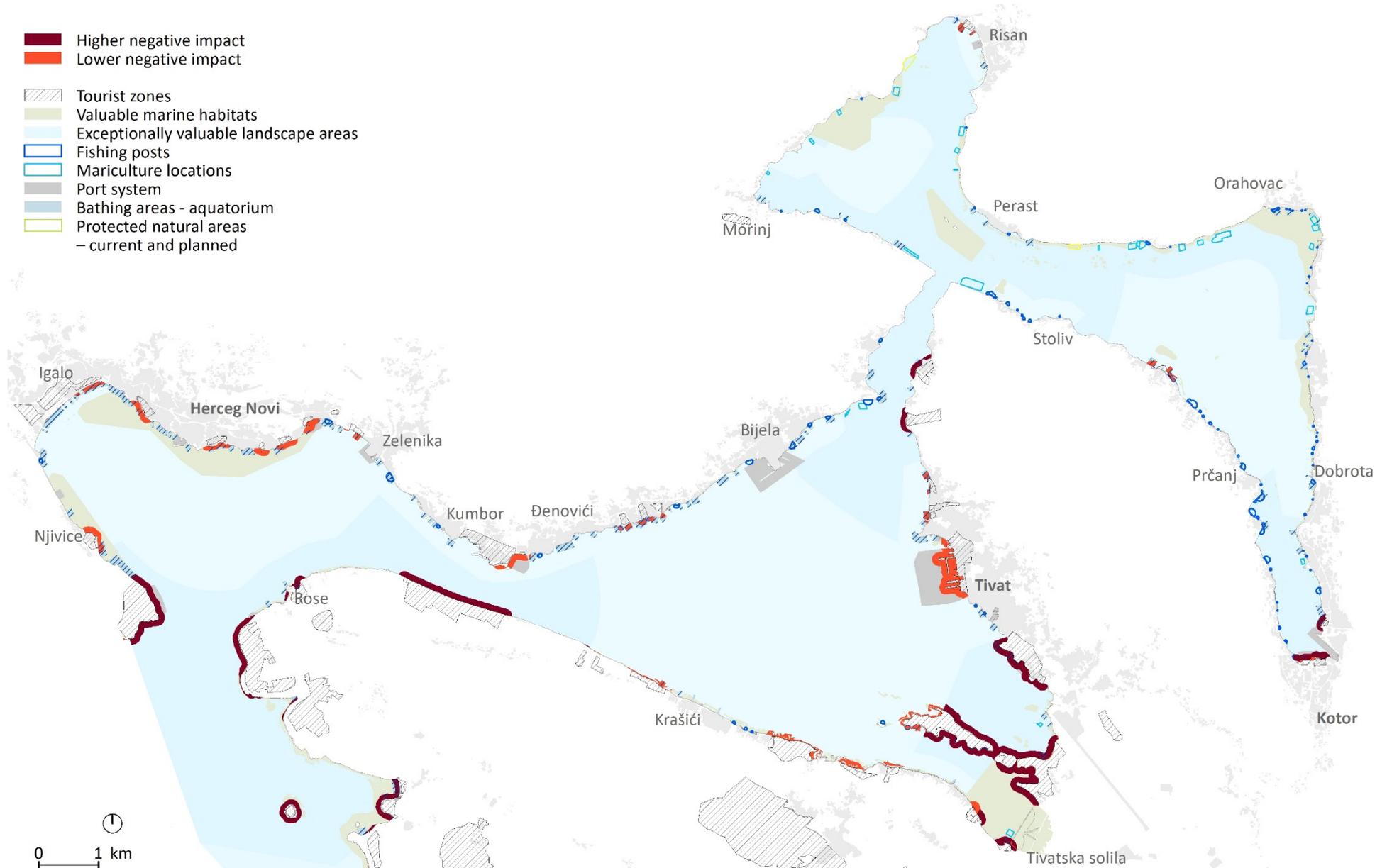
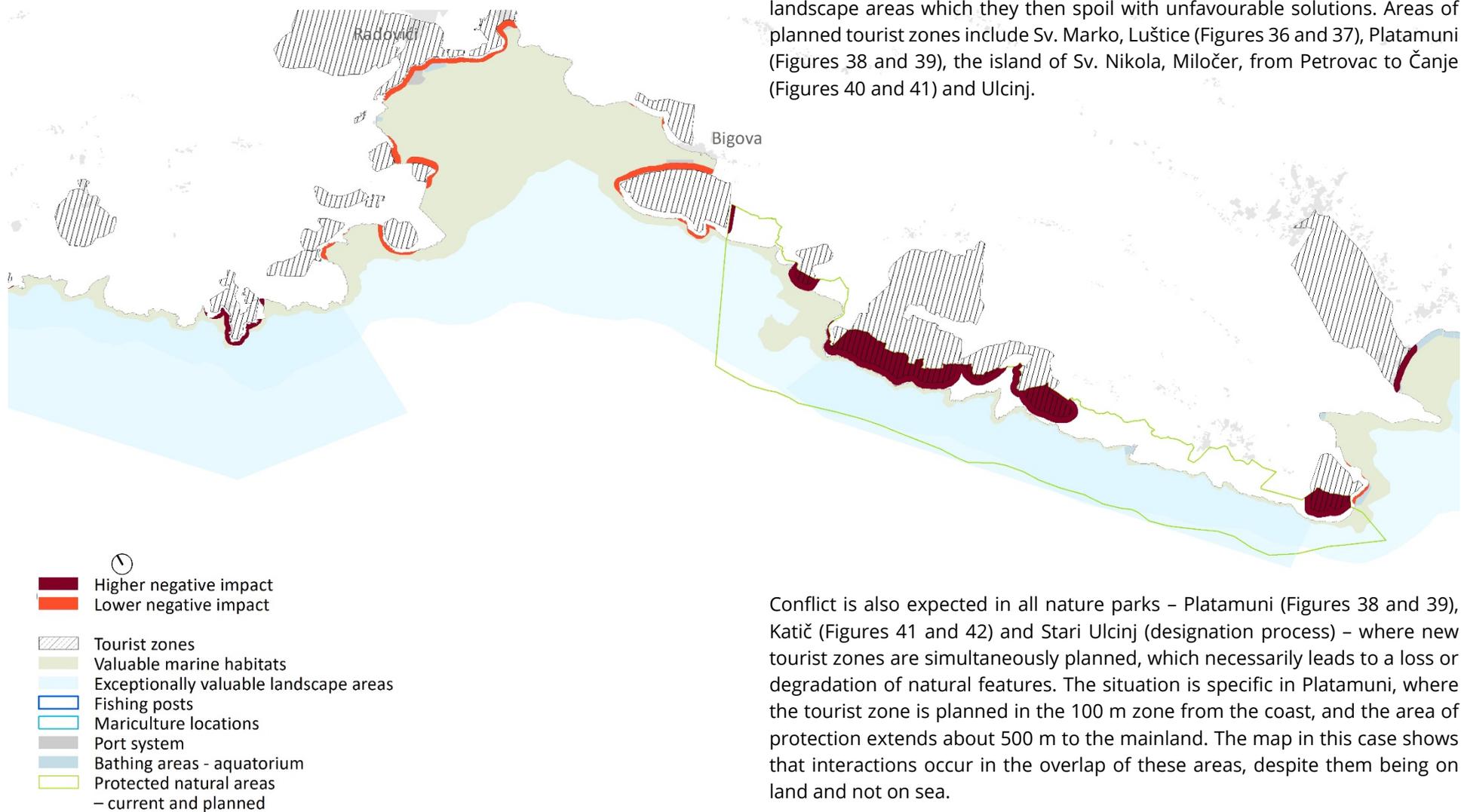


Figure 37: Interactions of tourist zones with the sea – frequency: Boka Kotorska Bay



Figure 38:
Interactions of tourist zones with the sea – maximum values: Trašte – Platamuni



New tourist zones in particular have a negative impact on extremely valuable sea areas due to the physical loss of landscape elements and visual changes, therefore unsuitable urban and architectural solutions can be considered as degradation of the wider area. Tourist resorts are looking for attractive landscape areas which they then spoil with unfavourable solutions. Areas of planned tourist zones include Sv. Marko, Luštice (Figures 36 and 37), Platamuni (Figures 38 and 39), the island of Sv. Nikola, Miločer, from Petrovac to Čanje (Figures 40 and 41) and Ulcinj.

Conflict is also expected in all nature parks – Platamuni (Figures 38 and 39), Katič (Figures 41 and 42) and Stari Ulcinj (designation process) – where new tourist zones are simultaneously planned, which necessarily leads to a loss or degradation of natural features. The situation is specific in Platamuni, where the tourist zone is planned in the 100 m zone from the coast, and the area of protection extends about 500 m to the mainland. The map in this case shows that interactions occur in the overlap of these areas, despite them being on land and not on sea.

Figure 39: Interactions of tourist zones with the sea – frequency: Trašte – Platamuni



Figure 40: The central part of the Platamuni nature park where a large tourist zone is planned

Figure 41: Interactions of tourist zones with the sea – maximum values: Budva – Čanj

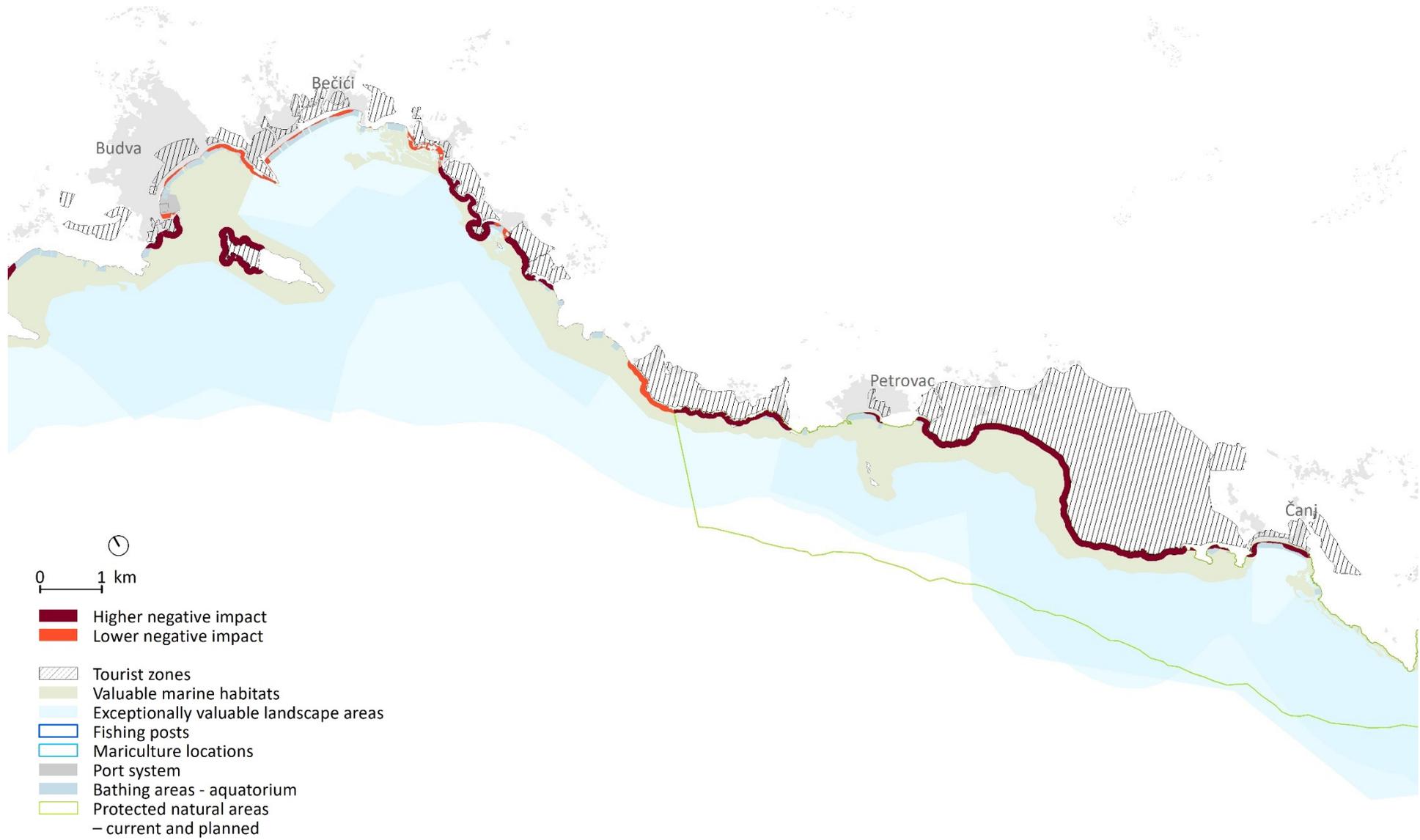


Figure 42: Interactions of tourist zones with the sea – frequency: Budva – Čanj



The impact of tourist zones and settlements on valuable marine habitats due to artificially altered coastlines, an input of materials/materials from the coast, beach infrastructure and recreational/tourist activities was assessed as minor. The appeal of natural bathing areas can also be reduced for this reason. Such interactions occur along the entire coast.

