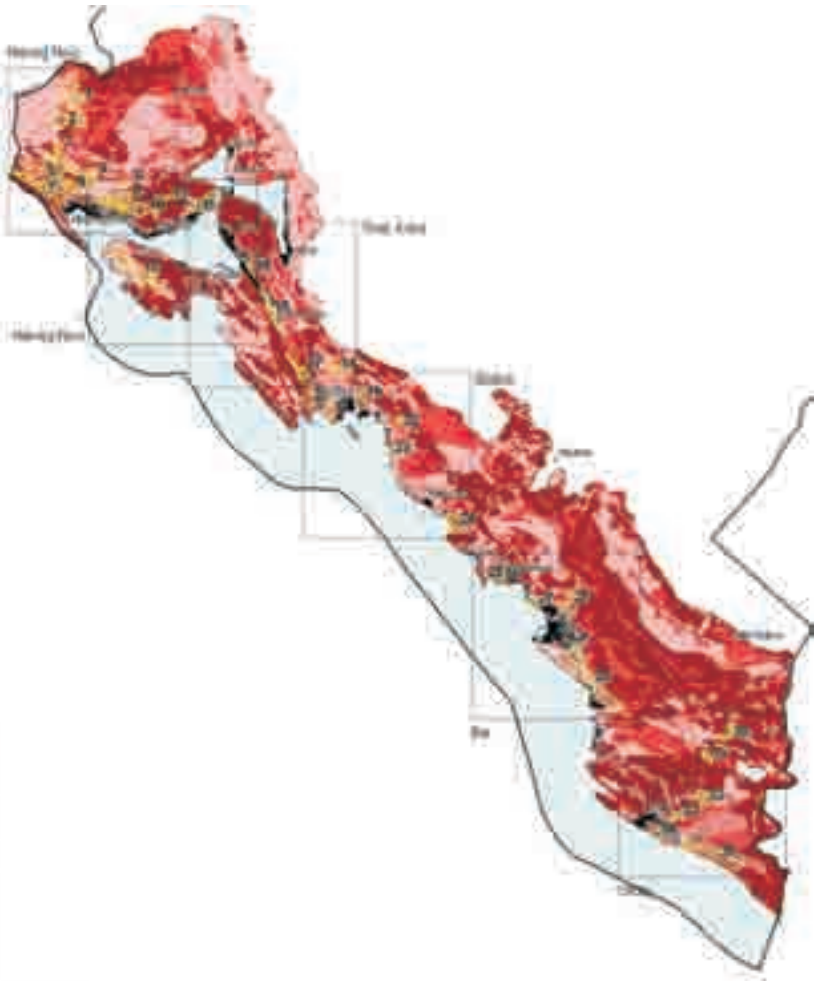
July 2013

CAMP Montenegro

General Vulnerability Assessment

Summary



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Project:

CAMP Montenegro
Vulnerability and suitability assessment

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Assessment of general vulnerability

Date:

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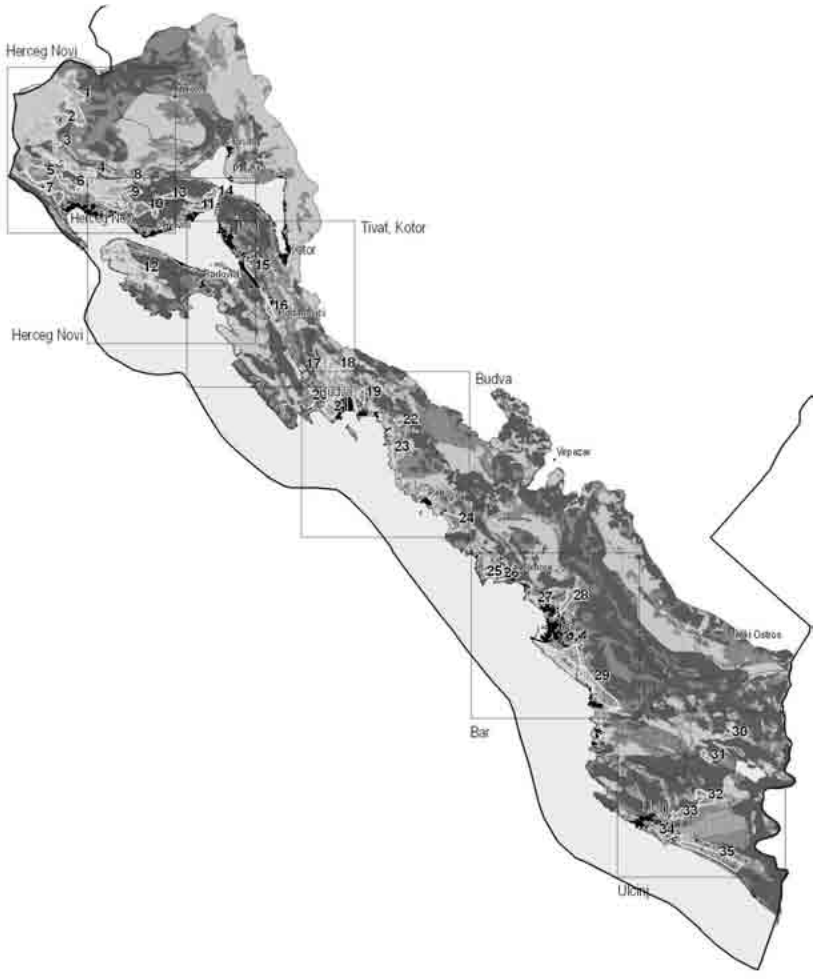

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List of Abbreviations

A	Sign for water quality category (1, 2, 3)
Amax	Maximum amplitude (ground acceleration)
ANSES	National Social Security Administration (in eng.)
AQI	Air Quality Index
BQ	Biological quality
C	Sign for water quality categories used for growing of lower quality fish species (*ciprinidae*)
CA	Construction areas
CAMP	Coastal Area Management Programme
CEMP	Co-ordinated Environmental Monitoring Programme
CFR	Code of Federal Regulations
CLC	CORINE Land Cover (system)
CUW-UK	Centre for Urban Water – United Kingdom
dB(A)	Decibel (A-scale)
E	East
EBS	Eutric brown soil
EC	European Commission
EEA	European Environment Agency
EG	Engineering-geological (categorisation of space)
EIA	Environmental Impact Assessment
EMS	European Macro-seismic (scale)
EU	European Union
EW	East-West
FEPA	Food and Environment Protection Act
GIS	Geographic Information Systems
GTZ	German technical cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit)
ha	Hectare
HELCOM	Baltic Marine Environment Protection Commission
HIJRM SFRJ	Hydrographical Yugoslav Navy Institute of (former) Yugoslavia
HIRM	Hydrographical Navy Institute
HMZ	Hydro-meteorological Institute of Montenegro
IBM	Marine Biology Institute
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management
INS	Institute of Nuclear Sciences
IPA	Instrument for Pre-Accession Assistance
IUCN	International Union for Conservation of Nature
JKP	Public communal enterprise
JP	Public enterprise
JPMD	Public enterprise *Morsko dobro*
K	Sign for water quality categories used for bathing (K1 – excellent; K2 – satisfactory)
LAeq Db(A)	Mean energy value of the noise of changeable level equivalent to the noise of continuous level measured over at least 15 minutes in the periods from 06 to 22 hours (day) or from 22 to 06 hours (night)
LBS	Land-Based Sources (of pollution)
MAC	Maximum allowed concentrations
MAP	Mediterranean Action Plan
MCS	Merkalli-Cancani-Sieberg's (scale)
MedPAN	Mediterranean Protected Areas Network
MedPartnership	Strategic Partnership for the Mediterranean Large Marine Ecosystem (LME)

MEDPOL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Region
MEPPP	Ministry of Environmental Protection and Physical Planning
MNE	Montenegro
MPA	Marine Protected Area
MSDT	Ministry of Sustainable Development and Tourism
N	North
NE	North-East
NFP	National Focal Point
NM	Nautical mile
NP	National Park
NW	North-West
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAP/RAC	Priority Actions Programme Regional Activity Centre
PCB	Polychlorinated biphenyls
PLV	Pollution limit values
PMF	Nature and Mathematics Faculty
POPs	Persistent Organic Pollutants
PPPNMD	Special Purpose Spatial Plan for the Public Maritime Domain
RAC/CP	Regional Activity Centre for Cleaner Production
RAC/SPA	Regional Activity Centre for Specially Protected Areas
RCG	(former) Republic of Montenegro
REC	Regional Environmental Center
RHMZ	Republican Hydro-meteorological Institute
RZUP	Republican Institute for Urban Development and Planning
S	Sign for water quality categories used for growing of high quality fish species (*salmonids*)
Š	Sign for water quality categories used for growing of shell fish species
S	South
SE	South-East
SEE	South-East Europe
SEE/CCFAP	Climate Change Framework Action Plan for the SEE Region
SFRJ	(former) Socialist Federative Republic of Yugoslavia
SMPSWM	Strategic Mater Plan for Sewage Waste Management
SPA/RAC	Specially Protected Areas / Regional Activity Centre
SPAMI	Specially Protected Areas of Mediterranean Importance
SPSPCZ MNE	Special Purpose Spatial Plan for the Coastal Zone of Montenegro
SW	South-West
TDA	Transboundary Diagnostic Analysis
USAID-IRD	US Agency for International Development – International Relief and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNDRO	United Nations Disaster Relief Organisation
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
W	West
WHO	World Health Organisation
ZHMS	Institute for Hydro-meteorology and Seismology
ZIB	Institute for Development of Bar
ZZZZ	Institute for Health Protection

1. Introduction

1.1 CAMP Montenegro

Coastal area management programme (CAMP) is implemented by the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP). The programme promotes integrated coastal zone management (ICZM) by rationalising systems and ensuring coordination and harmonisation of different activities in the coastal areas. The main objectives of the CAMPs are:

a) to develop sustainable development strategies and procedures in the areas that fall within projects' scopes, with special emphasis on implementation of the Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol);
b) to apply relevant methodologies and instruments;
c) to contribute to capacity building at local, national and regional level; and
d) to ensure wider use of results achieved in the region.

The main objectives for CAMP Montenegro are:

(i) to create necessary mechanisms that can help achieve sustainable development of the coastal area;
(ii) to support implementation of national policies and of the ICZM Protocol to the Barcelona Convention;
(iii) to promote integrated planning and management in the coastal area; and
(iv) to build national and local capacities for ICZM by helping with transfer of knowledge on application of instruments and approaches for integrated coastal zone management.

CAMP Montenegro will be implemented for the entire coastal zone of Montenegro since the systemic problems that need to be addressed in order to ensure sustainable coastal development are the same for the entire area. Project area encompasses territory of six coastal municipalities – Herceg Novi, Kotor, Tivat, Budva, Bar and Ulcinj – with the total surface of 1.591 km^2 as well as inland waters and territorial sea of Montenegro with the surface of 2.500 km^2.

Coastal zone of Montenegro is an area with high development potential where there are complex interactions between human activities and natural environment, with pronounced pressures on natural resources. In order to maintain development potential, primarily through preservation of resource base of the area and of the quality of natural and man-made environment, it is necessary to provide for an integrated approach in planning and managing the coastal area. In the context of previously mentioned aspects, CAMP can play an important role in creating conditions for integrated and effective management of the coastal zone in Montenegro.

1.2 Assessment of vulnerability and pollution

In line with the Protocol on Integrated Coastal Zone Management in the Mediterranean and in the context of conducting analyses needed for spatial planning and environmental protection, one of the activities undertaken within CAMP Montenegro was **assessment of general vulnerability** based on vulnerability of individual environmental segments. Moreover, existing **pollution (the extent to which the environment has been endangered)** of individual environmental

segments has been analysed as a specific characteristic. Results of the assessment served as one of the baselines for defining spatial vulnerability and for identifying remediation measures.

Spatial vulnerability is defined as a condition of the environment, space, soil or phenomena which can give rise to negative impacts in case certain intervention is implemented. Vulnerability assessment or determination of sensitivity/ susceptibility of space is a method used to determine more vulnerable (that is unsuitable) spatial segments for the given (planned) intervention or activity.

However, in order to still determine parts of space that are **suitable** for specific activities, in addition to vulnerability assessment it is necessary to evaluate space in relation to development goals within the **attractiveness assessment**. The next step is to compare and harmonise protection and development goals within the **suitability assessment**.

The flow of vulnerability assessment within CAMP Montenegro as well as potential uses of its results are presented in a graphic manner in the illustration 1.1.

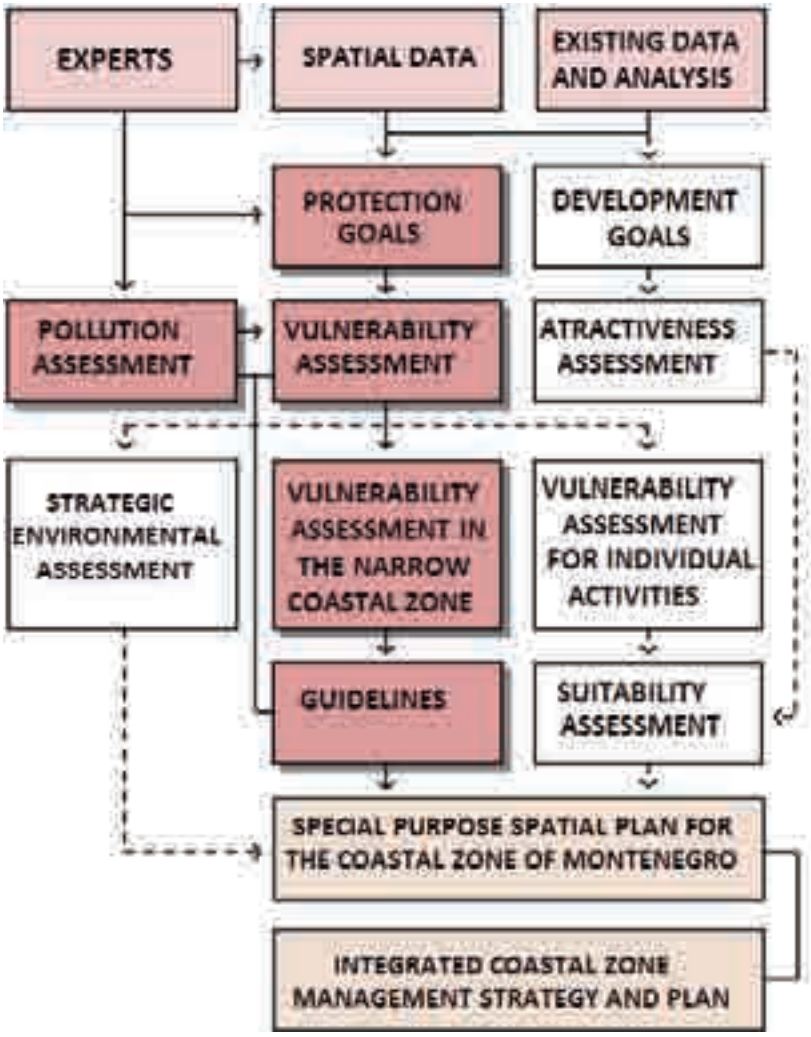


Illustration 1.1: Flow chart for vulnerability assessment within CAMP Montenegro and possible uses of results (white cells)

Assessment of general vulnerability is not an independent assessment *per se* – it is rather a baseline for preparation of the Special Purpose Spatial Plan for the Coastal Zone of Montenegro (SPSPCZ MNE) as well as for the Strategy and Plan for Integrated Coastal Zone Management. **The assessment determines the most valuable spatial units that should be preserved from future degradation i.e. those spatial segments that are unsuitable (or less suitable) for planning of certain activities or interventions.** Results of the vulnerability assessment require two principles of data processing in the spatial plan:

1. Spatial and siting improvements in a sense of location changes for given interventions and definition of alternative solutions for determining land uses; and
2. Defining options in the context of technological improvements, changing existing technologies and introducing advanced technological alternatives and/ or spatial solutions.

1.3 Method of work

Method of work for the assessment of general vulnerability was based on processing and analysing selected environmental segments and on preparation of vulnerability and pollution models. Assessment refers to the territory of six coastal municipalities: Herceg Novi, Kotor, Tivat, Budva, Bar and Ulcinj, with the exception of Skadar Lake National Park[1]. Some of the typical natural features of the coastal zone that are at the core of the area's vulnerability include diverse geological composition and complex geo-tectonic structure, coastal plain areas/ fields and beaches, steep slopes of Orjen, Lovćen and Rumija mountains, short watercourses and unique Bay of Boka with few smaller bays.

1.3.1 Analysed environmental segments

Environmental segments that have been considered in the assessment were selected in line with the Law on Strategic Environmental Assessment[2]. The following models of vulnerability and pollution have been prepared:

1. **Environment and human health** (noise; air pollution; soil pollution at *hot spot* locations; joint vulnerability model for environment and human health);
2. **Flora and fauna – biodiversity** (flora and fauna; nature protected areas; marine biodiversity; joint vulnerability model for flora and fauna i.e. for biodiversity);
3. **Soil** (erosion; agriculture and agricultural land; seismic hazard);
4. **Water** (terrestrial surface waters; terrestrial groundwater; sea);
5. **Air/ Climate, climate change** (droughts; forest fires; heavy rains; storm winds; joint vulnerability model for climate change); and
6. **Landscape**.

1.3.2 Preparation of vulnerability and pollution models

Dealing with environmental segments and preparation steps

A founding step in developing vulnerability and pollution models was selection of the key environmental segments significant in the context of SPSPCZ MNE. Having in mind selected segments, models have been prepared in several steps:

1. **Conceptual** model development which entailed initial determination of higher or lower vulnerability of environmental segments;
2. Determining a **set of relevant data** through an analysis of individual data;
3. Preparation of **matrices with grades by categories** for analysed individual data and/ or grades for combinations of data/ categories that referred to spatial situations affecting the level of vulnerability;

[1] Area surrounding Virpazar in Bar municiplaity was not inlcuded in the analysis due to a lack of data.

[2] Cultural heritage and material assets vulnerability was not prepared due to a lack of digitalised data.

4. **Graphic presentation** of individual and joint models, as well as of models of cumulative vulnerability/ pollution;
5. **Comments** that presented analysis of acquired results, including warnings on possible shortcomings of the model;
6. **Guidelines** that included:
   a) recommendations for the SPSPCZ MNE preparation;
   b) remediation measures;
   c) description of further work.

Based on the expert matrices, individual models have been prepared (as graphic presentations) representing basic potential vulnerability i.e. showing individual zones of exceptional value which are thus more susceptible to changes/ damages. Where it made sense, **joint models** have been prepared by segment entailing individual models and showing a more complex/ complete vulnerability of various environmental segments. For some segments (sea, environment and human health), model of the **extent to which the environment has been endangered/ polluted** has been prepared, meaning that there are individual or joint models showing zones where negative changes have already taken place. Information on the extent to which environment has been endangered/ polluted is partially integrated in the vulnerability models but is also presented as a separate model.

In the concluding part of the assessment, **models of cumulative vulnerability** i.e. **pollution** have been prepared, which entailed joining together (overlapping) of individual and/or joint models prepared for different environmental segments. These models represent synthesis part of the assessment of general vulnerability. The entire assessment has been prepared in various ways whereas each way contains specific information and matches different environmental protection scenarios:

a) Model of cumulative vulnerability according to the **principle of maximum value**;
b) Model of cumulative vulnerability according to the **principle of regulated average value**;
c) Model of cumulative vulnerability according to the **principle of direct valuation of the most significant components**. These models have been prepared for two possible scenarios:
   - scenario of pronounced protection of the most significant environmental components/segments;
   - scenario of the lowest level of acceptable protection (legally prescribed level of protection) of some environmental components/segments.

Moreover, other models have been prepared while addressing specific environmental segments. These models can be observed independently and include:

(i) climate vulnerability, that is vulnerability to **climate change**;
(ii) total pollution/ the extent to which the **environment and human health** are endangered, through presentation of the areas where environmental remediation needs to be undertaken (for *hot spot* locations and other sources of pollution);
(iii) total pollution/ the extent to which the **sea** is endangered, which indicates areas where remediation of marine *hot spot* locations needs to take place; and
(iv) as a separate conclusion or segment, **accidents** have been considered – this type of vulnerability does not result from vulnerability to interventions i.e. to land use changes, but from probability of accidents occurring at the sea.

Raster way of work was applied when these models were prepared. Information and grades were used in models in various ways, depending on the model's concept and specificities of the environmental segment being processed. Modelling was done with the application of ProVal2000 programme, whereas application of any GIS programme platform was also possible.

Principle of preparation of vulnerability model is shown in a graphic manner in the illustration 1.2.

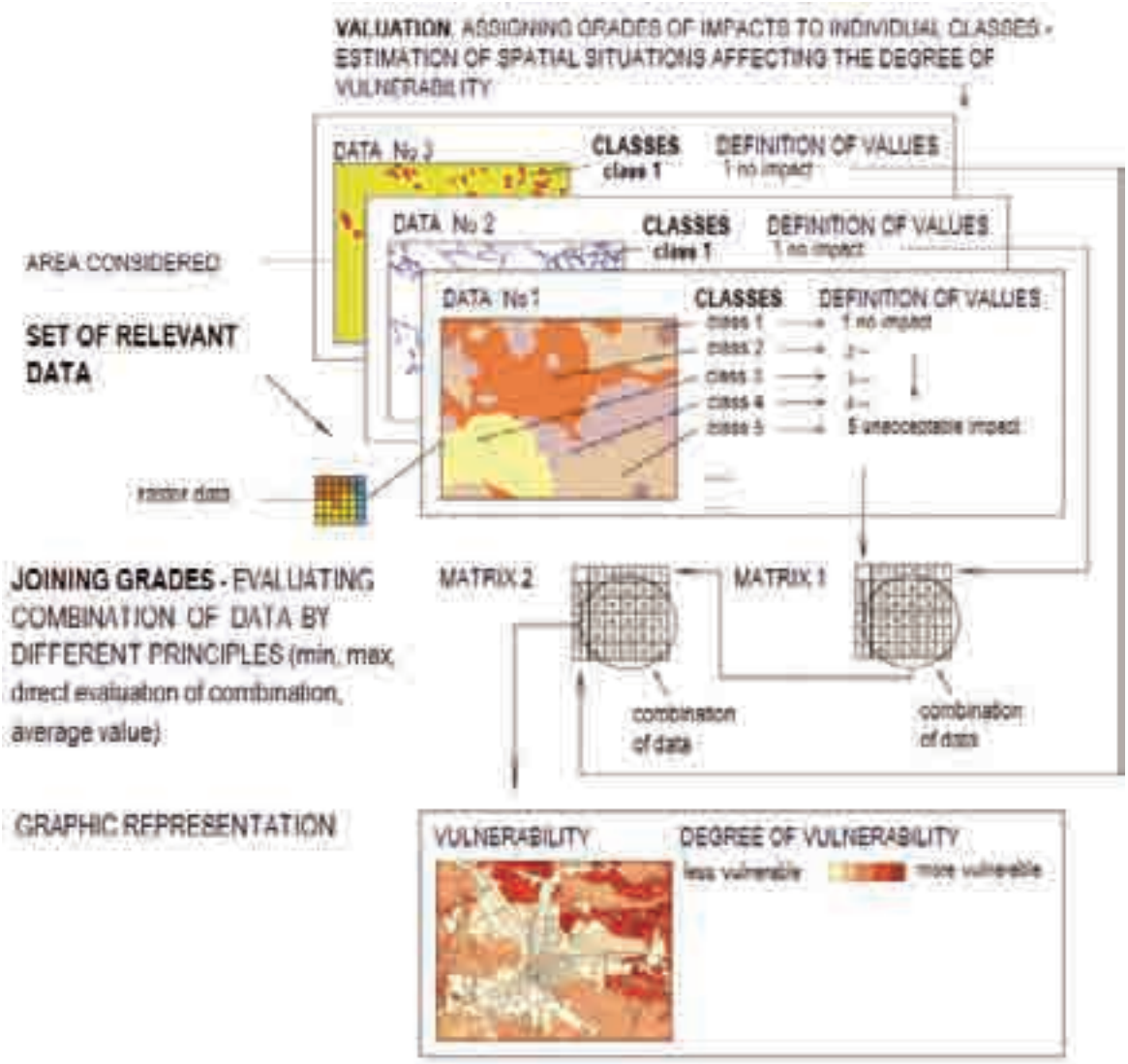


Illustration 1.2: Principle of development of vulnerability model

Manner of assigning grades

In spatial modelling that entails vulnerability assessment two tasks are important: division of space into homogenous spatial units, and assigning of grades to these units. The model or the obtained values need to provide an answer on what are the characteristics of the environment on which the magnitude of impact depends upon and in which way. Magnitude of an impact depends on the: (1) scope of expected change and (2) environmental quality. If the scope of expected change is greater, a larger impact on the environment is expected and consequently higher vulnerability of the area, and *vice versa*. In other words, if environmental quality is better, it is considered that a change would have a larger impact on the environment thus resulting in higher vulnerability of the area and *vice versa*. Values (grades) are assigned based on official measurement data, legal provisions on protection of certain units and/or space, and deliberated expert judgement based on application of transparent criteria.

Valuation of vulnerability degrees and general criteria for determination of grades are shown in the table 1.1.

Table 1.1: Evaluation of vulnerability with general criteria for determining grades and colour in graphic representations

Vulnerability grade	Criteria
1	**Very low vulnerability.** In case of an intervention i.e. land use change, there is no impact or the impact is negligible.
2	**Low vulnerability.** In case of an intervention i.e. land use change, impact is moderate –meaning a small/ moderate change in environmental components which is not particularly qualitatively defined and/ or can be easily remedied.
3	**Medium vulnerability.** In case of an intervention i.e. land use change, impact is significant – meaning a major change in environmental components and/ or difficult remediation.
4	**High vulnerability.** In case of an intervention i.e. land use change, impact is highly significant – meaning a very large change or loss of environmental components which is qualitatively defined and/or is very difficult to be remedied.
5	**Very high vulnerability.** In case of an intervention i.e. land use change, impact is inadmissible/ unacceptable, it exceeds tolerance threshold meaning a very large change or loss of environmental components which is particularly qualitatively defined and/ or is not possible to be remedied.

Evaluation of vulnerability depends on natural characteristics, existing land uses and potential for particular uses, and in some segments (such as sea, environment and human health) it also depends on the evaluation of the extent to which specific area is endangered/ polluted. Dilemma with evaluation of degraded/ endangered i.e. polluted areas is basically one of the central dilemmas of protective planning. In some situations, however, a different approach can be taken (based on certain goals and expert judgements). **If some parts of the environment are already polluted** (e.g. by noise or emissions to air) **above the legally permitted level or to the extent where new interventions** (new emissions) **would lead to increase in pollution above legally permitted levels, such areas are considered as highly vulnerable.** Impact of new interventions i.e. land use changes would be inadmissible/unacceptable unless remediation measures were implemented to address the existing pollution.

Evaluation of pollution/ the extent to which an area is endangered

The level of pollution in a given area is evaluated based on the prescribed quality standards that are primarily set with the objective to protect human health and the environment. Grades are based on official measurement data, legal provisions for protection of certain units and/ or space, and deliberated expert judgements based on application of transparent criteria. **Due to importance of the extent to which an area is endangered/ polluted, evaluation of the level of pollution is also shown as parallel, distinct information. This information indicates what are the areas/ phenomena for which it is necessary to implement remediation measures and serves as a basis for identification of remediation measures that need to be integrated in the spatial plan.**

Evaluation of the extent to which an area is endangered/ polluted and criteria for determining grades are shown in the table 1.2.

Table 1.2: Evaluation of the extent to which an area is endangered/ polluted with general criteria for determining grades and colour in graphic representations

Grades for the extent to which an area is endangered/pollution	Criteria
1	No impact or negligible impact
2	Moderate impact
3	Significant impact
4	Highly significant impact
5	Inadmissible/ unacceptable impact

Comments and guidelines

Comments have been prepared in the final stage presenting analysis of the acquired results, including warnings on possible shortcomings of the model as well as **guidelines** that include:

(i) recommendations for the SPSPCZ MNE preparation;
(ii) remediation measures; and
(iii) description of further work.

Results of the analysis have been prepared in a way so they can be used for:

- development of vulnerability assessments for individual activities i.e. development of suitability assessment; and
- strategic environmental assessment.

The next phase of the vulnerability assessment of space is based on **detailed analysis of vulnerability in the narrow coastal zone** that will be used for determination of the set-back line i.e. for determination of the zone with restricted or prohibited construction along the shoreline in accordance with the ICZM Protocol.

2. Processing of environmental segments

Environmental segments processed for this assessment have been selected and considered in line with the Law on Strategic Environmental Assessment. Assessment of general vulnerability represents a baseline for preparation of the Special Purpose Spatial Plan for the Coastal Zone of Montenegro (SPSPCZ MNE), as well as for preparation of Integrated Coastal Zone Management Strategy and Plan for Montenegro. All the input data used for preparation of individual or joint models for environmental segments are based on the use of official data from competent line ministries and public administration bodies tasked with implementation of environmental monitoring and reporting on the state of individual environmental segments, monitoring of spatial conditions and maintenance of cadastre baselines, such as: Ministry of Sustainable Development and Tourism, Agency for Environmental Protection, Institute for Hydro-meteorology and Seismology of Montenegro, Geological Institute of Montenegro, Centre for Eco-toxicological Research of Montenegro, Real Estate Administration of Montenegro, Public Enterprise for Montenegro Public Maritime Domain Management, Public Enterprise "Regional Water Supply of Montenegro", and others. At the same time, exchange of information with the consulting firm developing the SPSPCZ MNE has been established in order to prepare CAMP Montenegro materials in line with the format of processing the spatial data needed for the development of SPSPCZ MNE.

2.1 Vulnerability assessment

In the spirit of the Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol) and in the context of conducting analyses needed for spatial planning and environmental protection, assessment of general vulnerability of the coastal zone has been completed within CAMP Montenegro on the basis of vulnerability of individual environmental segments. The degree of spatial vulnerability deduced from the assessment of general vulnerability does not depend exclusively on potential impacts of individual activities or interventions but also on (individual) characteristics and value of space.

2.1.1 Environment and human health

Assessment of environmental and human health vulnerability was done as an analysis of the existing environmental quality and vulnerability of space taking into account selected physical and psychosocial aspects of human life and health. Basic **goal** of the analysis was to recognise sensitivity and the extent to which the coastal environment has been endangered in order to secure sustainable spatial planning and management and thus provide for healthy and preserved environment. This includes maintenance of the quality of biological diversity, quality of air, food, drinking and recreational waters, as well as decrease of negative impacts on human health such as noise, air pollution, drinking water and sea pollution, and others.