The analysis shows that in some settlements these interactions do not exist or their scope is smaller (for example in Tivat). The reason is that these are areas of anthropogenically altered marine environment, where the scope of valuable elements (lack of habitats, landscapes, protected areas) is smaller.

On more than two thirds of the coast of the Boka Kotorska Bay, some interaction of settlements with the sea was noticed (Figure 44). The interaction of all settlements with exceptional sea landscape was assessed as interaction with greater impact. It should be noted that, due to simplification, the specific characteristics of settlements in individual locations have not been taken into account. A more detailed analysis would separate the parts of the coast where the impact on the perception of the sea landscape is really large and those where urban, architectural and landscape solutions are such that the impact can be considered as minor or even positive.

Figure 43: *Interactions of settlements with the sea*

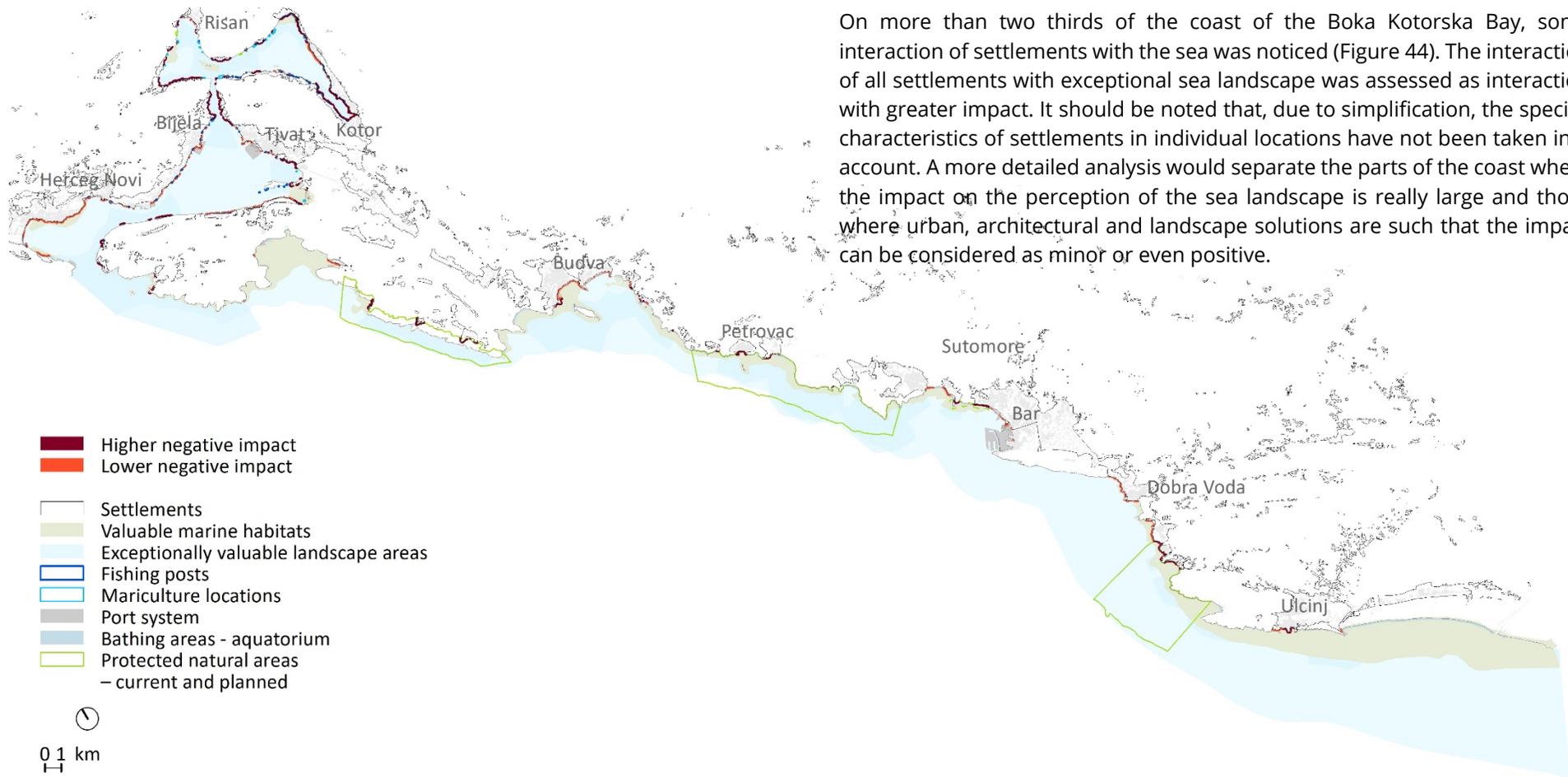


Figure 44: Interactions of settlements with the sea – maximum values: Boka Kotorska Bay

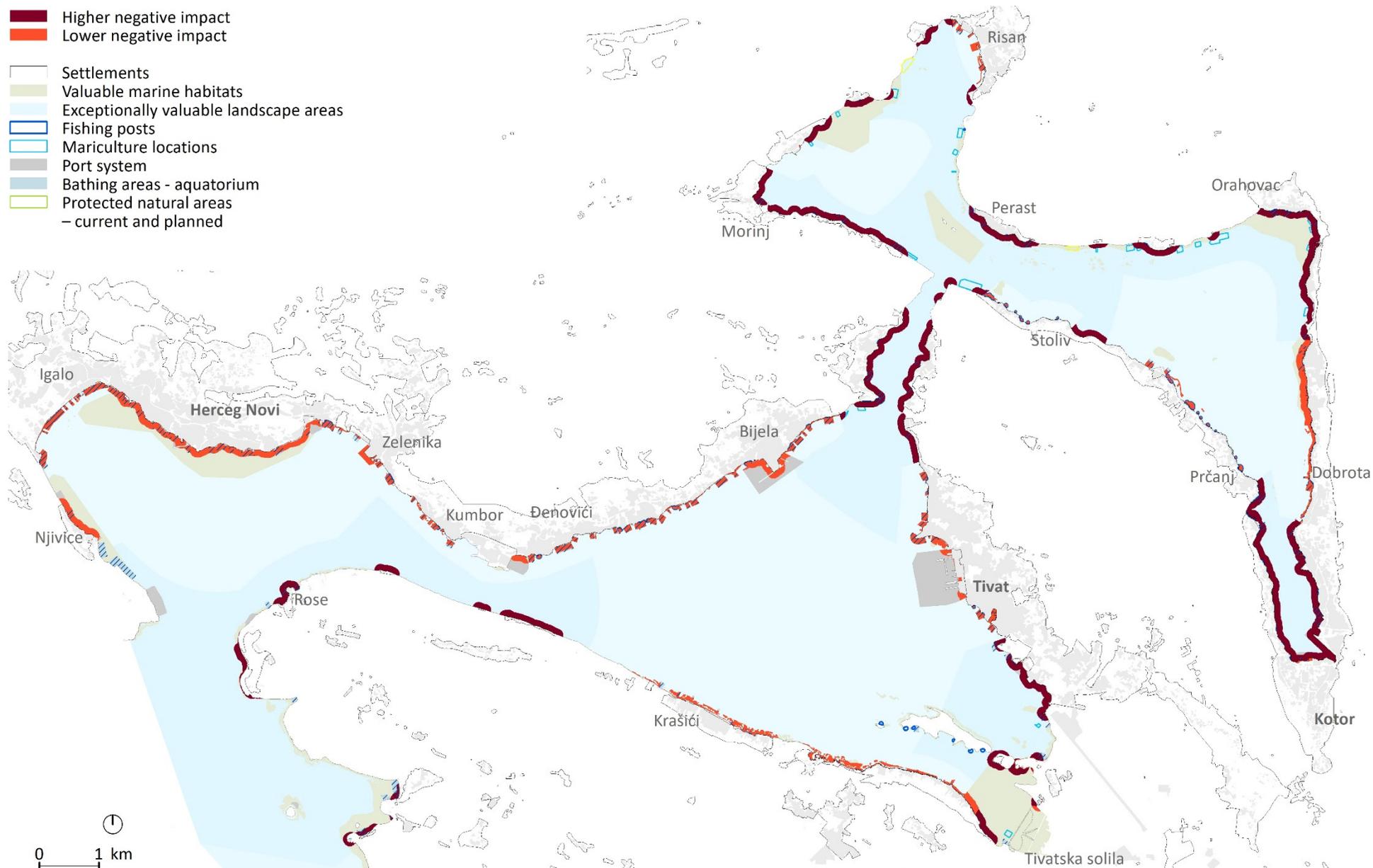


Figure 45: Interactions of settlements with the sea – frequency: Boka Kotorska Bay

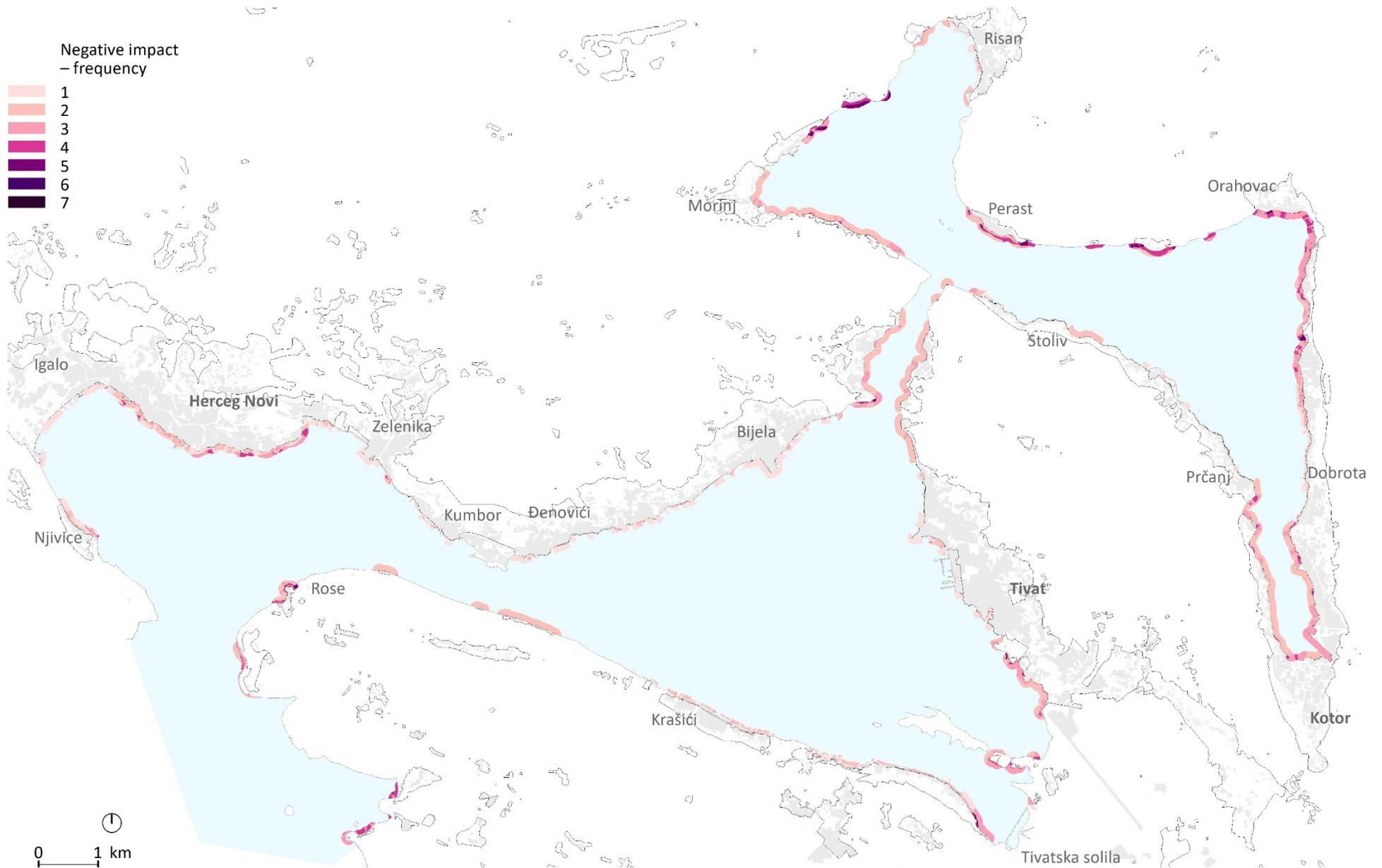


Figure 46: *Interactions of settlements with the sea – maximum values: Budva*

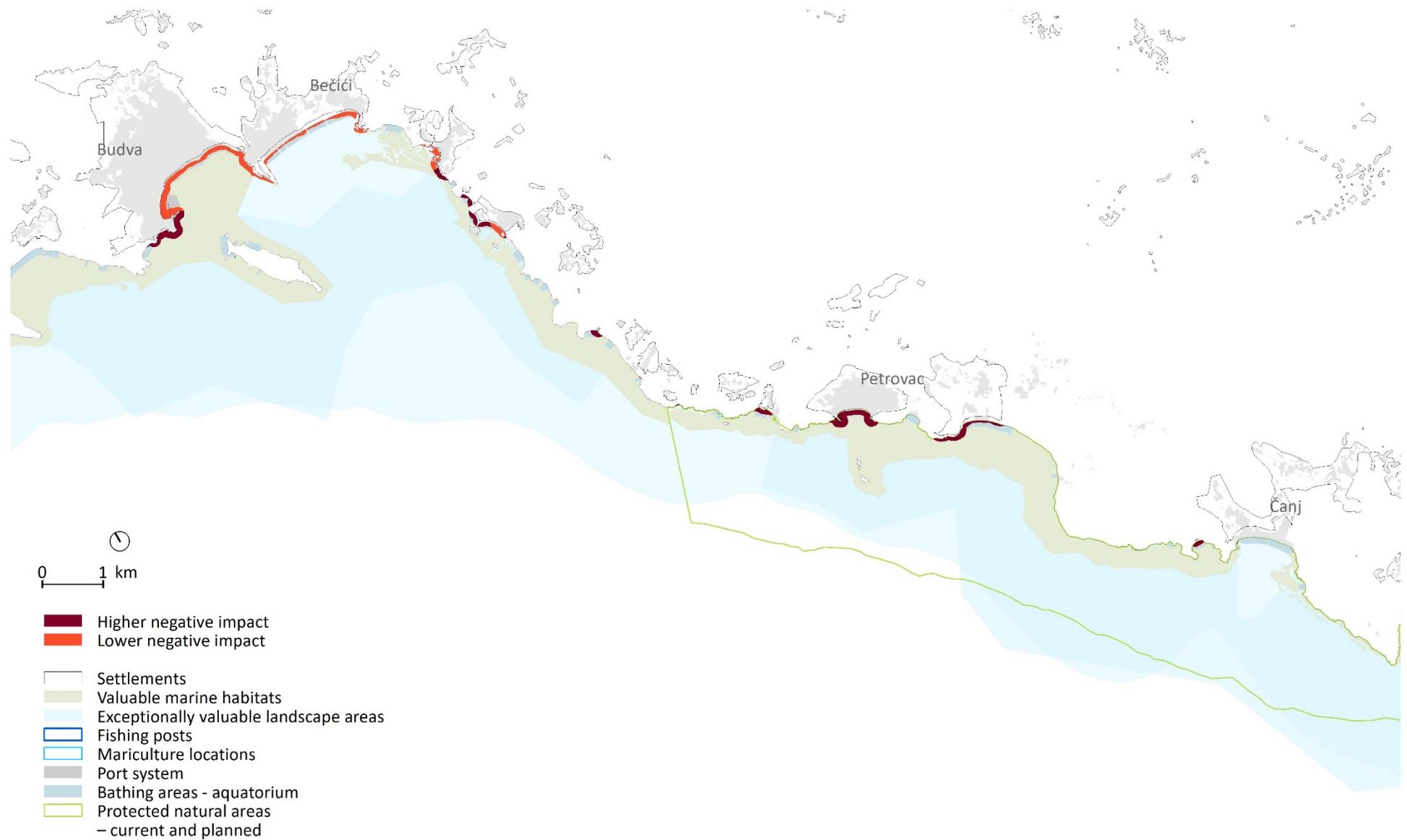
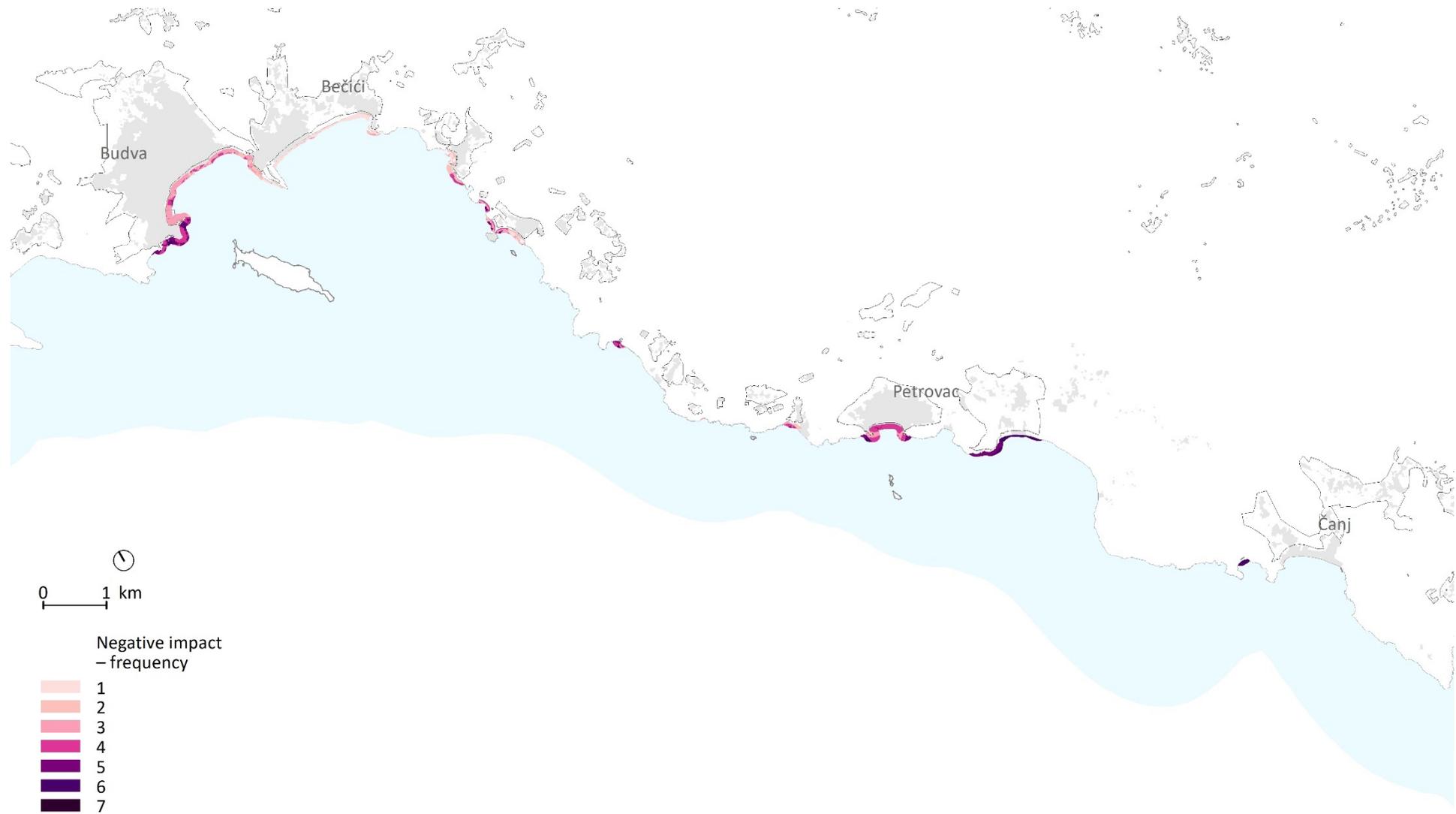


Figure 47: Interactions of settlements with the sea – frequency: Budva – Čanj



5.4 Bathing areas

Constructed bathing areas and bathing areas with a large beach infrastructure have a negative impact on extremely valuable landscape features and protected natural features, i.e. valuable habitats.

Bathing areas regularly filled with various environmentally damaging materials without supervision exert great negative influence. For example, the "Plavi horizonti" bathing area in Trašte has large amounts of sand poured in every year. Due to waves, winds and natural hydrodynamic processes, the sand ends up covering large parts of the sea bed in a short amount of time.

Bathing areas can potentially come into conflict with activities at fishing posts and mariculture sites, but the volume of such situations is negligible in reality.

Figure 48: *Interactions of bathing areas with the sea*

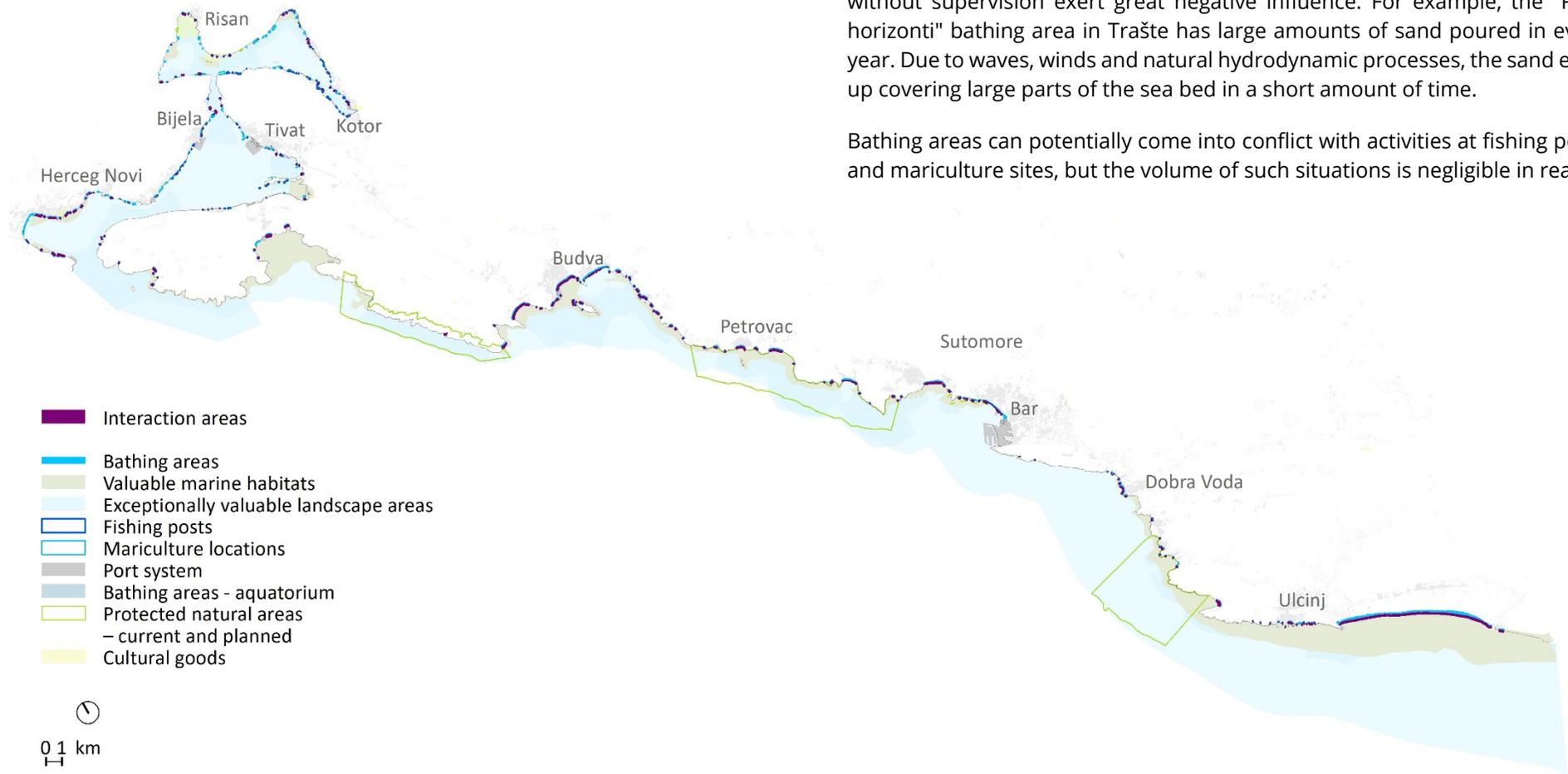
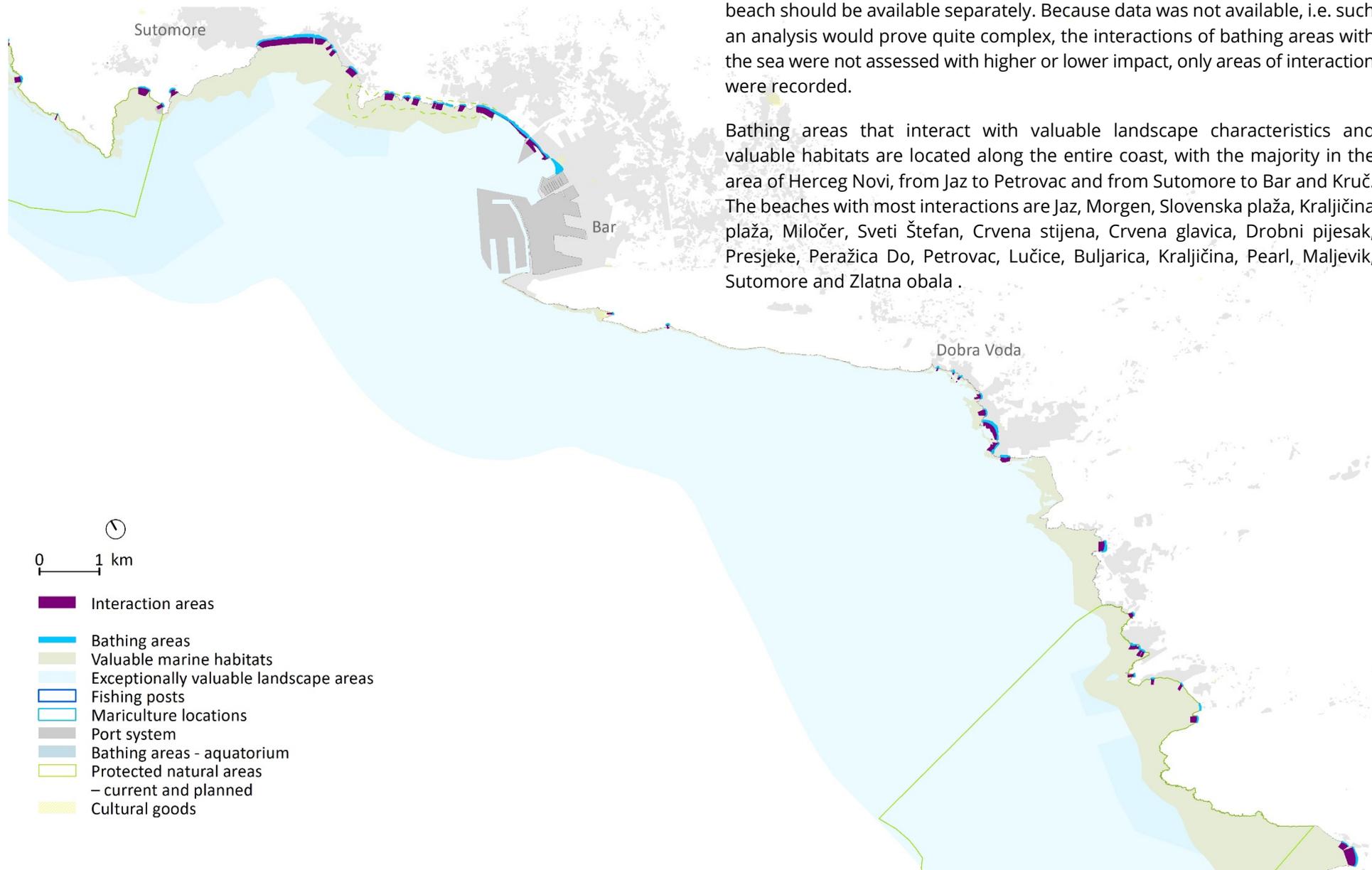