Assessment of environmental and human health vulnerability in the coastal zone of Montenegro was primarily done taking into account the impacts of noise, air and soil pollution. Moreover, these analyses have been joined with data on groundwater (only for the zones of sanitary protection) and sea vulnerabilities, as well as with the data on seismic hazard

vulnerability. When assessing coastal zone's vulnerability to noise impacts, air and soil pollution, criteria shown in the table 2.1 were used. Groundwater vulnerability criteria are shown in the sub-section 2.1.7 in the table 2.5, and criteria relevant for sea in the sub-section 2.1.8, table 2.5; seismic hazard is treated in greater detail in the sub-section 2.1.5, table 2.4, while the assessment of vulnerability to accidents is available in the long version of the document "Assessment of general vulnerability".

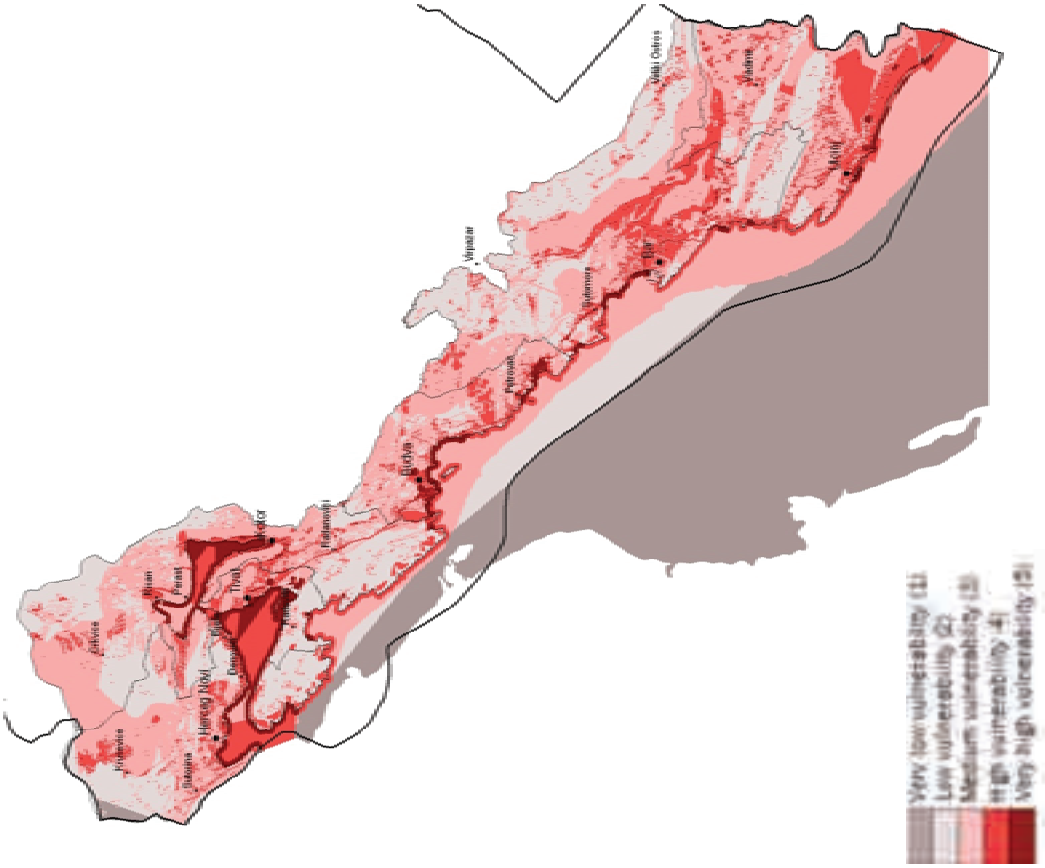
Table 2.1: Assessment of the area's vulnerability based on the impacts of noise, air and soil pollution

Vulnerability grade	Criteria		
	Noise	Air	Soil
1	Industrial, warehousing and services areas, hotels/ restaurants of the open type outside settlements	Industrial, warehousing and services areas; the most crowded crossroads	Waste disposal sites; industrial, warehousing and services areas; immediate surroundings of roads with heavy traffic
2	Urban centres, zones around city transport routes, main roads and highways	Zones around transport routes (mobile sources of air pollution)	Abandoned waste disposal sites; wider zones around disposal sites (more than 300 m); zones around transport routes; housing areas
3	Commercial-housing areas, tourist locations, children's playgrounds	City areas and tourist locations	Locations besides transport routes with more than 100 m in distance; non-cultivable land
4	Tourist areas, small village settlements, camps	Suburban settlements and city zones without transport	Cultivated land, park surfaces, vicinity of water springs or potential drinking water springs
5	Nature areas and areas for rest and recreation	Protected, ecologically sensitive zones of cultural and natural heritage	Nature areas and areas for rest and recreation; locations with deposits of medicinal mud/ peloid; water supply sources

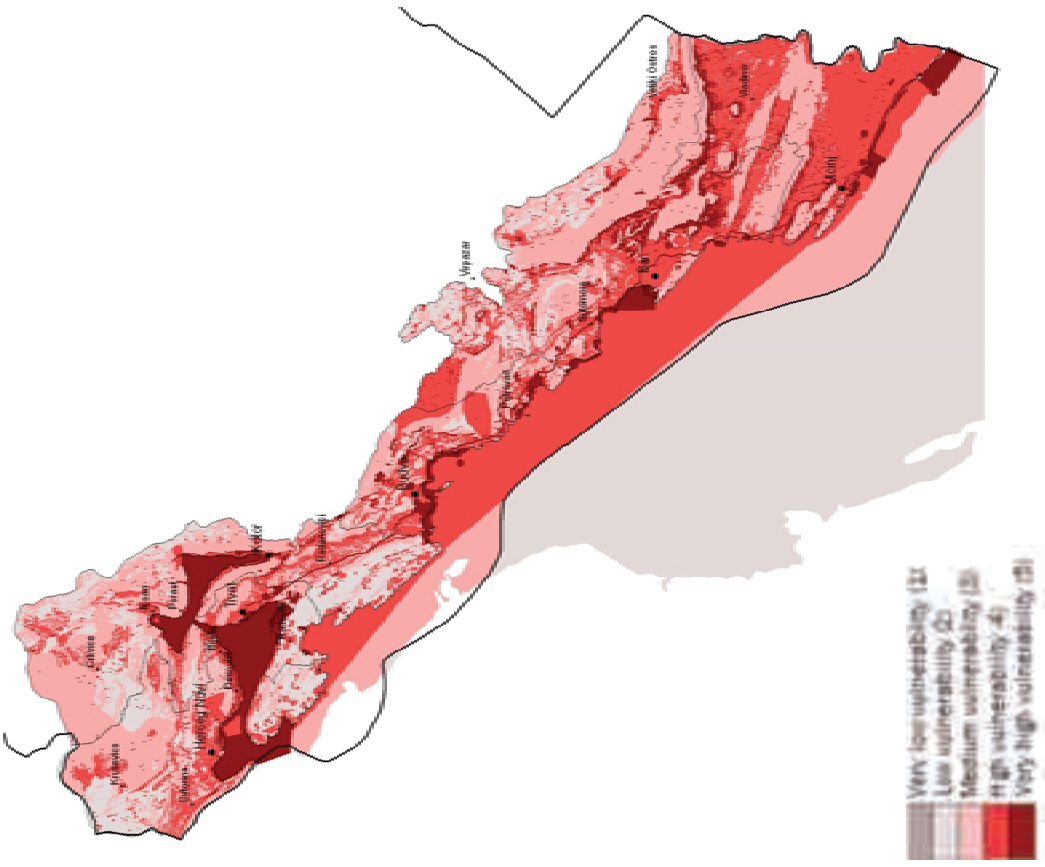
Key: vulnerability is shown on the scale 1 – 5, where 1 stands for the areas with lowest vulnerability and 5 for the areas with highest vulnerability given the existing state of the environment and greater sensitivity to future pollution.

Remark: Comprehensive presentation of criteria can be found in the long version of the document "Assessment of general vulnerability".

With the above in mind, **joint** vulnerability **model** for environment and human health has been prepared through integration of noise, air and soil vulnerability models. Models for groundwater (for sanitary protection zones only) and for sea with accidents, as well as model of vulnerability due to seismic hazard, which have been prepared as separate models and are discussed in more detail in the following chapters, have been also integrated. This joint model is prepared through application of two principles (two scenarios): principle of maximum value, and principle of regulated average value of each of the prepared sub-models. Principle of regulated average value includes expert evaluation of each sub-model in the cumulative model (on a scale of 1 to 2). *Soil* vulnerability sub-model was thus assigned a value of 1.5 in the cumulative model, sub-models for *noise* and *groundwater* (sanitary protection zones) as well as vulnerability model for *sea with accidents* were assigned values of 1.75, while as vulnerability models for *air* and *seismic hazard* received maximum values of 2 in the cumulative model. Results of joint vulnerability for environment and human health by the principle of maximum value as well as by the principle of regulated average value are shown on the subsequent maps 2.1 and 2.2.



Map 2.2: Joint vulnerability model for environment and human health by the principle of regulated average value



Map 2.1: Joint vulnerability model for environment and human health by the principle of maximum value

Vulnerability assessment clearly indicates **exceptional vulnerability of the environment** in the coastal zone of Montenegro. Pressures are particularly pronounced at tourist settlements and beaches (illustration 2.1), as well as at areas entirely used for housing in Kotor, Budva, Bar and Ulcinj. The same applies for the sea quality in the Bay of Boka as well as for the narrow coastal sea strip, especially in the shallow areas of Ulcinj beach and Budva Riviera. This is something that necessitates guidelines in the context of implementing measures to decrease impacts on environmental quality and human health.

Illustration 2.1: Medicinal mud – peloid (Source: daily newspaper "Politika")

2.1.2 Flora and fauna – biodiversity

Biodiversity vulnerability assessment was completed by considering spatial distribution of areas with significant flora and fauna components, with a special emphasis on nature protected areas. Basic **goal** of this analysis was to preserve spatial wholeness (integrity) of ecologically valuable areas, including nature protected areas under national legislation commitments as well as those covered by international agreements. In order to assess biodiversity vulnerability, vulnerability of **nature protected areas** has been taken into account in addition to **flora and fauna** vulnerability (illustrations 2.2 and 2.3). Forests have been included in the analysis in the sense of their natural/ biodiversity significance, while as forestry (sensitivity of wood-producing forest function) was not treated separately due to low economic significance of Montenegrin coastal region's forests.

Illustration 2.2: Vrmac – planned regional park, view from Lovćen mountain slopes (Source: Nature Protection Institute of Montenegro)

Illustration 2.3: Special nature reserve Tivat Saltpans, view from Lovćen mountain slopes (Source: Nature Protection Institute of Montenegro)

In addition to vulnerability assessment for terrestrial biodiversity, a limited assessment of marine biodiversity was also produced. Results and available data from the project "*Start-up of Katič MPA in Montenegro and Assessment of marine and coastal ecosystems along the coast*" and field surveys at selected locations, as well as limited archive data available from official documents (e.g. military *map of sediments of sea bed* for former SFRY, Barcelona Convention protocols, IUCN standards, EU directives) and selected literature served as a basis for evaluation of marine biodiversity vulnerability. The MPA Katič project is implemented in the framework of donor support of the Italian Ministry of Environment, Land and Sea, while as field surveys were conducted within MedPAN project with SPA/RAC support.

For the assessment of biodiversity vulnerability, criteria presented in the table 2.2 were used. It should be kept in mind that criteria shown in the table represent quite simplified version of complex criteria used for vulnerability assessment. The entire classification of criteria taking into account different data sources can be found in the long version of the document "Assessment of general vulnerability".

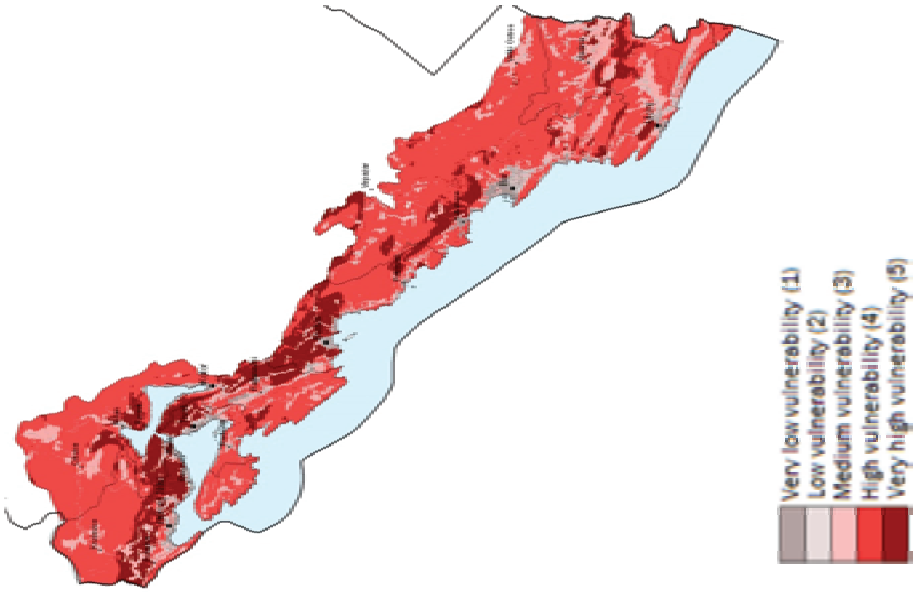
Table 2.2: Evaluation of vulnerability for different areas based on flora and fauna and protection status

Vulnerability grade	Criteria	
	Flora and fauna/ marine biodiversity	**Protected (and potentially protected) areas**
1	Artificial surfaces	-
2	Non-irrigated cultivable land, surfaces for sports and recreation	-
3	Agricultural surfaces (olive orchards, agricultural land with larger areas of natural vegetation), pastures, park surfaces	Monuments of nature (including proposed ones), landscapes with exceptional features, areas protected under municipal regulations
4	Forest areas, wetlands, rocks, etc. Sandy bottom, bare stone bottom, sludge, biocenosis of coastal detritic bottoms, etc.	National parks, potential (proposed) national and regional parks
5	Protected plant species, key coastal and water habitats based on CLC (beaches, dunes, sandy terrains, watercourses, river mouths etc.); protected marine species (SPAMI list and national legislation), fields of *Posidonia oceanica*, sea caves, corals formations, stony overgrown bottom, reef bottom, sandy/ clay sludge, etc.	Special nature reserves, protected dendrological objects.