Figure 49: Interactions of bathing areas with the sea: Boka Kotorska Bay



Figure 50: Interactions of bathing areas with the sea: Sutomore – Dobra



The general assessment of all beaches with the same impact assessment would be misleading, and for a realistic impact assessment, data from each beach should be available separately. Because data was not available, i.e. such an analysis would prove quite complex, the interactions of bathing areas with the sea were not assessed with higher or lower impact, only areas of interaction were recorded.

Bathing areas that interact with valuable landscape characteristics and valuable habitats are located along the entire coast, with the majority in the area of Herceg Novi, from Jaz to Petrovac and from Sutomore to Bar and Kruč. The beaches with most interactions are Jaz, Morgen, Slovenska plaža, Kraljičina plaža, Miločer, Sveti Štefan, Crvena stijena, Crvena glavica, Drobni pijesak, Presjeke, Peražica Do, Petrovac, Lučice, Buljarica, Kraljičina, Pearl, Maljevik, Sutomore and Zlatna obala .

5.5 Natural protected areas and cultural goods

Protection of land – natural and cultural assets – has a positive impact on the characteristics of the sea (habitats, marine area, cultural assets) because the protection measures on land (inadmissibility, restrictions on activities) contribute to less burdens on the coast and sea. At the same time, the regimes have restrictions for the development of maritime activities, meaning a negative impact, for example for the development of ports/marinas and mariculture (areas with cultural heritage sites on the coast or underwater archaeological sites) are considered unacceptable, regardless of how otherwise attractive they may seem).

The reality of the positive impact of protection – the prevention of adverse interventions – should be verified from location to location.

Figure 51: *Interactions of natural protected areas with the sea:*

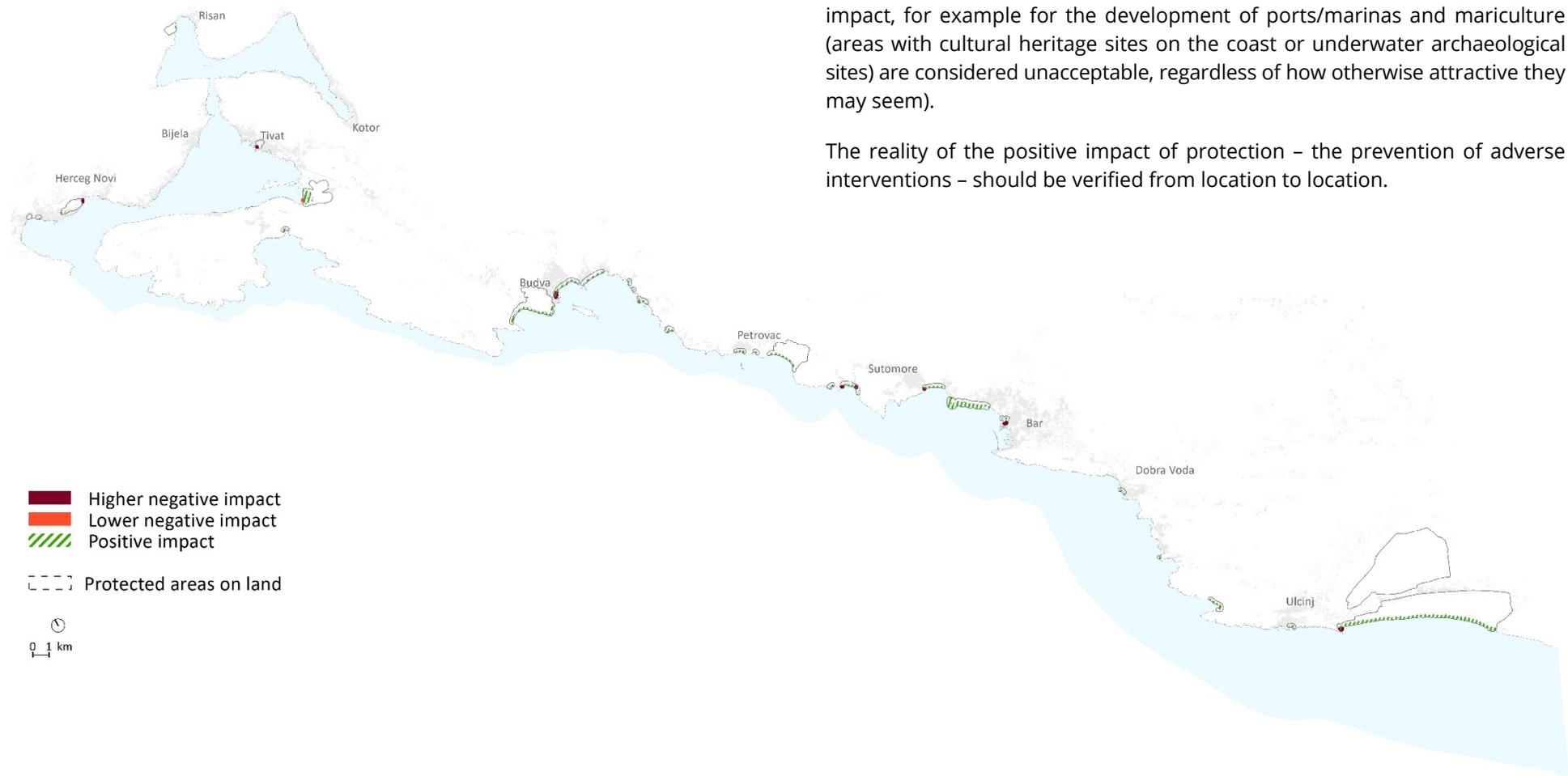


Figure 52: Interactions of natural protected areas with the sea: Budva – Čanj



Figure 53: *Interactions of cultural goods with the sea*



Figure 54: *Interactions of cultural goods with the sea: Boka Kotorska Bay*

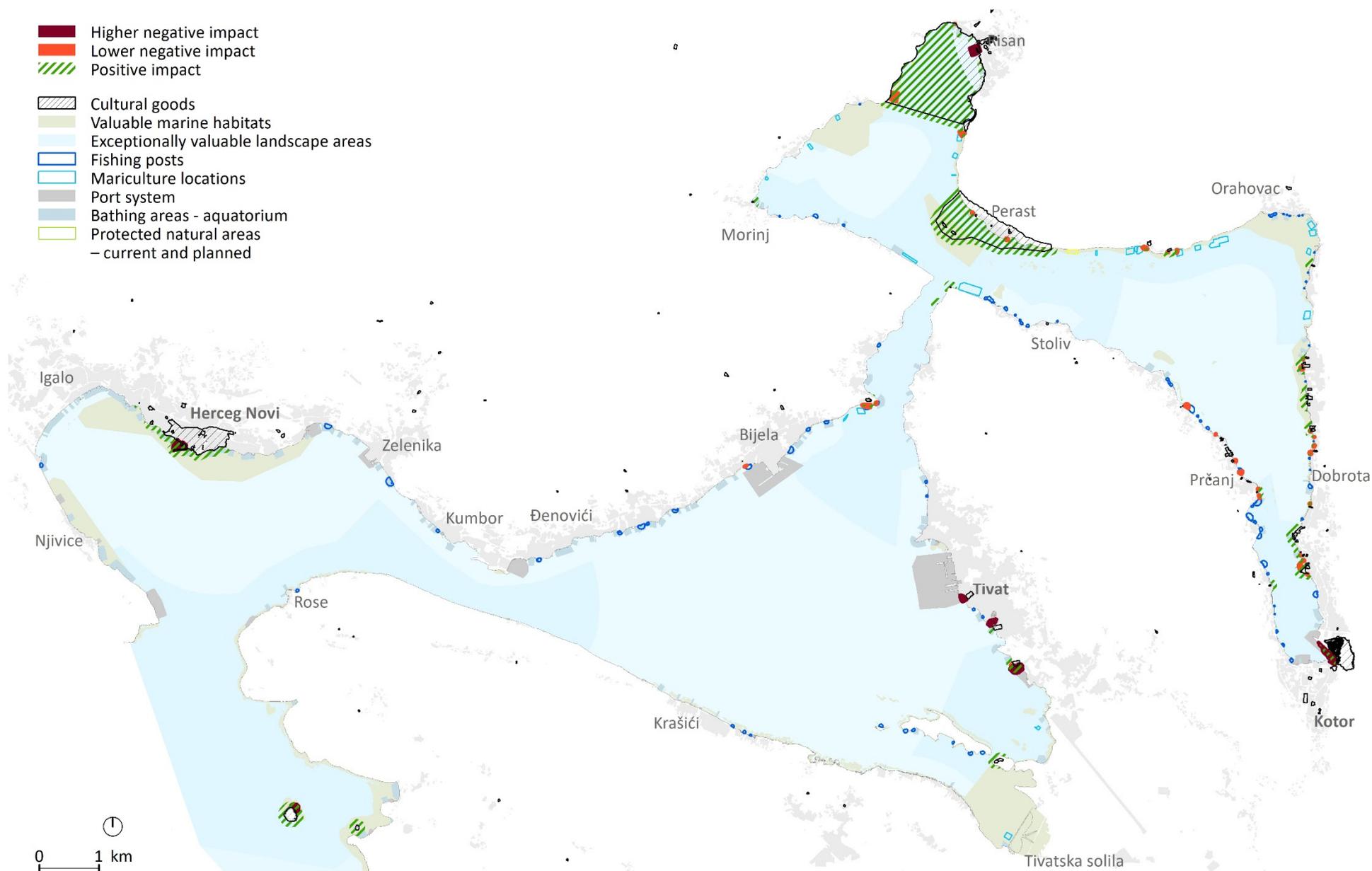
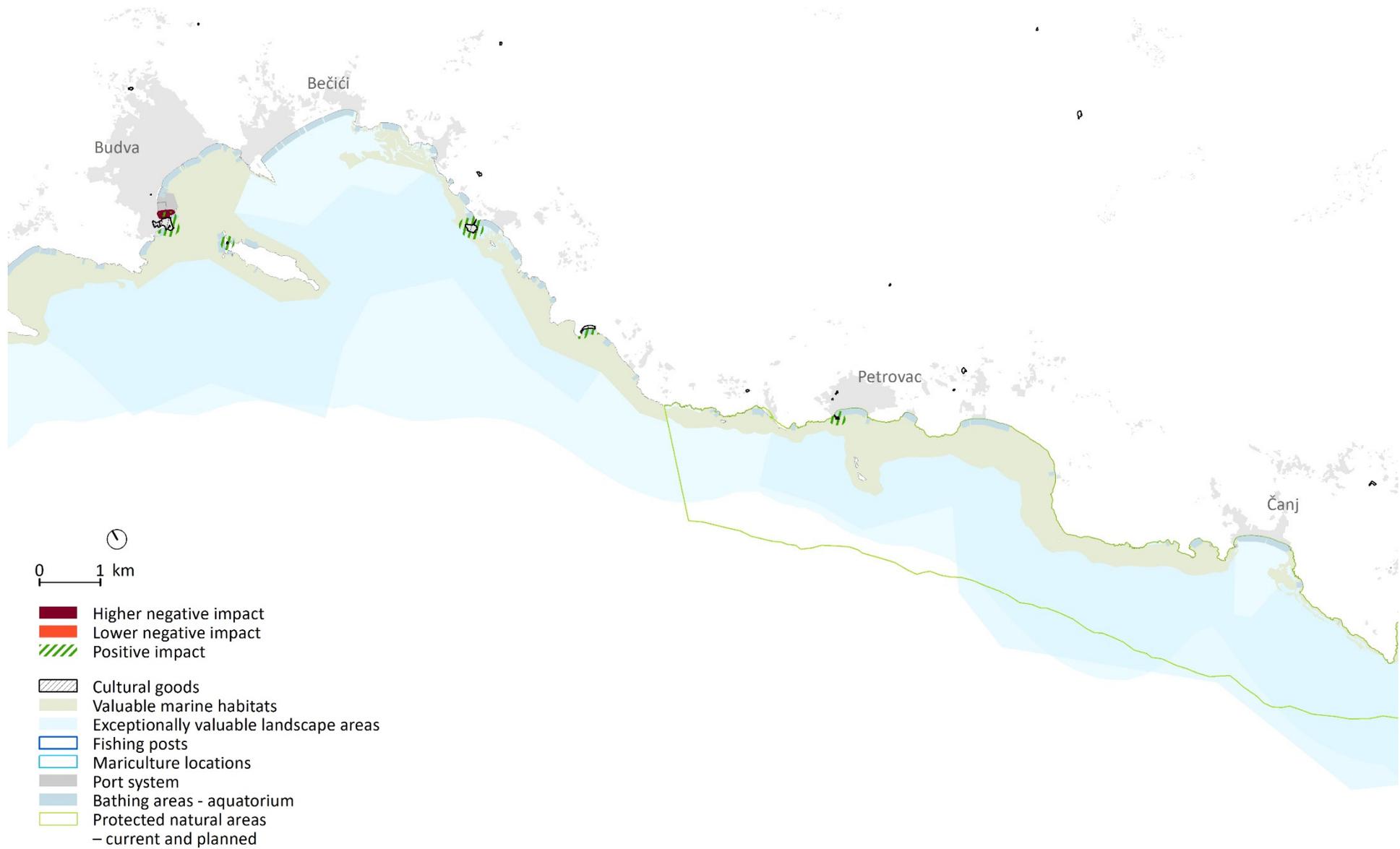
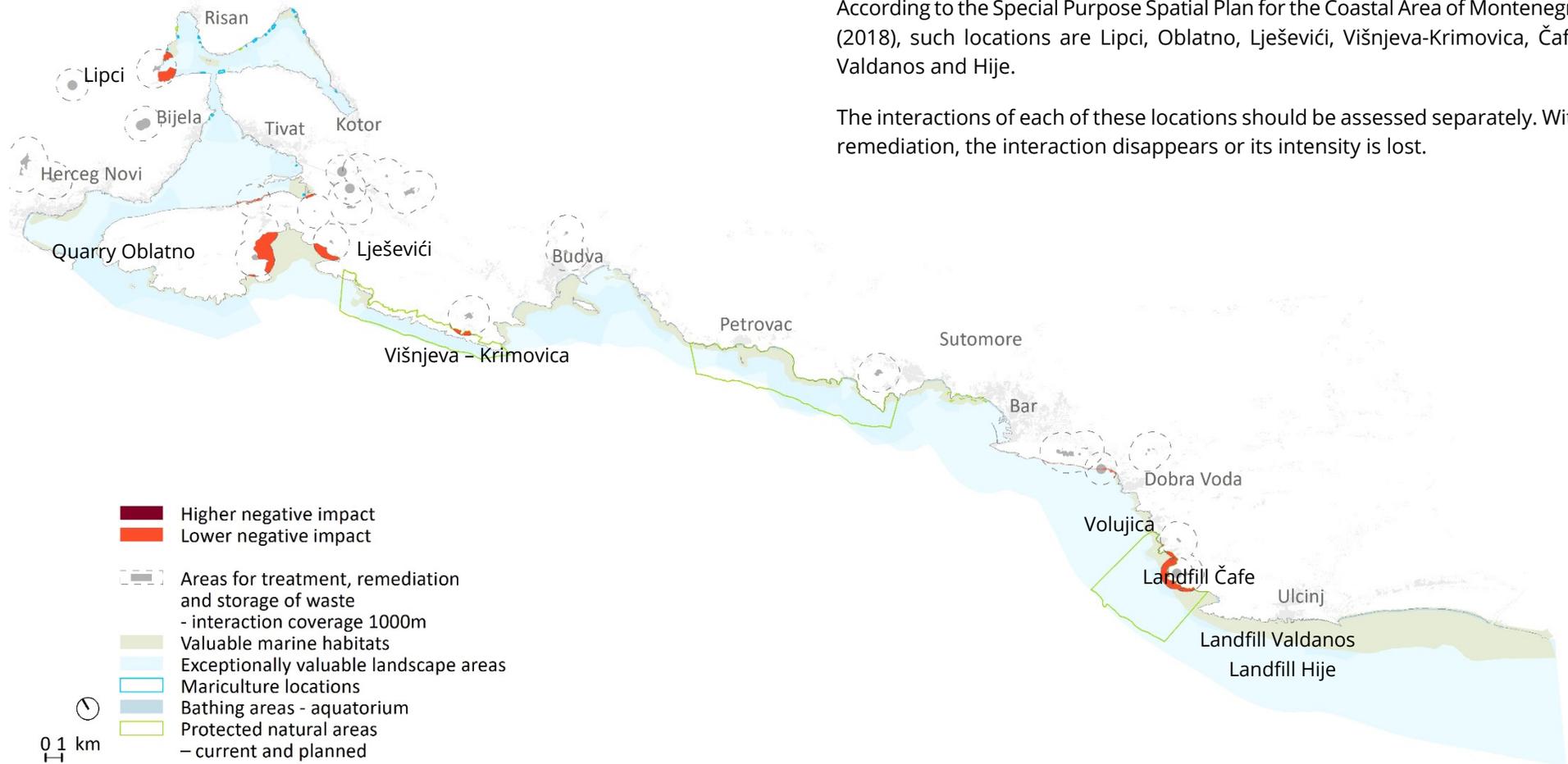


Figure 55: Interactions of cultural goods with the sea: Budva – Čanj



5.6 Areas for waste treatment, remediation and storage

Figure 56:
Interactions of areas for waste treatment, remediation and storage with the sea



Areas for treatment, remediation and storage of waste near the coast are problematic due to leaching of materials (especially pollutants) and aeolian transport of materials into the sea, and visual degradation of the sea area. According to the Special Purpose Spatial Plan for the Coastal Area of Montenegro (2018), such locations are Lipci, Oblatno, Lješevići, Višnjeva-Krimovica, Čače, Valdanos and Hije.

The interactions of each of these locations should be assessed separately. With remediation, the interaction disappears or its intensity is lost.

Figure 57: Interactions of areas for waste treatment, remediation and storage with the sea: Boka Kotorska Bay

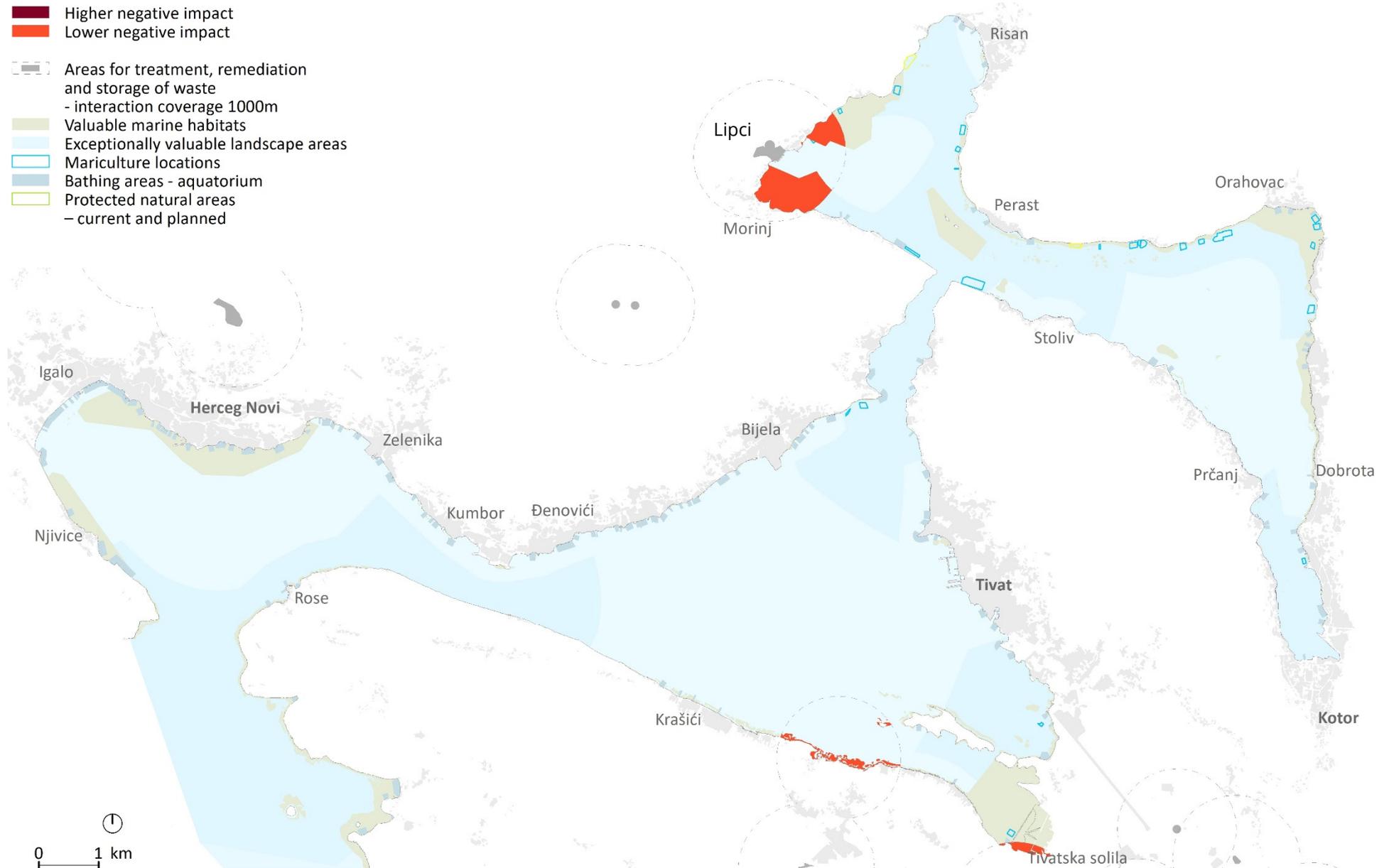
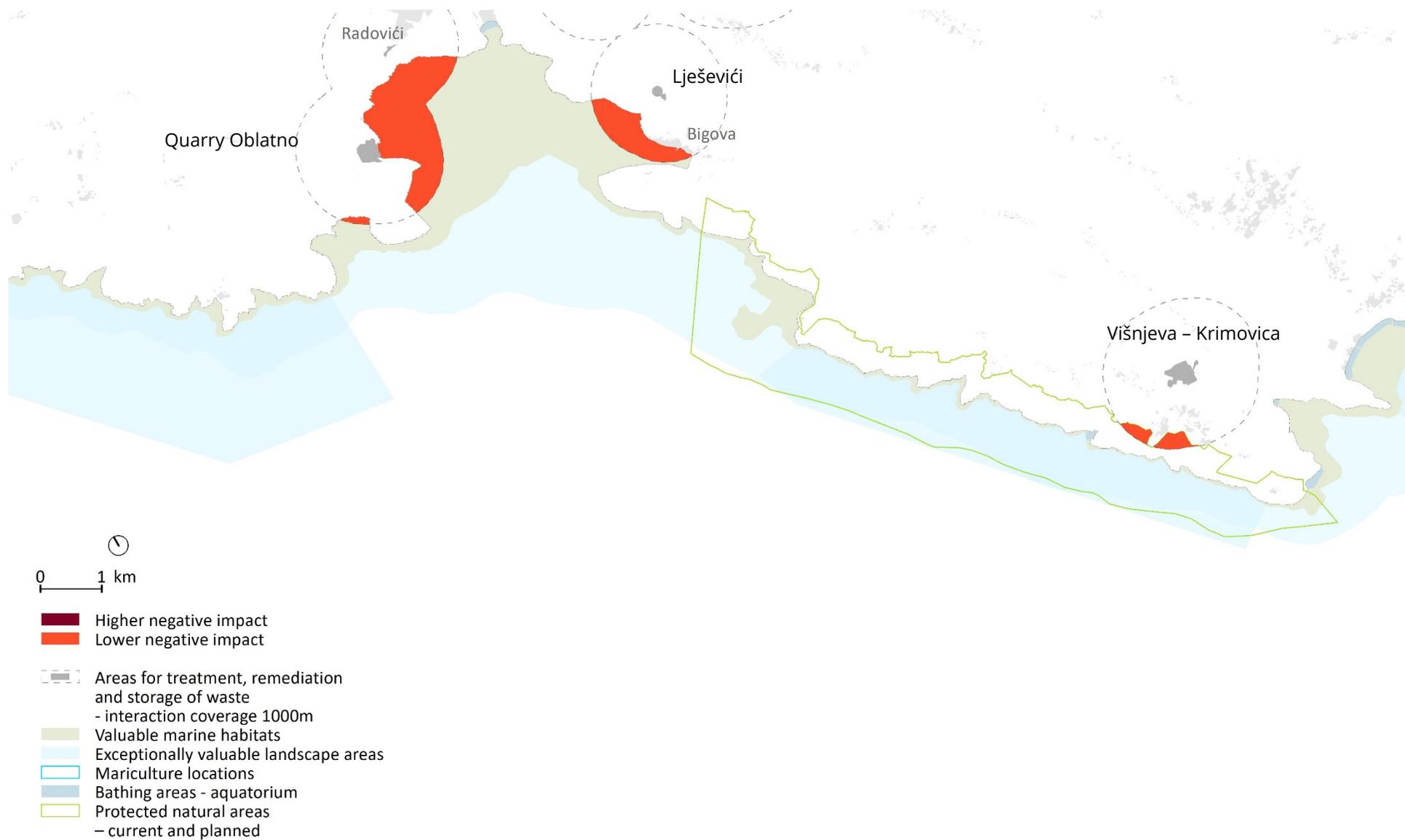


Figure 58: Interactions of areas for waste treatment, remediation and storage with the sea: Trašte – Platamuni



5.7 Uses and activities: total land-sea interactions

Interaction maps by individual uses/activities have been combined into integral maps according to the principle of maximum value and frequency. In the frequency model, the area of higher negative impact is scored with the grade 2 and the area of lower negative impact with a score of 1. From this we can determine the locations where the largest overlap of relevant interactions has occurred – so-called hot spots.