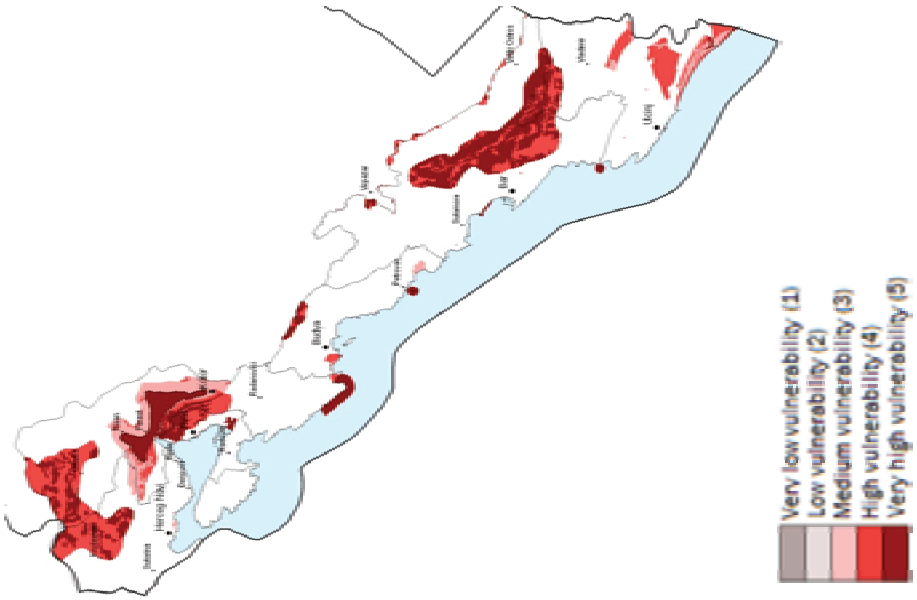
Vulnerability model for flora and fauna is not complete due to missing data on habitat types and lack of good quality data on the use of land. Approximation was therefore done by using so called derived data – combinations of various (indirectly used) data. Data for evaluation of marine biodiversity vulnerability was especially weak but the analysis nevertheless makes the most complete presentation of the state of marine biodiversity in Montenegro.

Some of the joint models for terrestrial biodiversity, protected areas and marine biodiversity by the principle of realistic characterisation and valuation of vulnerability of two habitat types – *Posidonia* fields and submarine caves – (concept 1) are shown, respectively, on the maps 2.3, 2.4 and 2.5 below.

Map 2.5: Vulnerability for marine biodiversity (concept 1)



Map 2.4: Vulnerability for protected areas



Map 2.3: Vulnerability for terrestrial biodiversity

Assessment of **flora and fauna** (biodiversity) **vulnerability** indicates exceptional vulnerability of species and habitats in the entire coastal zone and confirms that the existence of current and plans for potential protected areas are justified. Analysis of marine biodiversity emphasises vulnerability of submarine caves in the coastal sea (illustration 2.4) and of *Posidonia oceanica* habitats (illustration 2.5).

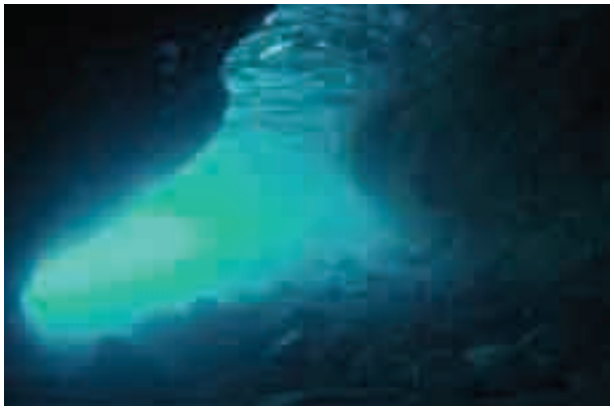


Illustration 2.4: Pećin – submarine cave (Source: MPA Katič project)

Illustration 2.5: *Posidonia oceanica* (Source: MPA Katič project)

2.1.3 Erosion

While conducting assessment of soil vulnerability to erosion, a model was prepared for torrential watercourses with an **objective** to firstly recognise the extent of the problem and then to undertake necessary measures to prevent or mitigate erosion processes. The analysis referred to the following torrential watercourses and their catchment areas: Bečićka river, Bojana, Bratićki stream, Gradiošnica, Grđevica, Jaška river, Kolożun, Ljeskovački stream, Vodolježnica, Rikavac, Sutorina, Vještica and Željeznica. Vulnerability **grades** were assigned from the 1 – 5 scale according to destructiveness category (excessive – grade 5; strong – grade 4; medium – grade 3; weak – grade 2; and very weak erosion – grade 1). Examples of weak, moderate and excessive erosion are shown, respectively, on the illustrations 2.6, 2.7 and 2.8 below.

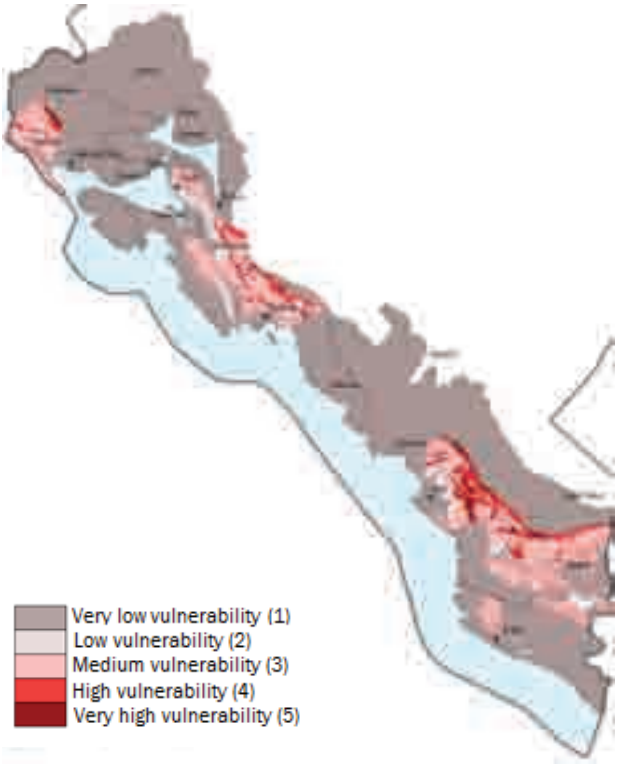
It was not necessary to process sections outside the listed catchment areas including flat terrains, wetlands, saltpans, settlements, areas of macchia and preserved forests, as well as bare terrains that cannot be forested at the level of graphic representation. With the exception of bare terrains, these areas are not threatened by erosion, even though there are still some smaller sections where torrents and flooding bring sediments and cover up fertile land or where soil is physically lost as the shore gets destabilised and landslides occur. Erosion can be exacerbated due to destruction of vegetation cover, construction of roads, damages of supportive walls for terraced areas and in other ways, but this is not typically occurring in wider areas and remediation actions can be implemented by local communities in cooperation with local self-governments.

Results of the analysis show that almost the entire coastal region is threatened with water **erosion** which manifests in various forms: as surface, mixed and deep erosion, as well as through landslides and flooding deposits. Soil vulnerability to erosion is shown on the map 2.6.

Illustration 2.6:
Example of the area with weak erosion (of moderate impact)
(Radanovići, Google Earth, 2005)

Illustration 2.7:
Example of the area with medium erosion (of significant impact)
(south from Šasko Lake, Google Earth, 2009)

Illustration 2.8:
Example of the area with excessive erosion (of inadmissible/ unacceptable impact)
(east of Bar, Google Earth, 2009)



Map 2.6: Soil vulnerability to erosion

2.1.4 Agriculture and agricultural land

Model of vulnerability for agricultural land has been conceptually prepared as an attractiveness model. This means that the land with highest potential for agriculture has been evaluated as the most sensitive. Basic **goal** of this analysis was to recognise and undertake necessary measures to preserve fertile land (alluvial and alluvial-colluvial soils of coastal fields and valleys and anthropogenic terraces) for agriculture.

Vulnerability assessment of agricultural land is shown in the table 2.3. In preparing the model for agricultural land vulnerability, slope of the terrain, altitude belts, exposure to sun and paedology were taken into account as the basic categories for assigning vulnerability grades. Furthermore, urban areas and infrastructure lines (roads, transmission lines, railroad) were taken into account and were mainly recognised as the areas of lowest vulnerability.

Table 2.3: Agricultural land vulnerability assessment

Vulnerability grade	Criteria			
	Slope of the terrain	Altitude belts	Exposure to sun	Paedology
1	0-5% (0-3°); flat or slightly corrugated terrains	> 1,500 m above sea level	-	Very poorly developed soils on gravel, marine (live) sand, oranogenic limestone-dolomite black coloured soil, marsh gley soils
2	5-12% (3-6°); slightly sloped flat terrains and mild slopes	1,000 – 1,500 m above sea level	North (N) orientation	Organo-mineral and brownish limestone-dolomite black coloured soil, Rendzina on moraine deposits, pseudogley eutric brown soil (EBS) on lake sediments, brown acid soil on cherts, shallow brown soil on limestone, alluvial carbonate sandy, clay and brackish soil
3	12-27% (6-9°); moderately steep slopes	500 – 1,000 m above sea level	Northeast (NE) and Northwest (NW) orientation	Colluvium without carbonate, alluvial-colluvial leached soil, leached EBS on lake sediments and on alluvial and colluvial deposits, medium deep and deep EBS on Eocene flysch
4	5-12% (3-6°); slightly sloped flat terrains and mild slopes	200 – 500 m above sea level	Southeast (SE), Southwest (SW), East (E) and West (W) orientation	Redeposited limestone-dolomite black coloured soil, EBS on lake sediments, EBS on alluvial and colluvial deposits, EBS on Eocene flysch, medium deep and deep terra rosa, alluvial carbonate clay soil
5	0-5% (0-3°); flat or mildly corrugated terrain	0 – 200 m above sea level	Flat areas; South orientation (S)	Alluvial-colluvial soil, alluvial carbonate loam soil

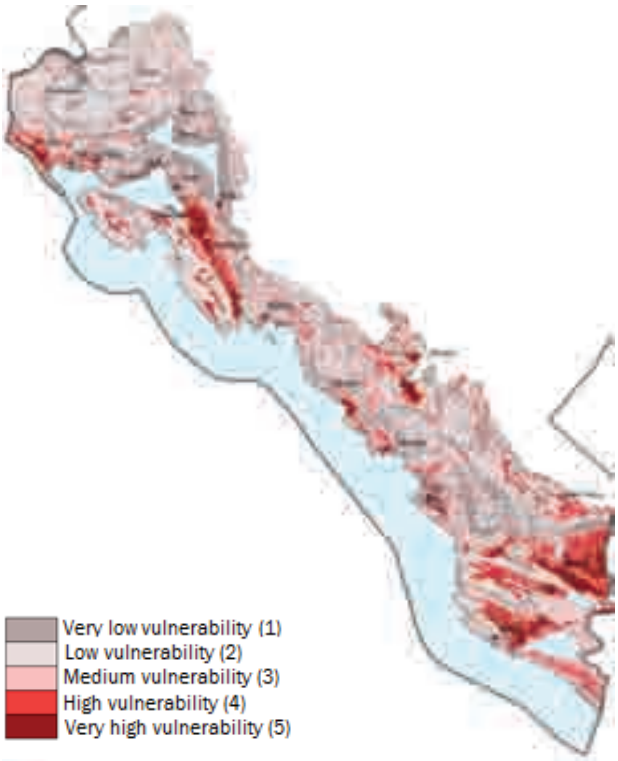
Model has been prepared by the principle of direct evaluation of combinations of categories, with equivalent grades for the most vulnerable paedological units and flat areas. Examples of the areas of high, medium and low vulnerability of agricultural lands are shown, respectively, on illustrations 2.9, 2.10 and 2.11.

Illustration 2.9: Example of the area with high vulnerability (of inadmissible/unacceptable impact) – flat terrain at an altitude of 20 m, alluvial-delluvial soil without urbanisation (Šasko field, Google Earth, 2009)

Illustration 2.10: Example of the area with medium vulnerability (of significant impact) – moderately steep slopes at an altitude of 300 m, eutric brown soil, partly urbanised (Dobra voda, Google Earth, 2009)

Illustration 2.11: Example of the area with low vulnerability (of moderate/negligible impact) – steep slopes at an altitude of 700 m, Calcomelansol, carbonate-dolomite black coloured soil (Rumija, Google Earth, 2008)

Agricultural land vulnerability model (map 2.7 below) clearly shows areas of high significance and potential impact. In preparing the model, potential of the soil as a resource was analysed, independently from planned land uses. As such, the model can serve to analyse whether previous extensions of construction areas at the expense of the best agricultural land were sensible and justified. The largest areas of high vulnerability are located in Ulcinj municipality. These areas are characterised with alluvial and alluvial-colluvial soils on flat terrains, especially at Ulcinjsko field, Štoj, Šasko and Anamalsko fields. In Bar municipality, besides some smaller complexes in the northern part of the municipality, Barsko field should be singled out as highly vulnerable; however, this area is largely urbanised and 'cut through' with infrastructure. Surface of the high vulnerability areas is smaller but still significant in other municipalities, whereas Sutorina, Tivatsko and Mrčevo fields stand out.



Map 2.7: Agricultural land vulnerability

2.1.5 Seismic hazard

Seismic vulnerability is presented in the model of general vulnerability as a component that expresses potential effects of earthquake activities in the region i.e. potential effects of seismic hazards[3], as well as their contribution to cumulative spatial vulnerability. General seismic activity is defined based on relevant database on seismic history for the territory of all the coastal municipalities of Montenegro, capturing regional as well as local aspects of seismic activity throughout several past centuries. Basic **goals** of such an analysis were to perform characterisation of space in relation to seismic impacts, to point out to the obligation of applying national regulations and to stimulate integration of produced analyses in the process of development of spatial planning documentation for the entire coastal zone as to ensure lowering of total seismic risks.

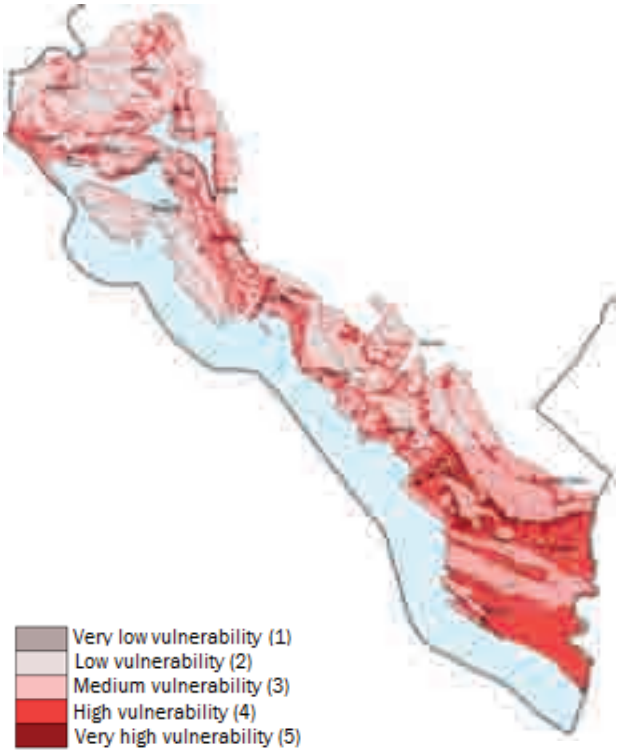
In the model of general vulnerability of space, general seismic vulnerability is expressed as low, moderate or high (grades from 1 to 3, respectively). It is linked to conditions of the basic i.e. hard rock masses and is derived from basic seismic categorisation of space. Seismic vulnerability determined in this way was then combined (convolved) with the data on engineering-geological categorisation and terrain slopes on the basis of lithological composition, given its evident influence on increasing or decreasing grades for basic seismic vulnerability. Cumulative seismic vulnerability was derived in this way and expressed in grades ranging from 1 to 5, whereas grade 4 stands for very significant impact and grade 5 for an impact that exceeds acceptable criteria and possibilities to ensure safety (table 2.4).

[3] Based on generally accepted definition of UNDRO expert group from 1979, seismic hazard is a term used to express probability of earthquake occurance at a given location that will result in a given effect: most frequently, the effect is measured as maximum ground accelaration (usually expressed in parts of Earth's gravitational acceleration – in g) or maximum intensity (expressed through some of the intensity scales such as MCS – Merkalli-Cancani-Sieberg's, European macroseismic scale EMS98 or similar).

Table 2.4: Matrix with combination of grades in the model: engineering geological (EG) categorisation / slope / seismic categorisation of space

		Seismic categorisation of space		
		Expected maximum ground acceleration (475 years): <0.25 g	Amax: 0.25 – 0.35 g	Amax: 0.35 – 0.60 g
Grade for EG categorisation / slope	**Vulnerability grade**	**1**	**2**	**3**
1/1 (tied well petrified rocks / 0-5%)	1	1	2	3
1/2 (tied well petrified rocks / 5-20%)	1	1	2	3
1/3 (tied well petrified rocks / 20-35%)	2	2	2	3
1/4 (tied well petrified rocks / >35%)	3	3	3	3
2/1 (flysch / 0-5%)	1	1	2	3
2/2 (flysch / 5-20%)	2	2	3	4
2/3 (flysch / 20-35%)	3	3	4	4
2/4 (flysch / >35%)	4	4	4	5
3/1 (complex tied non-petr. and untied / 0-5%)	1	1	2	3
3/2 (complex tied non-petr. and untied / 5-20%)	2	2	2	4
3/3 (complex tied non-petr. and untied / 20-35%)	3	3	3	4
3/4 (complex tied non-petr. and untied / >35%)	4	4	4	5
4/1 (tied non-petrified – clay / 0-5%)	1	1	2	3
4/2 (tied non-petrified – clay / 5-20%)	2	2	3	4
4/3 (tied non-petrified – clay / 20-35%)	3	3	4	5
4/4 (tied non-petrified – clay / >35%)	4	4	4	5
5/1 (untied clastic rocks / 0-5%)	2	2	3	4
5/2 (untied clastic rocks / 5-20%)	3	3	4	4
5/3 (untied clastic rocks / 20-35%)	4	4	4	5
5/4 (untied clastic rocks / >35%)	5	5	5	5

The largest areas of high **seismic vulnerability** (grade 5) i.e. zones with expected ground acceleration between 0.35 g and 0.60 g are found in Bar and Ulcinj municipalities. These are areas characterised by significant terrain slopes and/ or with predominantly untied clastic rocks, which are mainly located in wider surroundings of Ulcinj, surroundings of Gornje Klezne (Ulcinj municipality), on southern slopes of Rumija mountain range and Možura hill, or in other words – between Bojana river and Bar. Some towns (such as Bar and Ulcinj) and some larger settlements (for example Vladimir and Donji Štoj near Ulcinj) are located in the areas characterised by very high seismic vulnerability (grade 4). Other areas of significant seismic impact are also found in the vicinity of Sutomore, Petrovac, Budva, Radanovići, Kotor, Risan and Herceg Novi settlements (map 2.8).



Map 2.8: Cumulative seismic vulnerability

2.1.6 Surface waters

As a part of the vulnerability assessment for terrestrial surface waters permanent and occasional surface watercourses typical for the Montenegrin coastal region's hydrology were analysed from the aspect of sensitivity of surrounding areas during the existence of surface flows. The analysis encompassed Bojana river as a dominant surface watercourse and border river to Albania, two permanent watercourses – Željeznica and Sutorina, as well as ten minor occasional watercourses. Analysis of Skadarsko and Šasko lakes was also conducted as a part of the vulnerability (sensitivity) assessment. The basic **goal** of the analysis was to determine vulnerability of watercourses based on their hydrological and hydro-geological characteristics as well as to identify qualitative aspects in order to ensure protection, preservation and improvement in the surface water quality, its biodiversity and other characteristics, in line with Montenegrin legal requirements.

Areas where water regime changes are inadmissible, as condition of receptors is closely related to risks to human health and biodiversity, were evaluated as the areas exhibiting very high vulnerability (5). Areas which are already under major and diverse pressures taking into account degree of development (construction) and numerous pollution sources were assessed to have relatively lower vulnerability (2). More detailed analysis based on vulnerability criteria is available in the long version of the document "Assessment of general vulnerability". Model of surface waters vulnerability was prepared by the principle of maximum value (map 2.9).

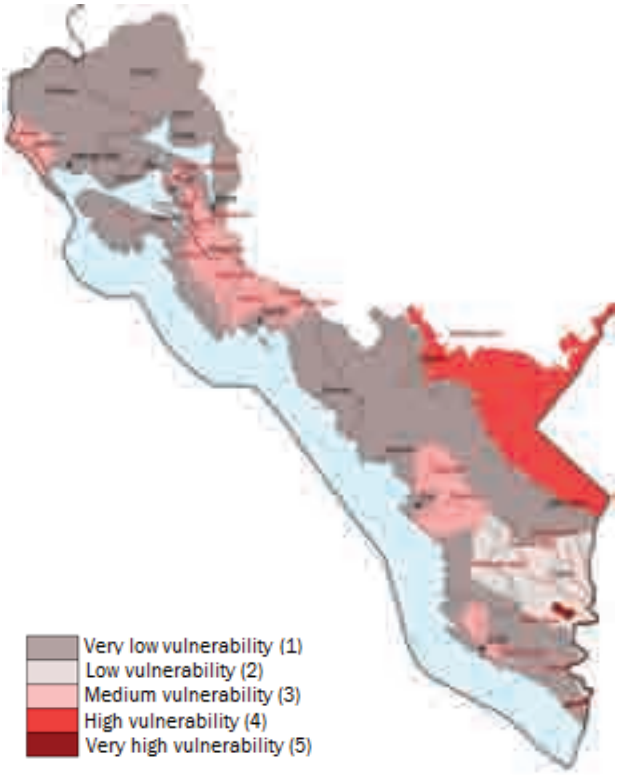
Moreover, vulnerability to flooding was assessed taking primarily into account Bojana river – a cross-border river towards Albania – from the aspect of sensitivity of surrounding areas to the periods of extremely high waters and flooding. In addition to Bojana river, other smaller watercourses were analysed as well as Skadarsko and Šasko lakes. Very high vulnerability (5) was identified for the areas where the level of change was inadmissible and condition of flooded terrains represented risk to human lives and health, to their assets and to biodiversity. Vulnerability to flooding impacts is shown on the map 2.10.

In the analysis of surface waters vulnerability it is necessary to single out distinct hydrological objects – Bojana river and Skadarsko and Šasko lakes. These hydrological objects are the most significant ones for the area and all possible impacts related to them need to be analysed in detail. As for the other hydrographical objects (surface watercourses), attention needs to be paid to those watercourses that flow into the sea in urban and beach areas (map 2.9).

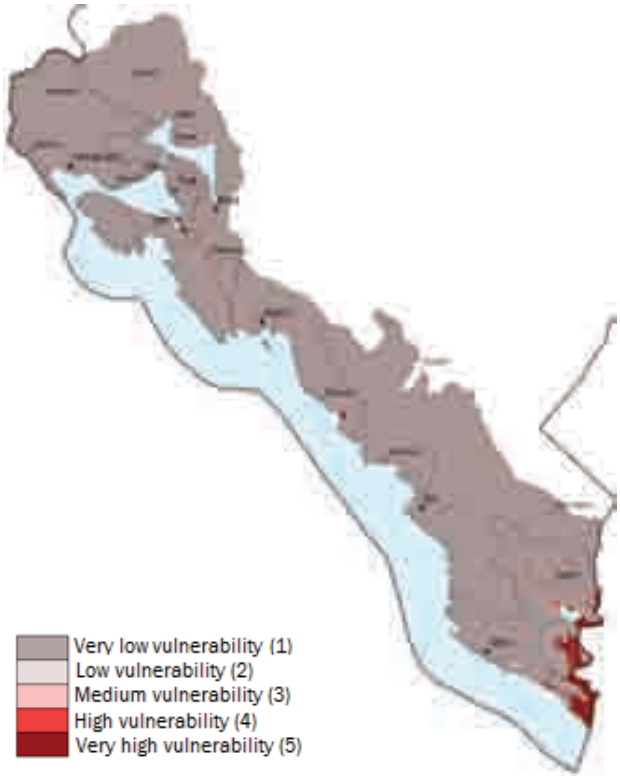
Municipal plans need to comprehensively address all watercourses of municipal significance, primarily from flooding and water quality protection aspects. **Flooding** caused by extremely high waters of Bojana river (illustration 2.12) represent a significant regional

and transboundary problem due to the fact that they are conditional to, among other things, high waters of Albanian Drim river. Flooding zones of Vladimirsko-Sukobinsko field, wider area of Šasko lake and Ulcinjsko field are of special importance. Flooding also takes place in the zones of smaller torrential watercourses along the entire region of Montenegrin coast (map 2.10).

Illustration 2.12: Flooding in the zone of Bojana river (Source: ZHMS database)



Map 2.9: Surface waters vulnerability – joint model



Map 2.10: Vulnerability from the aspect of flooding impacts

2.1.7 Terrestrial groundwater

Groundwater vulnerability assessment was based on the analysis of hydrogeological rock qualities, sanitary protection zones for water springs, as well as on the analysis of peloids and mineral waters deposits. Basic **goals** of the analysis were to define aquifer zones, especially for water supply springs, and to pay attention to peloid deposits and springs of thermal-mineral waters in order to protect them from degradation through (further) construction and urbanisation.

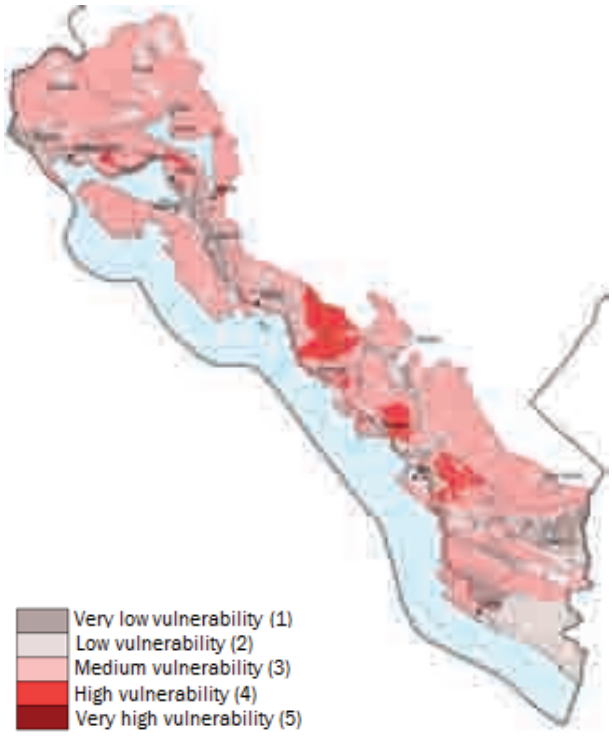
Vulnerability grades for the joint model according to the type of rock porousness, zones of sanitary protection around springs, and zones of peloid and mineral water deposits are shown in the table 2.5.

Table 2.5: Evaluation of vulnerability for terrestrial groundwater

Vulner. grade	Criteria	
	Hydrogeological features of rocks	Zones of sanitary protection and springs
1	Non-permeable rocks	-
2	Quatenary and pre-Quatenary rocks of intergranular porosity and weak transmissiveness	-
3	Quatenary rocks of intergranular porosity and good and very good transmissiveness, cracked rocks	Zones of supervision – III protection zone (wider protection zone)
4	Carbonate rocks of cavernous-cracked porosity and weak karstification	Zone of limited protection regime – II protection zone (narrower protection zone)
5	Carbonate rocks of cavernous-cracked porosity and good karstification	Zone of strict protection regime – I protection zone (zone of direct protection); sanitary protection belt (pipeline belt); immediate zone of mineral springs; spring zones – around each spring, water occurrence or water object; peloid deposits zones

Areas of carbonate rocks of cavernous-cracked porosity and good karstification have been identified as the areas with highest vulnerability (map 2.11 below). Zones of sanitary protection of springs should be singled out as exceptionally vulnerable and the same applies to sanitary protection belt around the Regional Water Supply System for Montenegrin coast, immediate zones around mineral springs, zones with peloid deposits, and zones around springs, water occurrences or water objects (illustration 2.13).

Illustration 2.13: Limestones Stari Bar (Source: Geological Institute of Montenegro)



Map 2.11: Groundwater vulnerability – joint model

2.1.8 Sea

Vulnerability assessment for the sea was primarily conducted with the **objective** to contribute to protection, preservation and improvement of the sea quality, marine biodiversity and other characteristics in line with Montenegrin legislation (Law on Environmental Protection, Law on Sea, Law on Public Maritime Domain, and others), constitutional provisions on Montenegro's development as an ecological state as well as in line with commitments accepted at ratification of the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its protocols.

Criteria used to determine importance and vulnerability of receptors in relation to water quality are shown in the table 2.6.

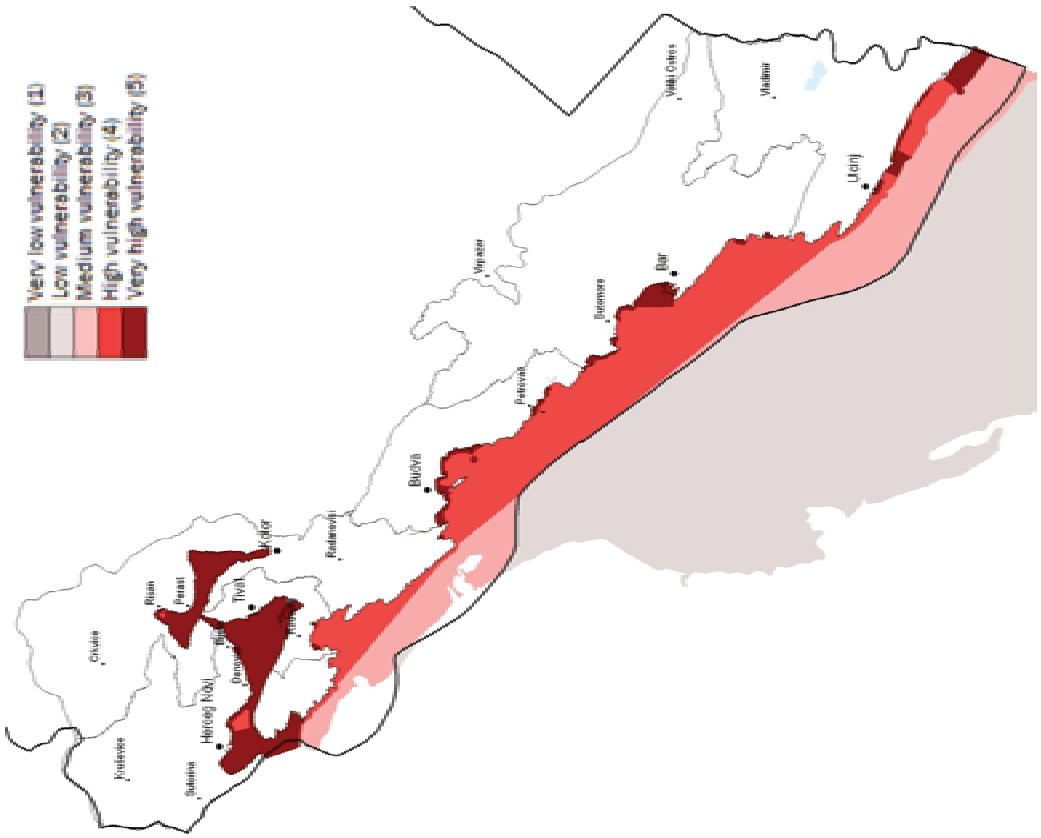
Detailed criteria on sea vulnerability, taking into account bathymetry, impact of waves, accidents and sea level changes (tide) as well as quality of the coastal sea, transitional (brackish) waters and sea water eutrophication, bathing water quality and *hot spot* locations from the aspect of marine eco-toxicology, sediment analysis and bio-indicators, having at the same time in mind wastewater impacts, are presented in the long version of the document "Assessment of general vulnerability", chapter 4.3.