Areas with the greatest overlap of the impact of uses/activities are beaches/bathing areas with the aquatorium or parts of the sea along settlements and tourist zones, which are endangered by activities, leaching/removal of materials (potentially and pollutants) from land to sea, pressures of temporary facilities, beach infrastructure and other manmade structures (roads, walls, parking lots, coastal fortification and construction of piers). Additional interaction occurs in cases where, in addition to these areas, there are also ports with additional coastal artificialization and (potential) pollution. The scope of interactions is focused on beaches which are, in addition to valuable marine habitats, in areas of extremely valuable coastal/maritime areas. Such beaches are in Herceg Novi, Orahovac, Njivice, Žanjice bay, Trašte bay, Jaz bay, Budva and the island of Sv. Nikola, around Sv. Stefan, the northern part of Buljarica, Utjeha and Ulcinj. Due to the volume of interactions, beaches are endangered as a natural phenomenon and as a tourist precondition, and they are still under the influence of natural processes (sea-level rise, erosion).

The second type are areas with not so much frequency of interactions but a larger surface area. These are natural areas where several layers of different analysed categories overlap – special habitat types, landscapes and protected areas. The complexity/diversity of these areas increases the number of interactions. Such areas include Sveti Marko and Ostrvo Cvijeća, from Petrovac to Čanj (particularly the area of the northern part of Buljarica) and Utjeha, and Stari Ulcinj.

The following areas have been recorded as specific areas of greater interactions:

- the areas of the ports of Kotor, Meljine, Herceg Novi, Risan, Njivice and Budva stand out due to interactions with areas of exceptional sea landscape which is defined as the environment of a wider area of cultural property on land and/or in combination with valuable habitats;
- interactions of the Lipci quarry with the industrial area and the Oblatno quarry emerge from the impact of the degraded area;
- the area of Bonić near Tivat unexpectedly stands out due to the complexity of the uses (marina, tourist zone, Kukuljina park, Byzantium complex), although the values in the sea are not significant;
- obviously the largest scope of interactions is in the area of Budva and Sv. Nikola, which is quite logical because it is a very complex space both in terms of uses/activities on land, and in terms of sea characteristics.

The analysis for large ports – Tivat (Porto Montenegro), Bijela, Kumbor, Zelenika, Bar – which have an evident negative impact on the marine environment, and can generally be considered as hot spot locations in terms of contamination and trophic levels, does not show major interactions with the analysed sea characteristics. The areas of these ports are degraded or artificially altered marine environments, in which there are no valuable elements (habitats, landscapes, protected areas, bathing areas).

As expected, the analysis shows the Boka Kotorska Bay as an area of greater interaction than along the coast of the open sea, where some natural parts of the coast are practically free of negative interactions with the sea.

Figure 59. Total interactions of uses and activities on land with the sea – frequency: Boka Kotorska Bay

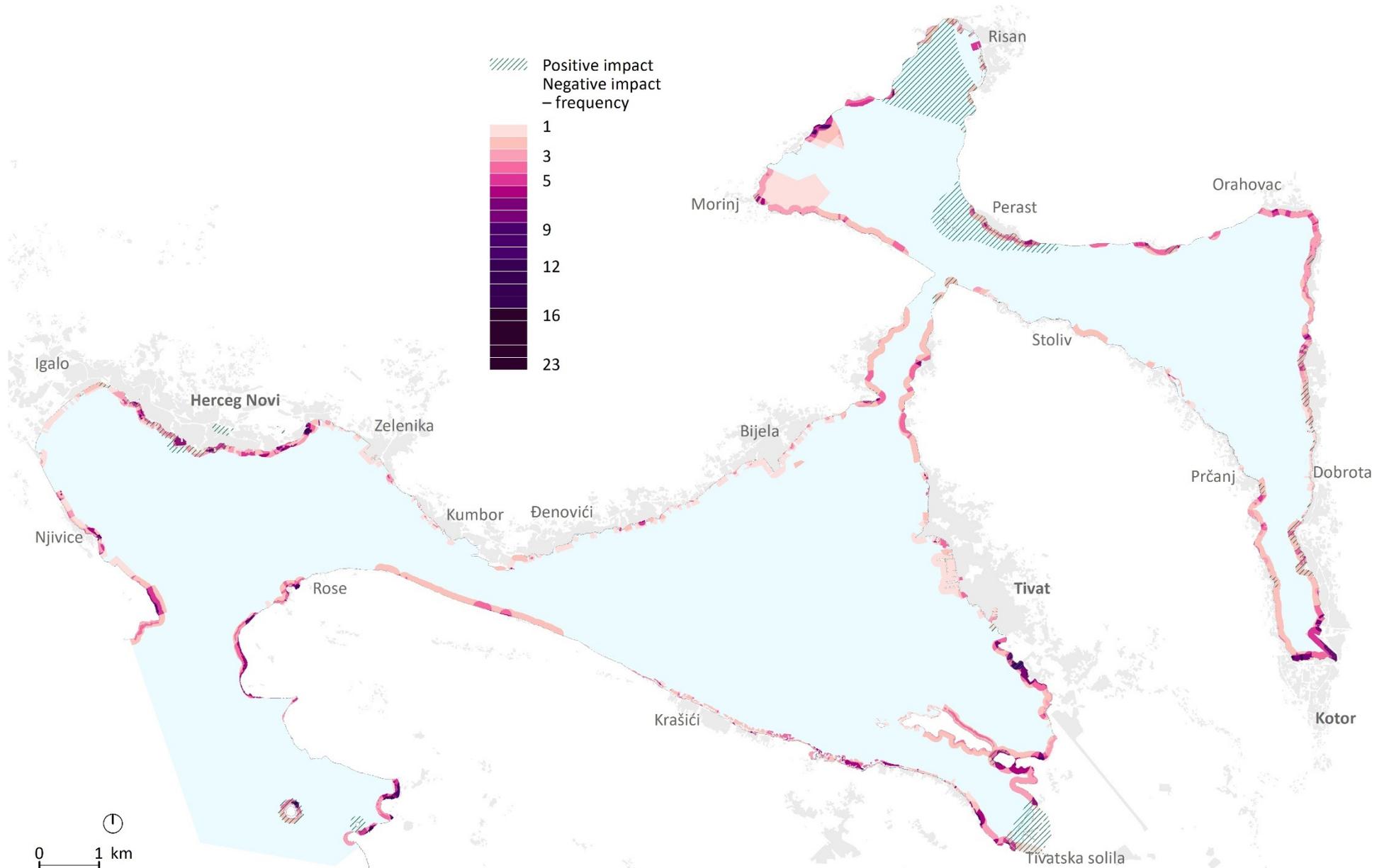


Figure 60. Total interactions of uses and activities on land with the sea – frequency: Trašte – Platamuni

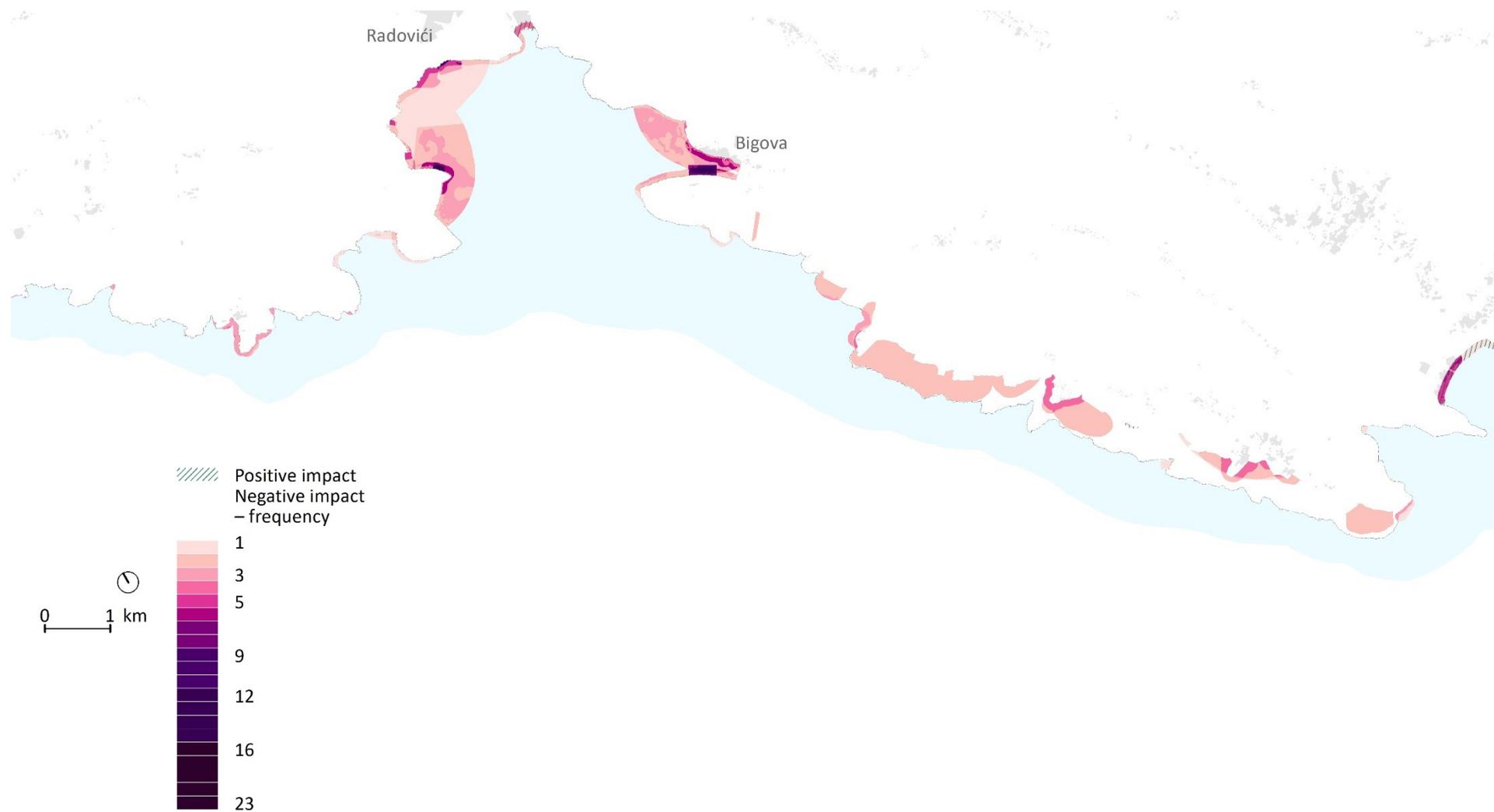


Figure 61. Total interactions of uses and activities on land with the sea – frequency: Budva – Čanj

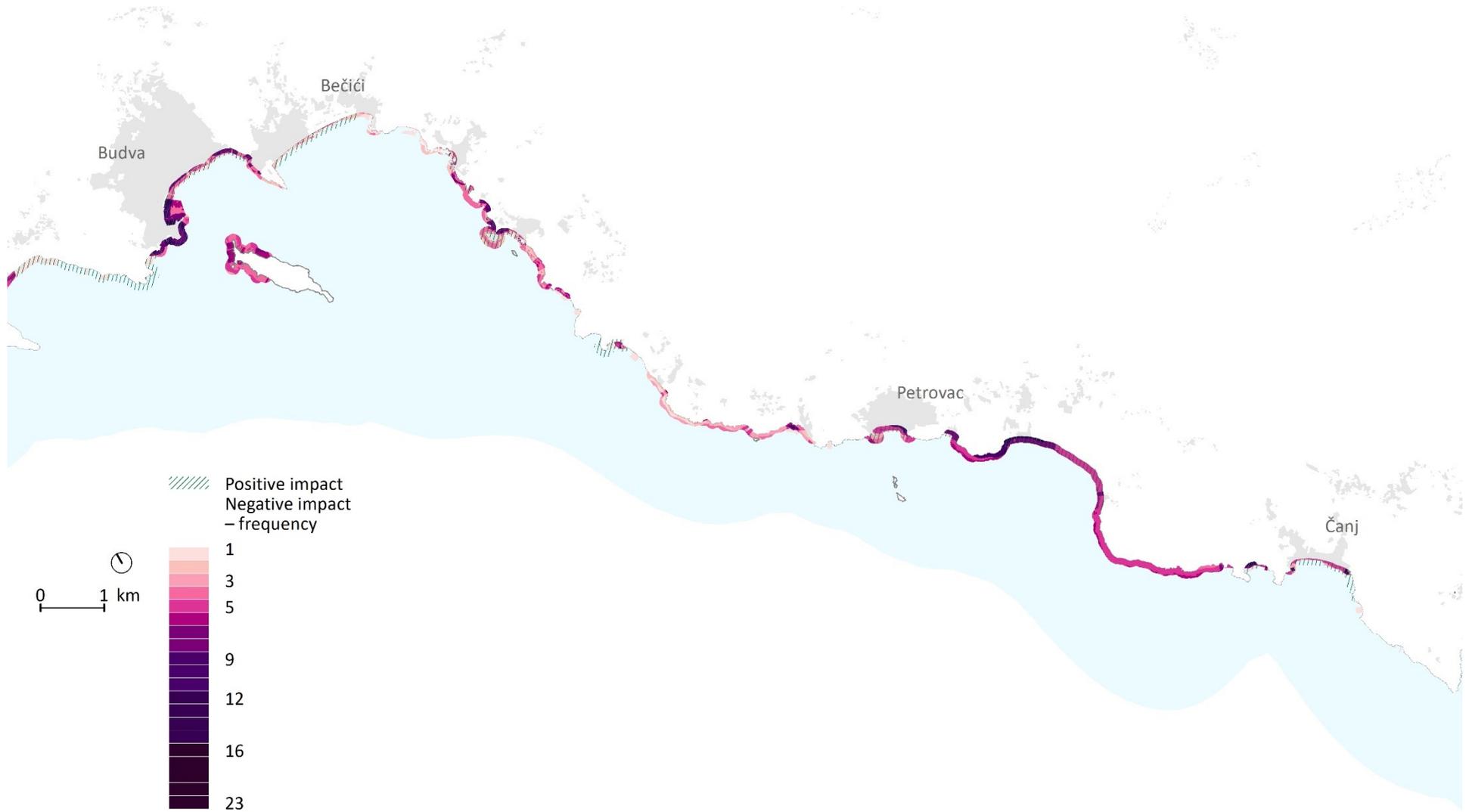
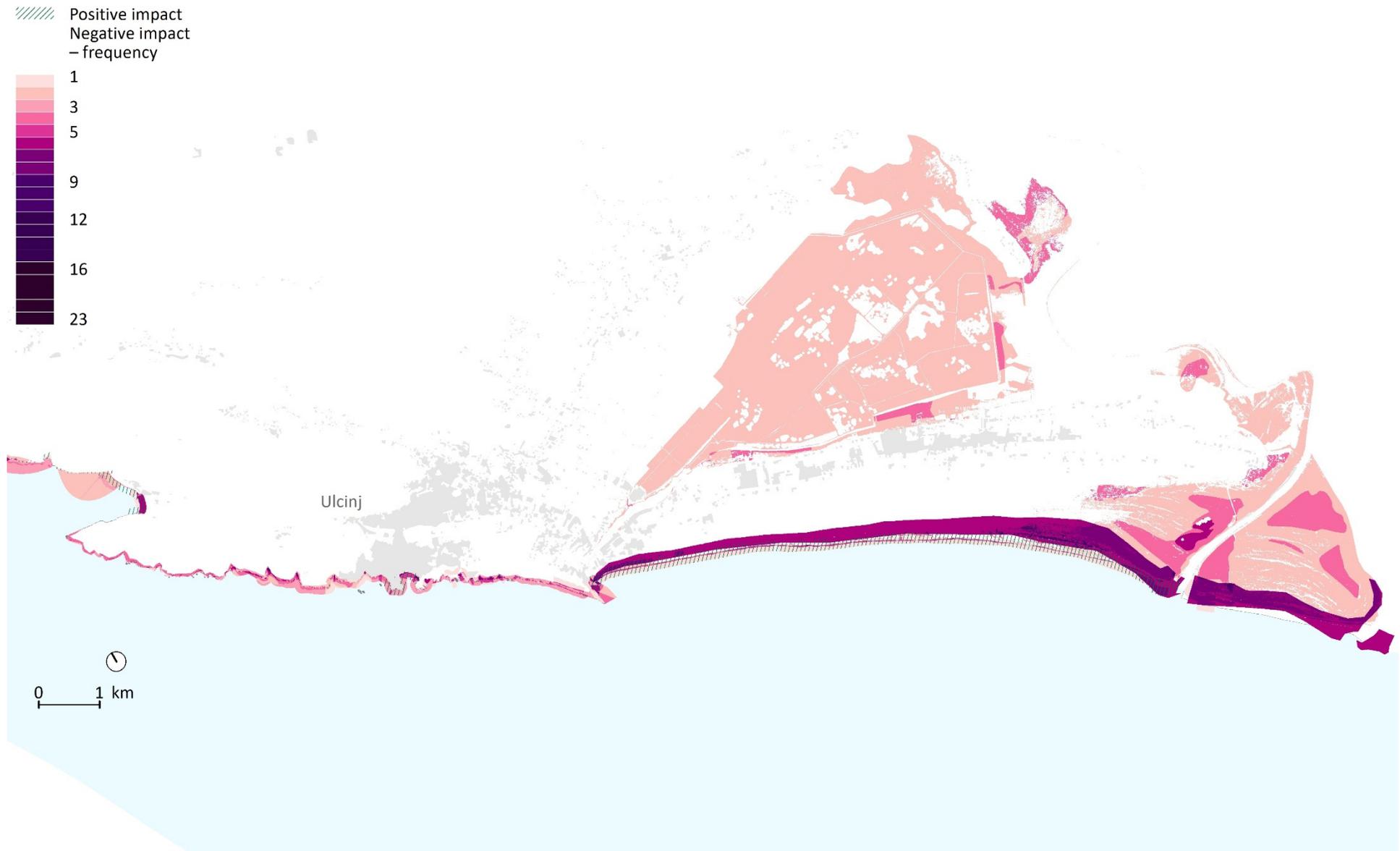


Figure 62. Total interactions of uses and activities on land with the sea – frequency: Sutomore – Dobra Voda



Figure 63. *Total interactions of uses and activities on land with the sea – frequency: Ulcinj – Bojana*



6 Conclusions

The aim of the land-sea interaction analyses was to include them in the planning and management processes – to prevent activities that may disrupt natural processes, degrade valuable phenomena or are in conflict with each other, and reduce negative impact.

The analysis of land-sea interactions shows the great complexity of the coastal area of the marine environment of Montenegro. This is especially true for areas where there are different types of interactions of uses and activity on land with the sea, and interactions of the sea with the land, and the impact of natural processes, which occur at the same time (Figures 64 – 68). The first type of such areas are beaches/bathing areas with aquatoria, i.e. coastal areas near settlements and tourist zones, which are threatened by activities, leaching/ materials from land carried off to sea, and impact from manmade structures. The scope of interactions is focused on beaches in valuable marine habitats and in extremely valuable coastal/maritime areas. Such beaches can be found in Herceg Novi, Orahovac, Njivice, the bays of Žanjice, Trašte, Jaz, Budva, the island of Sv. Nikola, around Sv. Stefan, the northern part of Buljarica, Utjeha and Ulcinj. Due to the volume of interactions, the natural and tourist aspect of beaches are threatened, and in addition they are still under the influence of natural processes (sea rising, erosion).

The second type of areas are natural sites where the number of interactions increases due to their complexity/diversity. These can be found in Tivat salt flats with the aquatorium, the bays of Trašte, Platamuni, the stretch from Petrovac to Čanj (especially the northern part of Buljarice), Utjeha and Stari Ulcinj, south of Cape Medra, Velika plaža and Ada Bojana.

The intensity of interactions is the result of the large scope and intertwining of uses and activities on land and sea, as well as the high volume of significant/ valuable characteristics of the marine environment. The analysis largely confirms the importance of areas the endangerment and vulnerability of which was already detected in previous analyses, especially beaches and natural parts of the coast along tourist zones and settlements. However, this analysis treats them in a more systematic and mapped-out way. It shows not only the existing interactions and pre-recorded conflict areas, but also the potential/ future or additional areas that should be taken into account in further spatial planning of the coastal and marine area. This is especially true for urbanization,

the port system and the protection of marine areas (nature parks in designation process) – activities that inevitably come into conflict. This conflict requires harmonization at the strategic planning level (withdrawal of some development proposals) and the level of construction terms and protection measures (defining reasonable measures).

The analysis has been prepared on a general level, but it can be "zoomed" to individual areas in the GIS for uses of planned harmonization. In this case, however, one should keep in mind the general nature of the analysis, i.e. specific and concrete characteristics at individual locations (capacities, technological solutions, frequency of occurrence, emission data) and also the characteristics (deficiencies, inaccuracies) of the input data, which have not been taken into account. A more detailed analysis of individual/smaller areas (by adapting the method like mapping additional information, including expert knowledge) would enable the elimination of these shortcomings.

The analysis was also prepared as a test method based on the document Land Sea Interactions in the framework of ICZM and MSP (Ramieri E., Bocci M., Marković M., PAP/RAC). It was assessed that the defined steps are logical, feasible and adaptable to different marine environments and processing levels.

Figure 64. Total interactions of natural processes, land-sea and sea-land interactions – frequency: Boka Kotorska Bay

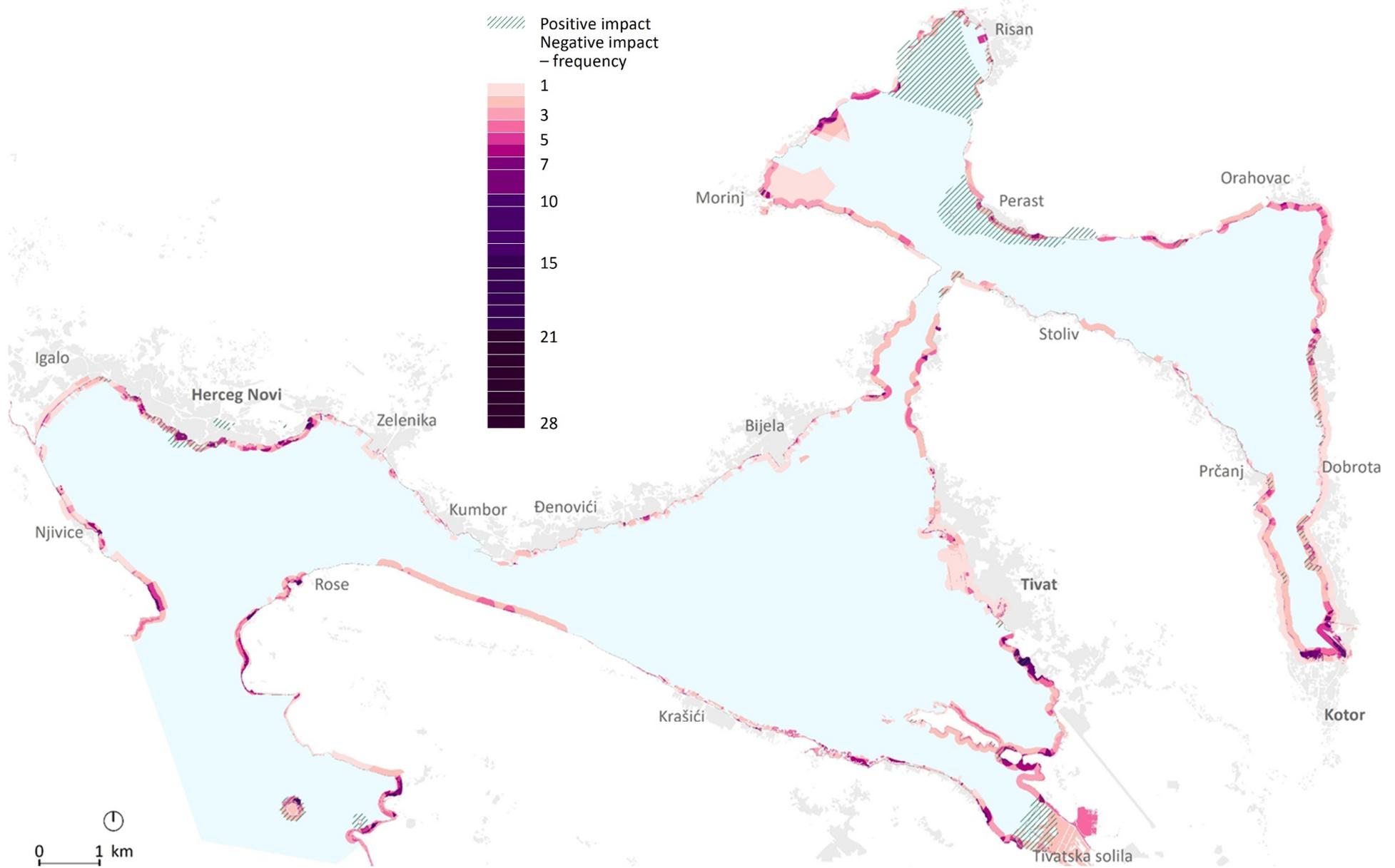


Figure 65. Total interactions of natural processes, land-sea and sea-land in-teractions – frequency: Trašte – Platamuni