Vulnerability assessment has been prepared under two scenarios: according to the model of maximum value (map 2.12) and the model of regulated average value (map 2.13). The analysis shows high **sea vulnerability** in the Bay of Boka and at open sea. Sea in the Bay of Boka is highly vulnerable, especially in the Bay's narrow part, in the section between Bijela Shipyard and Porto Montenegro harbour, as well as in Igalo bay. Given the attractiveness of the space intended for development of high quality tourism and having in mind potential impacts of pollution which in a transboundary context reaches the sea through Bojana river, possible transport of pollution by sea currents from Drač inlet in Albania as well as exceedances of beach capacities in the summer period, the most vulnerable part of the open sea in the coastal zone is limited shallow belt from Valdanos to Bojana river mouth. It should be also pointed out that the entire narrow coastal belt of the open sea and the Bay of Boka is highly vulnerable in case of accidental pollution (such as oil spills due to maritime accidents).

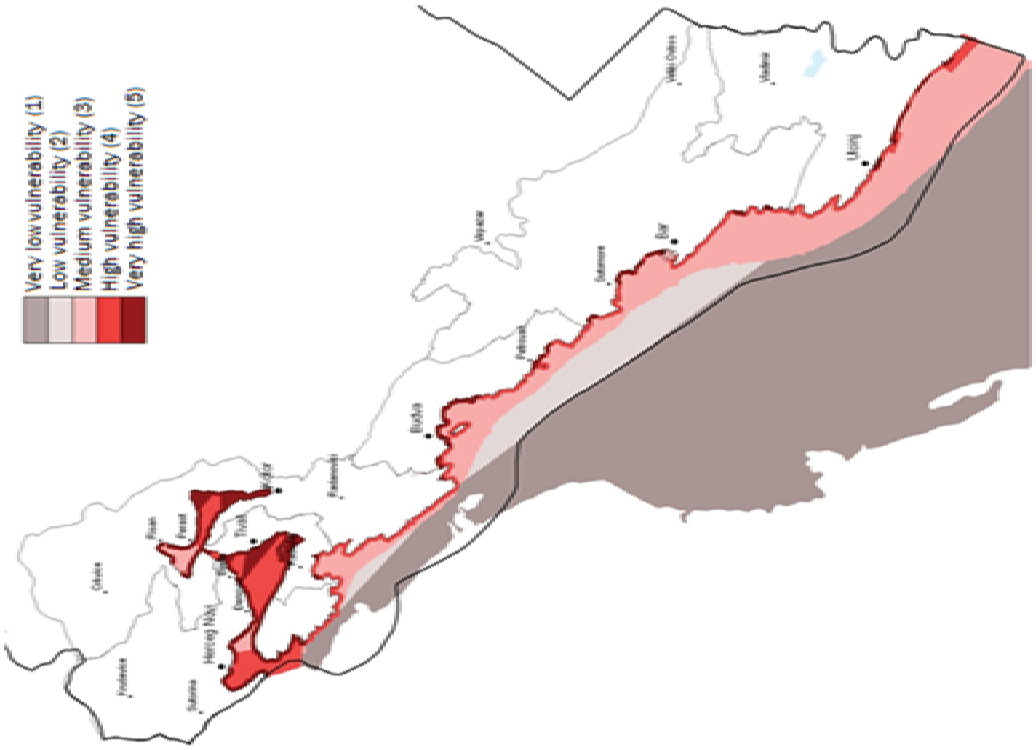
Table 2.6: Evaluation of the sea's vulnerability

Vulnerability grade		Criteria to evaluate vulnerability
1	Very low vulnerability: impact of the level of changes on the original conditions is very low or negligible	> A3 quality class or receptor of large accepting capacity* given the existing very high level of deviation from the original (natural) water status
2	Low vulnerability: impact of the level of changes on the original conditions is low	A3 water quality or receptor capable of accepting changes without significant alterations in BQ given the exiting high level of changes in the original (natural) water quality status
3	Medium vulnerability: impact of the level of changes is intermediate, and capacity for changing water quality status is low	A2, C water quality
4	High vulnerability: impact of the level of changes is high, and there is no capacity for accepting further water quality changes	A2, C, K2 water quality
5	Very high vulnerability: impact of the level of changes is very high i.e. further changes are inadmissible	A1, S, Š, K1 water quality or the existing conditions already require remediation measures

* Water quality classes prescribed under the Decree on classification and categorisation of waters (Official Gazette of Montenegro No 2/07) were used in the assessment of vulnerability and pollution.



Map 2.13: Sea vulnerability – joint model: regulated average value



Map 2.12: Sea vulnerability – joint model: maximum value

2.1.9 Landscape

Landscape vulnerability assessment was made with the **objective** to recognise the key landscape units and contribute to their long-term preservation as well as to preservation of the elements important for landscape distinctiveness. Due to a lack of data on coastal landscapes' characteristics, so called rapid assessment was applied to analyse landscape vulnerability. Furthermore, a proposal was made to prepare (in the process of spatial plan development) an expert baseline – detailed analytical elaboration including definition of landscape units, landscape valuation, definition of landscape samples and of typical landscapes.

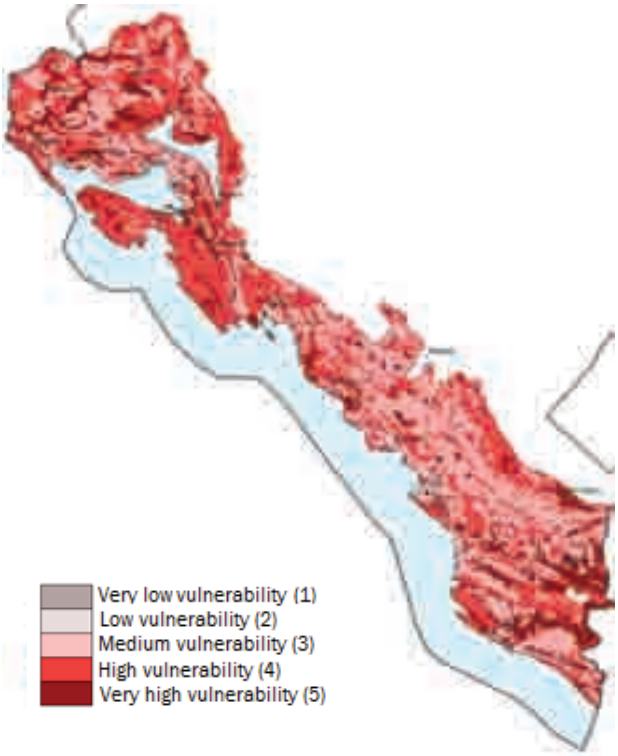
Concept of the model of landscape vulnerability is based on the approach where areas with special characteristics and major landscape diversity are considered more vulnerable (grade 5; illustration 2.14) while as areas that have already been quite degraded are considered less vulnerable (grade 1). Summarised vulnerability grades are presented in the table 2.7. Detailed evaluation of landscape vulnerability is presented in the long version of the document "Assessment of general vulnerability", chapter 6.

Table 2.7: Presentation of landscape vulnerability grades

Vulnerability grades		Criteria for vulnerability evaluation
5	Very high vulnerability	Areas of significant landscape distinctiveness and diversity with special relief forms, vegetation and traditional agricultural patterns, visibly exposed
4	High vulnerability	Areas of medium landscape distinctiveness and diversity, visibly exposed natural landscapes, grasslands
3	Medium vulnerability	Areas of minor landscape distinctiveness and diversity, forests and macchia
2	Low vulnerability	Urbanised areas with green surfaces
1	Very low vulnerability	Areas of infrastructure corridors, production activities, degraded areas

Illustration 2.14: Example of the area with high vulnerability (of unacceptable impact) – area of major landscape distinctiveness and diversity with special relief forms, vegetation and traditional agricultural pattern, visibly exposed (Dobra voda, Google Earth, 2009)

Results of landscape vulnerability model indicate relatively high vulnerability of the entire considered area, especially in relation to preserved landscapes of the hinterland as well as to major part of the coast itself (map 2.14). Sections of preserved natural coast, especially of rocky shore (e.g. near Ulcinj) and beaches whose immediate hinterland is not urbanised (e.g. Valdanos and Trsteno), areas of traditional agricultural landscape (for example, Male and Velike Gorane, area to the north and west from Šasko lake), areas of mountain landscapes (e.g. Rumija and Orjen), areas of visibly exposed cliffs (such as the ones above Kotor) and areas of interwoven naturally preserved landscapes, agricultural land and traditional village settlements (for example, northern slopes of Rumija) have all been highlighted through the **landscape vulnerability** assessment.



Map 2.14: Landscape vulnerability

2.1.10 Climate change

Vulnerability models for droughts, forest fires, strong rains and storm winds have been joined into a single model showing cumulative vulnerability to phenomena linked to climate change, climate variability and climate extremes by the principle of regulated average value by individual models as well as by relative difference in vulnerability. This served as a tool to depict those parts of space where several vulnerable areas coincide with each other for all the analysed phenomena and where larger, more complex impacts of climate change were expected to take place.

The existing state of vulnerability to climate change is depicted with areas of the highest vulnerability. Climate change impacts by scenarios are shown in a similar way.

Existing state

In a representation of the existing state of vulnerability to climate change in areas with the highest vulnerability, only the areas with grade 5 – very high vulnerability – were extracted from vulnerability models for droughts, forest fires, strong rains and storm winds. Each of the analysed phenomena was represented on its own layer; areas where individual layers overlapped were considered more vulnerable in total.

Under the existing climate conditions, differences in total impacts of droughts, forest fires, strong rains and storm winds in relation to climatological baseline 1961 – 1990 are on average ranging from 3 to 5. This means that vulnerability of the coastal region to these meteorological hazards is in the domain of medium to very high vulnerability. In order to decrease vulnerability it would be necessary to decrease exposure or sensitivity through application of special measures or by increasing adaptive capacity.

Under the existing climate conditions, the highest vulnerability to storm winds is found in Herceg Novi municipality and along north-eastern slopes of Rumija mountain. Vulnerability to forest fires is very high in Prevlaka zone and part of Luštica, as well as in a major part of southern coastal zone (from southern sides of Rumija towards coast and Bojana river valley). The largest area of very high vulnerability to droughts is found in the southern part of the coastal zone and it encompasses region from Sutomore towards Bar, Vladimir, upper flow of Bojana river (towards Skadarsko lake) and hinterland of Ulcinj. Map 2.15 contains graphic representation of the joint climate change model based on the existing conditions for areas of the highest vulnerability (grade 5).

Scenarios

Climate change impact is also shown for A1B/2001-2030, A1B/2071-2100 and A2/2071-2100 scenarios. From the climate change models for droughts, forest fires, strong rains and storm winds only areas with grades 6 or higher (meaning areas where high to exceptionally high climate change impact is expected) were extracted. Each of the analysed phenomena was shown on its own layer; areas where individual layers overlapped were considered as areas where larger/ more complex climate change impact was expected in total.

Scenario A1B/ 2001-2030

For conditions of A1B/ 2001-2030 scenario, grades 6 and higher were examined in order to single out meteorological hazards with the highest impact on the coastal region. On an annual level, droughts, forest fires and storm winds are likely to have the largest impact on Herceg Novi and Budva municipalities and on southern part of the coastal zone. Strong rains are likely to have the largest impact on parts of Kotor municipality and in Budva hinterland. Map 2.16 provides graphic representation of the joint model of climate change under A1B/ 2001-2030 scenario whereas observed areas under the highest impact of climate change on an annual level have average vulnerability grades of 6 or more.

Scenario A1B/ 2071-2100

Vulnerability of space to droughts is expected to increase for A1B/ 2071-2100 scenario in comparison to 2001-2030 period. On average, coastal region (with an exception of Kotor, Budva and Tivat) is an area where the highest impacts of droughts, forest fires and storm winds during a year are likely to occur. Map 2.17 gives graphic representation of the joint model of climate change under A1B/ 2071-2100 scenario whereas observed areas under the highest impact of climate change on an annual level have average vulnerability grades of 6 or more.

Scenario A2/ 2071-2100

Under conditions of A2/ 2071-2100 scenario, the entire coastal region is an area where the most significant impacts of droughts, forest fires and strong rains during a year are likely to occur. Strong rains would have the highest impact in the Bay of Boka hinterland and in the mountainous area towards Budva municipality. Map 2.18 gives graphic representation of the joint model of climate change under A2/ 2071-2100 scenario whereas observed areas under the highest impact of climate change on an annual level have average vulnerability grades of 6 or more.

Due to its specificities, joint model of climate change vulnerability is not directly integrated in the cumulative vulnerability scenarios – it is rather observed as a separate, especially important model that should be taken into account for any scenario of vulnerability modelling and related planning.

Map 2.15: Joint climate change model – existing state: areas of the highest vulnerability (grade 5)

Map 2.16: Joint climate change model – scenario A1B/ 2001-2030: average grades annual level – areas of the highest impacts (grade 6 or higher)

Map 2.17: Joint climate change model – scenario A1B/ 2071-2100: average grades annual level – areas of the highest impacts (grade 6 or higher)

Map 2.18: Joint climate change model – average values – scenario A2/ 2071-2100: average grades annual level – areas of the highest impacts (grade 6 or higher)

2.2 Pollution assessment

Assessment of pollution/ the level to which the environment is endangered was done as an evaluation of the areas that have already been polluted to a certain level. The assessment included analysis of pollution on land (by processing various environmental segments and significant impacts on human health) and sea. As with vulnerability assessment, all input data used for the pollution assessment were official data of line ministries and responsible administration bodies tasked with monitoring and reporting on the state of environment and achieving improvements in certain environmental segments. To evaluate the level of pollution, reference values prescribed under national and international standards relevant for the analysis of selected environmental segments and impacts on human health were used. The approach to the entire analysis was to determine vulnerability based on the existing and planned land uses, primarily starting from the given natural potential of the area, while as pollution assessment was used to determine the existing level of pollution which has an impact on the total degree of spatial vulnerability and which can be brought to prescribed (under relevant regulations) pollution levels through application of appropriate remediation measures and environmentally responsible management.

2.2.1 Assessment of pollution on land

Pollution/ the level to which the land has been endangered was assessed by evaluating segments i.e. characteristics that have direct impact on human life and health: noise, air quality and soil pollution. **General goal** was to gain an insight into the state of pollution on land as to ensure long term healthy and preserved environment, that is to provide for healthy living conditions for people in the coastal area, to preserve biodiversity, quality of air, food, drinking and bathing water, and to decrease negative impacts on human health such as noise and air and soil pollution. Pollution on land has been evaluated based on air quality (Air Quality Index – AQI), pollution of soil at *hot spot* locations and the level to which certain areas were endangered by noise (noise levels).

2.2.1.1 Noise

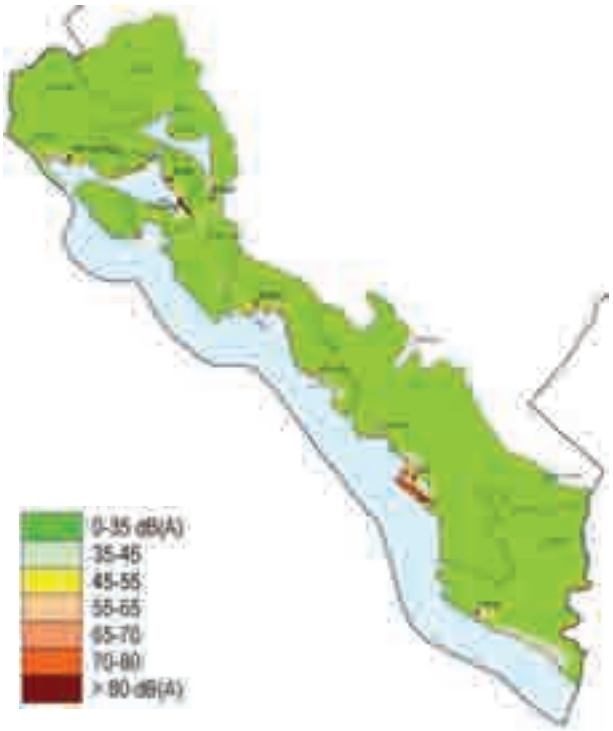
Noise pollution was evaluated based on the results of the *Programme for examining noise in the environment*. The **basic goals** of the analysis were: (i) to enable zoning of the existing levels of noise; (ii) to prepare action plans for noise management; and (iii) to plan towns, transport and other activities that contribute to noise pollution in an acoustic manner. Noise pollution was evaluated based on the results of the *Programme for examining noise in the environment* whereas sites located at significant distance from noise sources were assessed as least polluted (grade 1) and specially protected areas where limit values of permitted noise were exceeded were assessed as the most polluted (grade 5). A more detailed representation of evaluation criteria is given in the table 2.8.

Table 2.8: Evaluation of noise pollution

Pollution grade	Criteria
1	If locations are remote from noise sources and if the existing levels of noise do not have an impact on environment and human health
2	If the levels of noise are always below prescribed limit values for the set zones
3	If the levels of noise LAeq dB(A) in commercial-housing areas, tourist areas and on children's playgrounds are above 50 dB(A) during the day, 50 dB(A) in the evening and 45 dB(A) during the night
4	If the levels of noise LAeq dB(A) in tourist areas, small village settlements, camps and school zones are above 50 dB(A) during the day, 50 dB(A) in the evening and 45 dB(A) during the night
5	If the limit values LAeq dB(A) in specially protected nature areas are above 35dB(A) during the day, 30dB(A) in the evening and 30dB(A) during the night. For rest and recreation areas above 50 dB(A) during the day, 40 dB(A) in the evening and 40 dB(A) during the night

Results of the noise pollution assessment show that noise represents a significant burden especially in populated areas, on beaches that should serve for rest and recreation, and in areas around the main roads passing through settlements (grade 5). Results of the analysis especially indicate concentration of large and diverse noise burden in town settlements in Tivat, Kotor, Budva and Bar. The least endangered areas are specially protected nature areas (grade 2). In order to plan further development of towns in a proper manner, it is necessary to develop a cadastre of noise and to provide software programmes for noise mapping in municipal centres as well as for future hotel complexes and tourist settlements.

Evaluation of the extent to which the coastal zone of Montenegro is endangered by noise is graphically presented on the map 2.19 below.



Map 2.19: Noise levels – assessment of the degree to which certain areas are endangered

2.2.1.2 Air quality

Analysis of air pollution was conducted with the **aim** to:

- determine (and show) status of air pollution;
- propose measures to protect and improve air quality; and
- enable proper planning of spatial distribution of mobile emission sources, products and activities that cause air pollution.

Evaluation of air pollution was made based on air quality in relation to maximum allowed concentrations (MAC) in line with the Law on air quality (Official Gazette of the Republic of Montenegro 48/07) and Decree on determination of the type of pollutants, limit values and other air quality standards (Official Gazette of Montenegro 45/08 from 31/7/2008) which came into effect on 1/1/2010. In order to determine the levels of air vulnerability based on the ascertained levels of pollution (according to the approach outlined above), actual pollution levels were compared with standards prescribed under the new Law on air protection (Official Gazette of Montenegro no 25/10 from 5/5/2010) and the above-mentioned Decree: limit values of pollution, upper and lower limits for evaluation, tolerance thresholds, critical levels for ecosystem protection and for attaining target values set under this Law (table 2.9).

The new Law on air protection (Official Gazette of Montenegro 25/10 from 5/5/2010) requires evaluation of air quality by zones. Decree on establishment of measurement stations for air quality monitoring (Official Gazette of Montenegro 44/2010) initially determined only one measurement station – in Bar – for the entire coastal region or 'southern zone', and as of 2012, another one in Tivat.

Table 2.9: Air quality evaluation

Pollution grade	Criteria
1	Air quality in protected, environmentally sensitive zones of cultural and natural heritage, clean unpolluted air (R) where pollution limit values are not exceeded
2	Air quality of suburban settlements and city zones without traffic (UB) Purely housing areas, major city parks; beaches, hospital zones, tourist areas
3	Air quality in city areas (U, UT) Commercial-housing areas, tourist locations, children's playgrounds, city centres, crafts, trade, and administrative zones with housing units in settlements
4	Zones around mobile sources of air pollution – impact of transport (T) Zones next to city transport routes, main roads and highways, city crossroads
5	Air quality in industrial zones (I) Industrial, warehousing and service areas, transport terminals without housing structures and the most frequented crossroads, chemical industry

Since this approach does not provide for the necessary level of detail for coastal zone vulnerability assessment, target values defined under air quality monitoring programmes conducted until 2009 were taken as a point of reference to evaluate air pollution from the aspect of impacts on population's health and conditions of ecosystems, taking into account different land uses. Having in mind compatibility of national regulations from that time with World Health Organisation (WHO) recommendations, for the evaluation of air quality from the aspect of impacts on human health, Air Quality Index (AQI) used by the US EPA (American Environmental Protection Agency) was also taken into account in addition to the above mentioned criteria.

Air quality was evaluated based on the data on mean and maximum annual values for SO_2, NO_2 (NO_x), O_3 and PM_{10} in line with the US EPA guidelines. This evaluation based on the criteria of impacts on human health and application of AQI (Air Quality Index) showed that air quality was **satisfactory** in all the coastal towns where monitoring stations were located in 2009, except for Igalo station where measurements showed **good** air quality, meaning that air quality met prescribed standards for all the parameters. Other towns did not meet conditions for good air quality due to increased concentrations of particulate matter with diameter of less than 10 micrometres – PM_{10}, which has a highly negative impact on human health. In order to improve air quality, the most important planning measure in preparing the Special purpose spatial plan for the coastal zone of Montenegro should be dislocation of the main roads outside the settlements and construction of bypasses around towns, especially for Kotor and Budva which are the most endangered locations when it comes to air quality.

2.2.1.3 Soil pollution

Evaluation of soil pollution was done based on the results of soil analyses gathered through implementation of the *Monitoring programme for soil pollution in Montenegro* which is being carried out since 1998. **General goal** of the analysis was to provide for healthy, unpolluted and preserved environment in order to ensure healthy human lives and maintain biodiversity. Impact of pollution at locations where monitoring programme was executed was graded on a scale of 1 – 5, whereas the lowest grade was assigned to soils that are not polluted or where the impact of pollution to these soils is negligible. Maximum grade of 5 was ascribed to soils with inadmissible/ unacceptable pollution (table 2.10).

Table 2.10: Evaluation of soil pollution

Pollution grade	Criteria
1	Locations at beaches, national parks, locations without impact on groundwater, sea, air quality and human health
2	Non-arable land, forests, park areas, locations at arable land with organic agriculture
3	Surroundings of industrial zones, quarries, construction materials warehouses, zones around main and other transport routes at a distance of more than 100 m
4	Soil in the immediate vicinity of waste disposal sites, car services, industrial waste disposal sites, transformer stations where contamination with PCBs exists, disposal sites for sewage sludge and others. Zones in the immediate vicinity of transport routes
5	Locations of municipal and unregulated waste disposal sites, warehouses of dangerous substances (agricultural fertilizers and pesticides), decanting locations for petrol and used oils, waste disposal sites for grit and other dangerous substances. Zones besides highways and frequented main roads

The analysis showed that some locations, mainly town waste disposal sites in Herceg Novi, Bar, Tivat, Kotor and Ulcinj municipalities were polluted with dangerous and harmful inorganic and organic substances. Particularly problematic are disposal sites that are no longer in use but were not rehabilitated properly. A significant problem is pollution caused by activities in Bijela Shipyard and Port of Bar, as well as consequences of pollution caused by activities of the former Overhaul Institute in Tivat. For further work it is very important to re-examine existing and proposed solutions for disposal and treatment of communal and industrial waste in the coastal zone, analysing in particular possibilities for application of more modern and rational solutions.

2.2.2 Assessment of marine pollution

Basic goal of the assessment of pollution/ the extent to which the sea in Montenegro is endangered was protection, preservation and improvement of the sea quality, marine biodiversity and other characteristics in line with Montenegrin legislation, constitutional provisions on Montenegro's development as an ecological state as well as in line with commitments accepted at ratification of the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its protocols. Results of the assessment conducted within CAMP Montenegro will be used for preparation of the National strategy for integrated coastal zone management.

Marine pollution was analysed based on bathing water quality, eco-toxicology of the sea, marine pollution at *hot spot* locations and pollution with wastewater – all according to criteria of the magnitude of impact/ pollution which can be very low (1), low (2), medium (3), high (4) and inadmissible (5) (table 2.11).

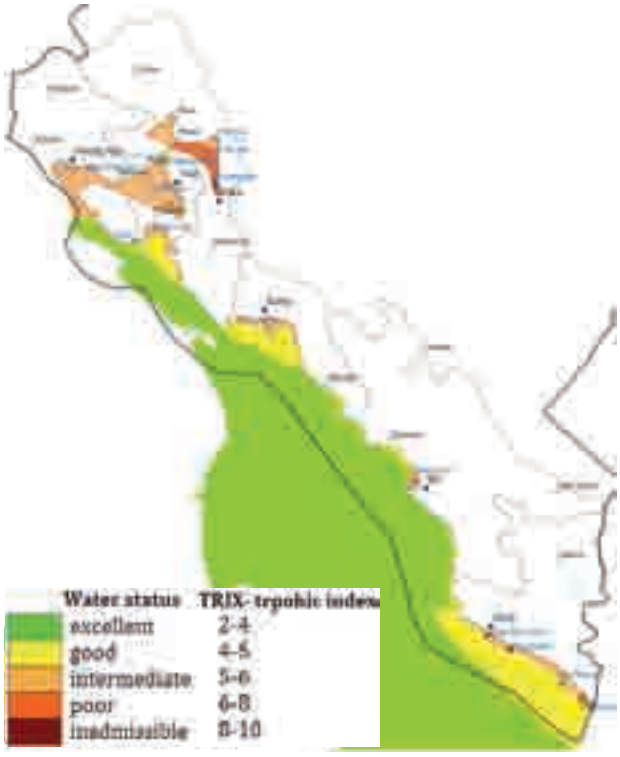
Table 2.11: Evaluation of the level of pollution

1	Very low level of pollution – no impact or negligible impact of pollution	Water quality classes A1,S,Š,K1
2	Low level of pollution – impact of pollution is low, changes will probably generate an impact in a short period of time	Water quality A2,C,K2
3	Medium level of pollution – impact of pollution is moderate and capacity for water quality status change is small	Water quality A2
4	High level of pollution – impact of pollution is high, whereas there is no capacity for further changes in water quality	Water quality A3
5	Very high pollution: impact of pollution is very high i.e. further water quality changes are inadmissible	> A3 quality classes

The basis for the assessment of vulnerability and pollution of Montenegrin coastal sea waters was data on its quality gathered through the implementation of the *Monitoring programme for the state of ecosystem of the coastal sea of Montenegro*, in line with water classification prescribed under the Decree on classification and categorisation of waters (Official Gazette of Montenegro 2/07).

2.2.2.1 Quality of the coastal sea

Most of the time during a year, quality of the coastal sea is in A1 or A2 classes; an exception is period July – October when the coastal sea quality is in A2 – A3 classes or falls outside of these classes. Obtained results indicate that problem of communal wastewater discharges needs to be resolved urgently, or in other words that wastewater has to be treated before discharging into natural recipient. The biggest problem for sea water quality is marine eutrophication or high content of nutrients (NO_2, NO_3, NH_4, PO_4) that fluctuates during a year.



Map 2.20: Pollution of the coastal sea from eutrophication aspect and in relation to TRX index values (with locations for the sea water quality monitoring)

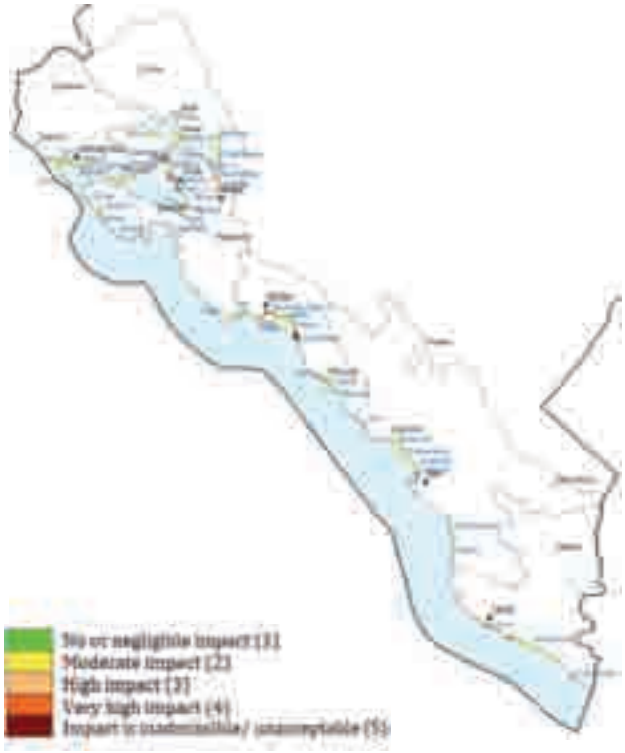
Assessment of water quality based on the values of TRIX index (map 2.20) shows that on locations outside the Bay of Boka water has **good – intermediate** quality, except in Ulcinj at Mala beach and Port Milena where **poor** water quality prevails. Water quality in the Bay of Boka is **intermediate – poor**, especially at Marine Biology Institute (IBM) location in Kotor Bay. The reason is high content of nutrients and chlorophyll.