Figure 66. Total interactions of natural processes, land-sea and sea-land in-teractions – frequency: Budva – Čanj

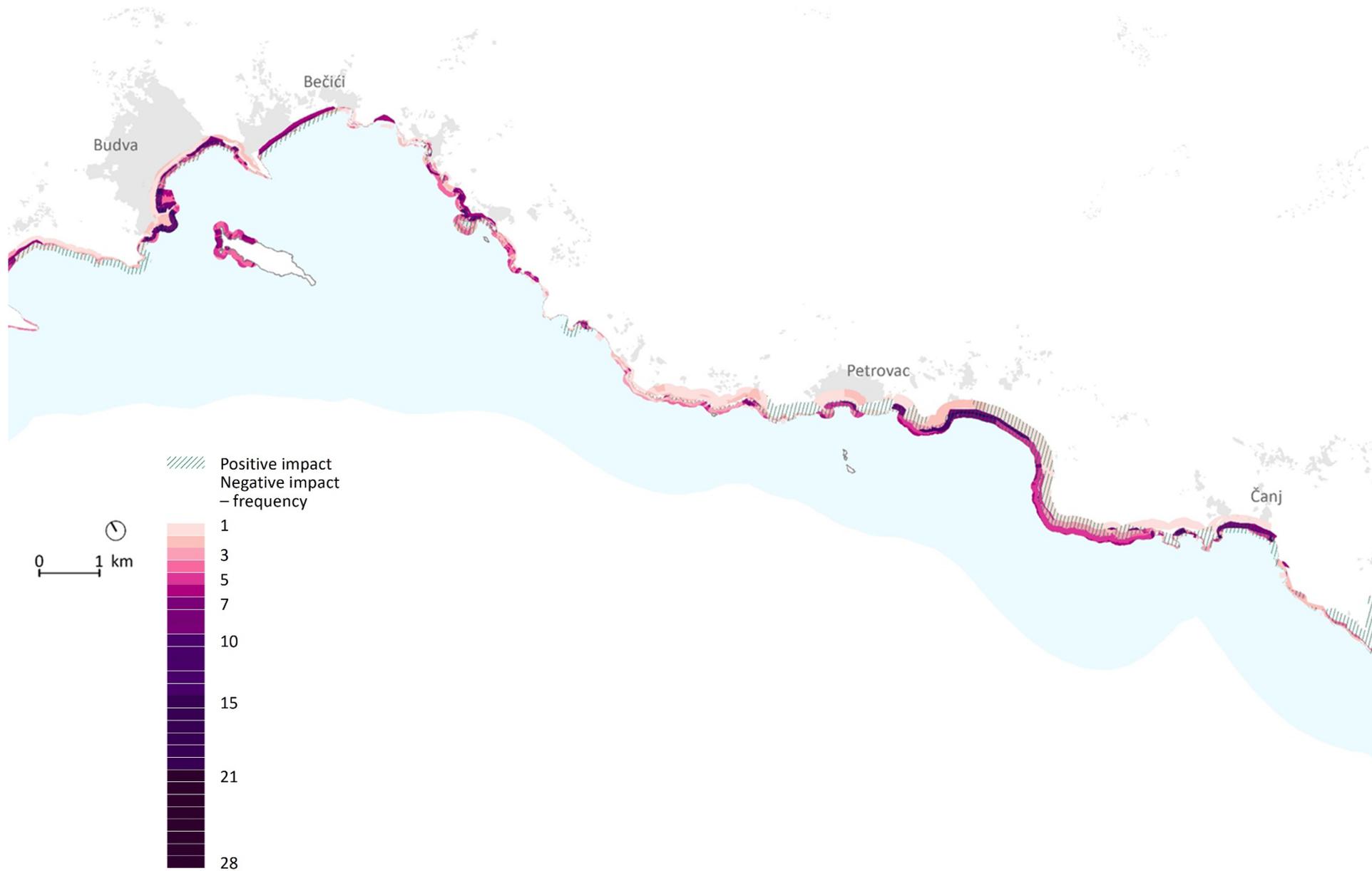


Figure 67. Total interactions of natural processes, land-sea and sea-land in-teractions – frequency: Sutomore – Dobra Voda

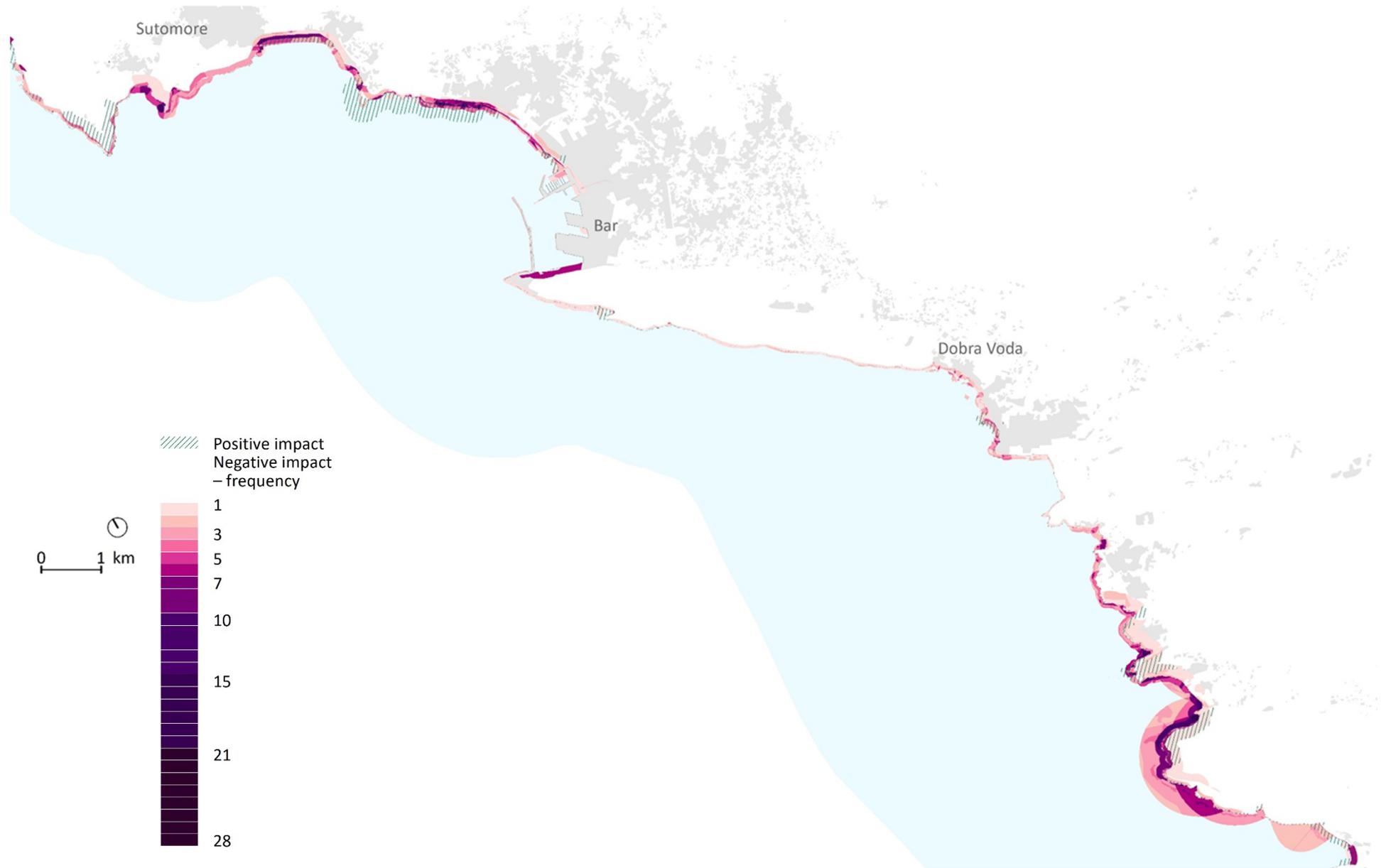
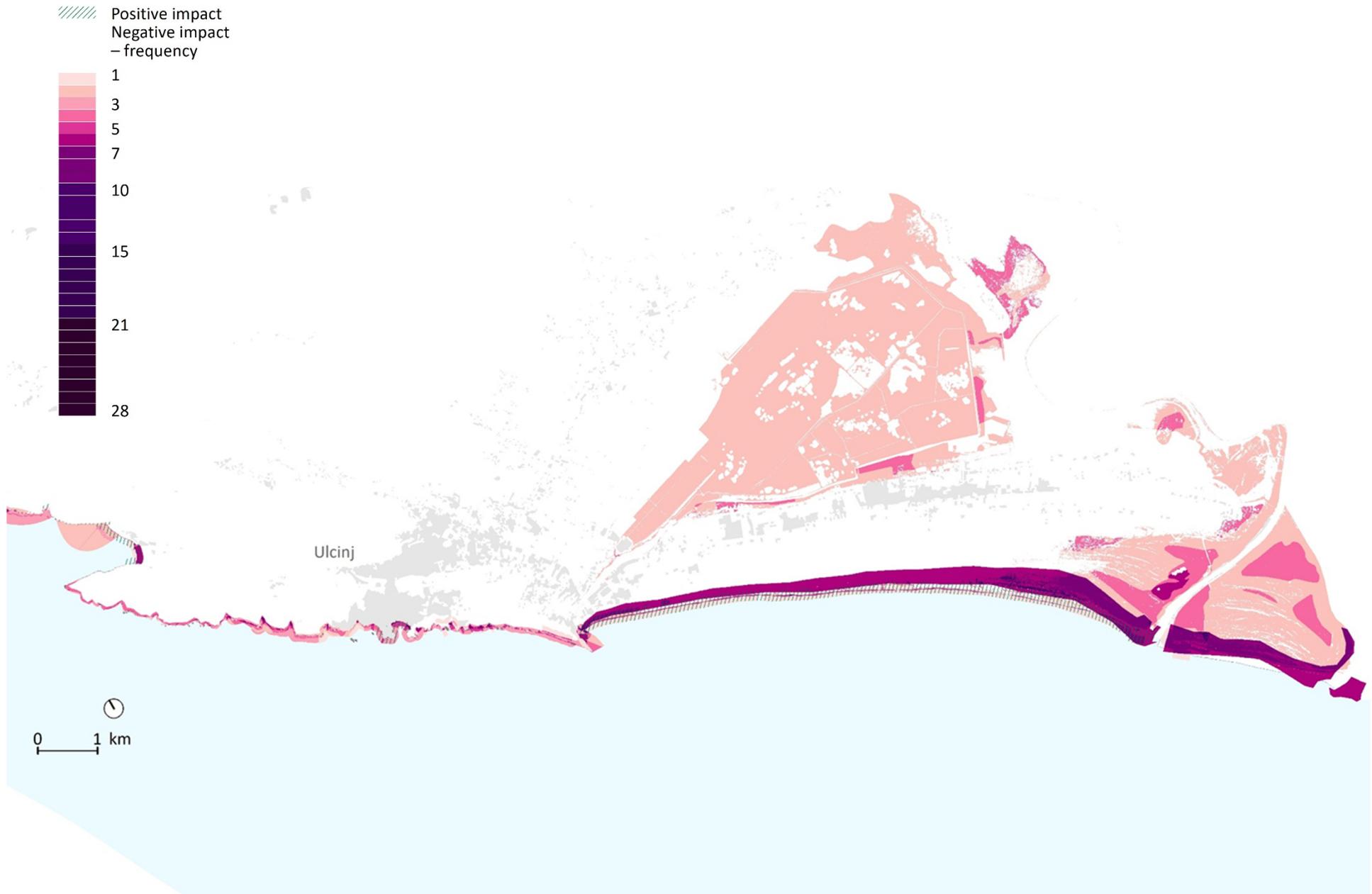


Figure 68. Total interactions of natural processes, land-sea and sea-land in-teractions – frequency: Ulcinj – Bojana





Implementation of the ecosystem approach in the Adriatic through marine spatial planning

The GEF-funded project “Implementation of the Ecosystem Approach in the Adriatic Sea through Marine Spatial Planning” (GEF Adriatic) is carried out across the Adriatic-Ionian region with focus on two countries: Albania and Montenegro.

The main objective of the project is to restore the ecological balance of the Adriatic Sea through the use of the ecosystem approach and marine spatial planning. Also, the project aims at accelerating the enforcement of the Integrated Coastal Zone Management Protocol and facilitating the implementation of the Integrated Monitoring and Assessment Program. Eventually, it will contribute to the achievement of the good environmental status of the entire Adriatic. The project is jointly lead by UNEP/MAP, PAP/RAC and SPA/RAC. In Montenegro, the project is being implemented with the coordination of the Ministry of Ecology, Spatial Planning and Urbanism.

The project duration is from 2018 to 2021.



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