2.2.2.2 Bathing water quality

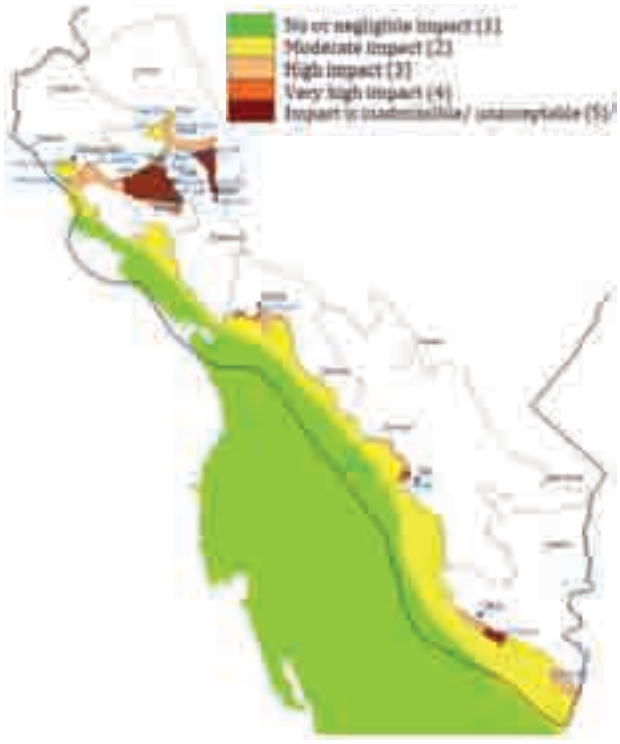
Water (sanitary) quality should be kept in mind as a factor that affects bathers' health; the area considered is a narrow zone of the coastal sea used for swimming (up to 50 m from the shore). Discharges of communal wastewater as well as streams with constant flows used for the same purpose (that is as wastewater recipients) have the most significant impact in this zone. Pollution/ the level to which the sea water is endangered was evaluated on a scale 1 – 5, whereas the lowest grade of 1 was assigned to beaches that do not have any local pollution sources in their vicinity and the highest grade of 5 was given for beaches that are occasionally under influence of accidental discharges, beaches affected by potential unidentified discharges from facilities located at the very sea shore as well as those under influence of current construction works at the coast (map 2.21).

2.2.2.3 Marine eco-toxicology

Pollution/ the extent to which the sea is endangered at *hot spot* locations from eco-toxicology aspect has been determined based on the data from the *Monitoring programme on the state of marine ecosystem in Montenegro* (MEDPOL program) which is continuously conducted since 2008. Having in mind requirements of the European Environment Agency (EEA), Barcelona Convention and LBS and ICZM Protocols, MEDPOL program is based on an assessment of the state of marine biodiversity through the analysis of biological and chemical pollution indicators. The aim of the programme



Map 2.21: Pollution/ the extent to which bathing water is endangered



Map 2.22: Pollution/ the extent to which the sea is endangered at *hot spot* locations from the aspect of marine eco-toxicology

is to determine ecological status of marine ecosystem and to allow for planning of measures to decrease pressures on the living world of the sea. It should be pointed out that majority of pollutants are of persistent nature and tend to bio-accumulate in biological materials.

Based on the assessment of pollution/ the extent to which marine ecosystem is endangered at *hot spot* locations from eco-toxicology aspect, grades were derived on the extent to which marine ecosystem is currently endangered at observed locations taking the data on the level of pollution gathered through the MEDPOL program in Montenegro as a starting point. Assessment done in this way is a guideline for planning the remediation measures needed to achieve desired state of marine ecosystems. Evaluation of pollution at observed locations is in line with criteria prescribed under the Decree on classification and categorisation of waters.

Pollution/ the extent to which the sea is endangered at *hot spot* locations from eco-toxicology aspect is shown on the map 2.22:

2.2.2.4 Hot spot locations – sediments and bio-indicators

Pollution/ the extent to which the sea is endangered at *hot spot* locations from the aspect of sediments analysis provides information on the absorption capacity of marine ecosystem at observed locations in relation to impacts that can lead to further pollution accumulation in sediments at observed sites. There are no regulations on sediments quality in Montenegro, therefore international standards regulating impacts of sediments on human health and ecosystem were applied in the assessment of sediment quality.

Sediment quality to a large extent affects quality of sea water as well as bio-accumulation of dangerous substances from sediment into shells and other biological organisms. Furthermore, sediments migrate due to sea waves and currents (around 3.5 m/s), and passing of ships, so pollution is spread in a relatively easy way. Of

special importance is bio-accumulation in shells at shell fish farming sites near *hot spot* locations: Shipyard Bijela, location of the former Overhaul Institute "Arsenal" in Tivat Bay, and Kotor Bay, where pollution impacts and the extent to which the sea is endangered have been assessed as inadmissible/ unacceptable (grade 5).

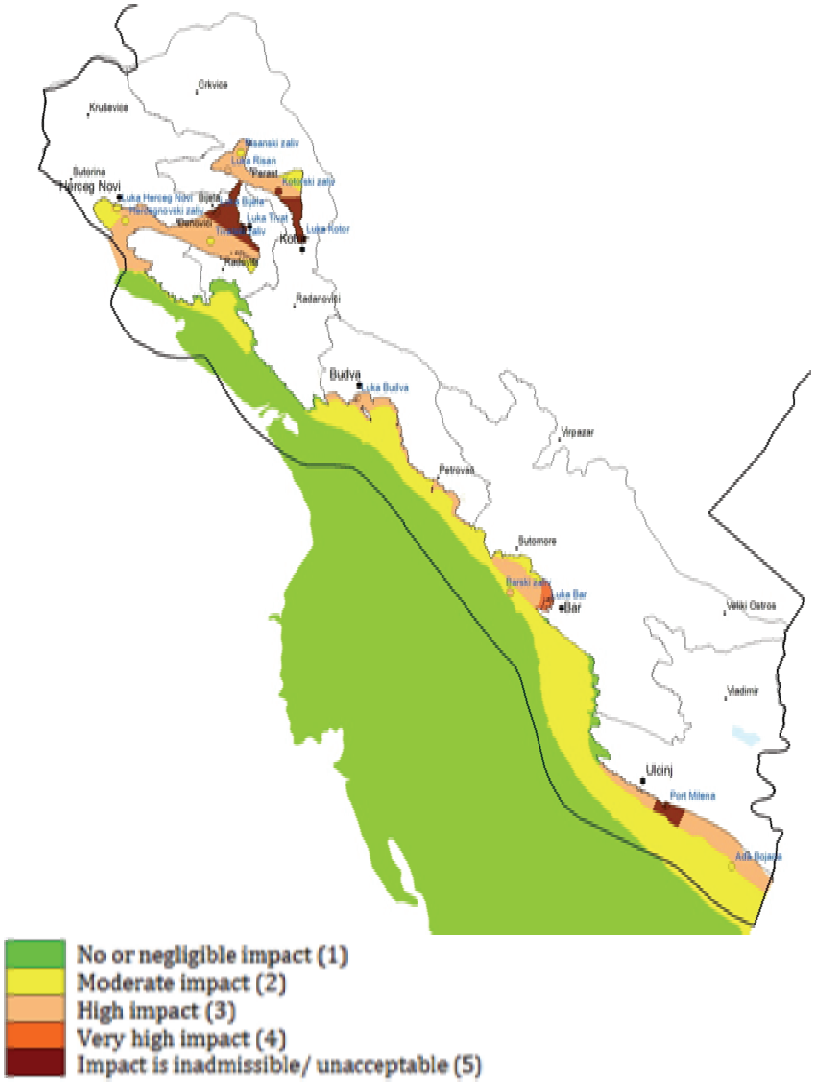
For the evaluation of marine environment from the aspect of the analysis of toxicological pollution for bio-indicators it is necessary to apply EU regulations setting the standards for maximum allowed concentrations of toxic substances. Table 2.12 provides summary information on pollution at locations where (in order to enable easy overview of the impacts sea and sediments quality have on the quality of bio-indicators) samples for all three media were taken at the same places.

Pollution/ the extent to which the sea is endangered at *hot spot* locations from the aspect of eco-toxicological analysis of pollution in bio-indicators and sediments is graphically shown on the maps 2.23 and 2.24. respectively.

Table 2.12: Comparative overview of marine ecosystem pollution at *hot spot* locations

No	SEDIMENT	SEA	SEDIMENT	BIO-INDICATOR		COMMENT
	Location	Pollution grade	Pollution grade	Vulnerability grade	Pollution grade	
1	Bar Bay 1 nmi from the shore	2	1	3	1	Red mullet – *Mullus barbatus*
2	Dobrota – Marine Biology Institute Bay	3	5	5	5	Mussels – *Mytilus galloprovincialis*
3	Port of Bar	4	4	5	5	„
4	Port of Kotor	5	5	5	5	„
5	Port of Herceg Novi	2	2	4	4	„
6	Port of Tivat – Porto Montenegro	5	5	5	5	„
7	Port of Risan	3	3	4	3	„
8	Shipyard Bijela	5	5	5	5	„
9	Ada Bojana	3	2	5	2	Red mullet – *Mullus barbatus*
10	Orahovac – Kotor Bay	3	-	5	1	
11	Saltpans – Tivat Bay	-	-	5	1	Mussels – *Mytilus galloprovincialis*

Map 2.23: Pollution/ the extent to which the sea is endangered at *hot spot* locations from the aspect of bio-indicators analysis

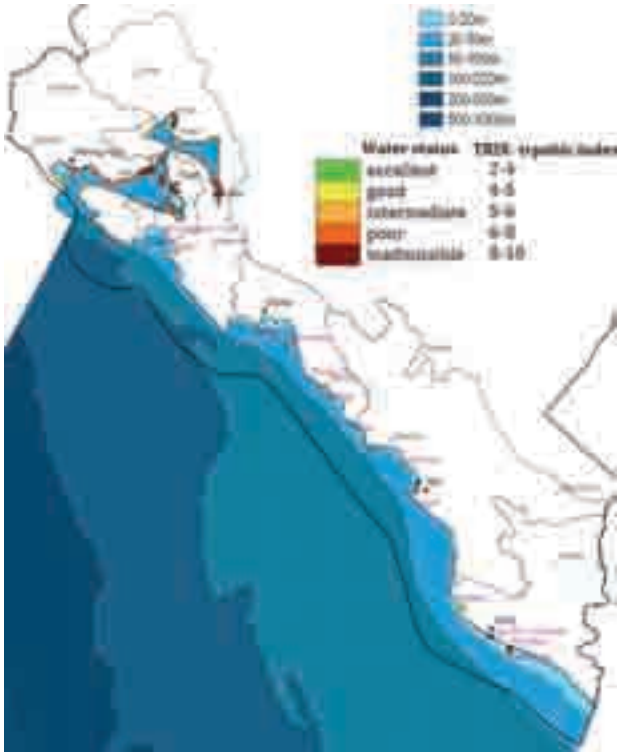


Map 2.24: Pollution/ the extent to which the sea is endangered at *hot spot* locations from the aspect of sediment analysis

2.2.2.5 Wastewater

Results of wastewater analysis based on the samples taken at all main sewage dischargers show that wastewater quality is outside the conditions prescribed under the Rulebook on quality and sanitary-technical conditions for discharging wastewater into natural recipient and public sewage network, and on ways and procedures for wastewater quality surveying, minimum number of tests and content of reports on established wastewater quality. From pollution aspect it is necessary to plan for remediation measures in Bijela Shipyard. The same applies to sediments in the Port of Tivat (former Overhaul Institute "Arsenal") which has a proven negative impact on the quality of sea and bio-indicators.

Assessment of pollution/ the extent to which the sea is endangered due to wastewater discharges is presented in a graphical way on the map 2.25:



Map 2.25: The extent to which the sea is endangered/ polluted due to wastewater discharges (with position of dischargers)

3.
Cumulative vulnerability and pollution

Preparation of cumulative vulnerability and pollution models represents a synthesis of the analysis of general vulnerability. It entailed joining (overlapping) of individual and/ or joint models prepared for specific environmental segments. Overall assessment was done in several ways, each of which contained specific information and corresponded with various environmental protection scenarios. The following models have been prepared:

1. Model of cumulative vulnerability by the principle of maximum value;
2. Model of cumulative vulnerability by the principle of regulated average value;
3. Model of cumulative vulnerability of natural characteristics by the principle of direct valuation of the most significant elements of environment for individual segments, such as:
   - model of pronounced protection of the most significant environmental segments, and
   - model of the lowest acceptable level of protection of environmental segments – legally prescribed necessary level of protection;
4. Model of total pollution/ the extent to which the environment is endangered for:
   - environment and human health, and
   - sea;
5. Model of accidents;
6. Climate model.

Models of cumulative vulnerability by the principle of maximum value and by the principle of regulated average value have been prepared with integration of all individual models except for climate/ climate change vulnerability. Climate i.e. climate change vulnerability was not included in the overall models due to its specificity. In this case vulnerability comes from natural characteristics or changes, while as for other environmental segments it comes from potential impacts of interventions or land use changes. Climate i.e. climate change vulnerability assessment can be observed as a separate (additional) model in the assessment of general vulnerability (see chapter 2.10 of the long version of the document). Accidents can be also seen as a separate conclusion i.e. segment since vulnerability to accidents does not come from vulnerability to interventions or land use changes but from probability of accidents happening (see chapter C 5 of the long version of the document "Assessment of general vulnerability").

Other cumulative models have been prepared by using completed considerations of specific environmental segments:

- overall analysis of natural characteristics was processed in the cumulative model by the principle of direct valuation of the most significant elements;
- overall analysis of environment and human health was shown in the total model of pollution/ the level to which the environment is endangered which depicts those parts of space where environmental remediation needs to be implemented (for hot spot locations and other sources of pollution) to decrease negative impacts on environment and human health;
- overall analysis of the sea was shown in the total model of pollution/ the level to which the sea is endangered which depicts those parts of space where remediation for *hot spot* locations needs to be undertaken to decrease negative impacts on marine ecosystems, including activities linked to using the sea (such as mariculture, tourism) and activities that indirectly make pressures on environment and human health.

Scheme for joining different models is shown in the table 3.1.

Table 3.1: Scheme for joining individual models into models of cumulative vulnerability and pollution

Models by environmental segments	Cumulative vulnerability – principle of maximum value	Cumulat. vulnerability – principle of regulated average value	Vulnerability of natural characteristics – pronounced protection	Vulnerability of natural characteristics – lowest level of acceptable protection	Total pollution/ the level to which environment is endangered	Accidents	Climate
1. Environment and human health							
1.1 Noise	■	■			■		
1.2 Air pollution	■	■			■		
1.3 Soil pollution	■	■			■		
2. Flora and fauna							
2.1 Flora and fauna	■	■	■	■			
2.2 Nature protected areas	■	■	■	■			
2.3 Marine biodiversity	■	■	■	■			
a) Concept 1		■		■			
b) Concept 2	■		■				
3. Soil							
3.1 Erosion		■	■				
3.2 Agriculture and agricultural land	■	■	■	■			
3.3 Seismic vulnerability	■	■	■	■			
4. Water							
4.1 Terrestrial surface waters	■	■	■	■			
4.2 Groundwater	■	■	■	■			
4.3 Sea	■	■					
a) Bathymetry	■	■					
b) Waves	■	■					
c) Accidents	■	■				■	
c) Sea level changes (tide)	■	■					
e) Quality of the coastal sea	■	■			■		
f) Bathing water quality	■	■			■		
g) *Hot spot* locations – sea	■	■			■		
h) *Hot spot* locations – sediments	■	■			■		
i) *Hot spot* locations – bio-indicators	■	■			■		
j) Wastewater	■	■			■		
4.4 Floods	■	■	■	■			
5. Climate, climate change							
5.1 Droughts							■
5.2 Forest fires							■
5.3 Strong rains							■
5.4 Storm winds							■
6. Landscape							
6. Landscape	■	■	■				

3.1 Cumulative vulnerability

Model of cumulative vulnerability was calculated by the principles of:

- maximum value;
- regulated average value; and
- direct valuation of the most significant elements of the environment.

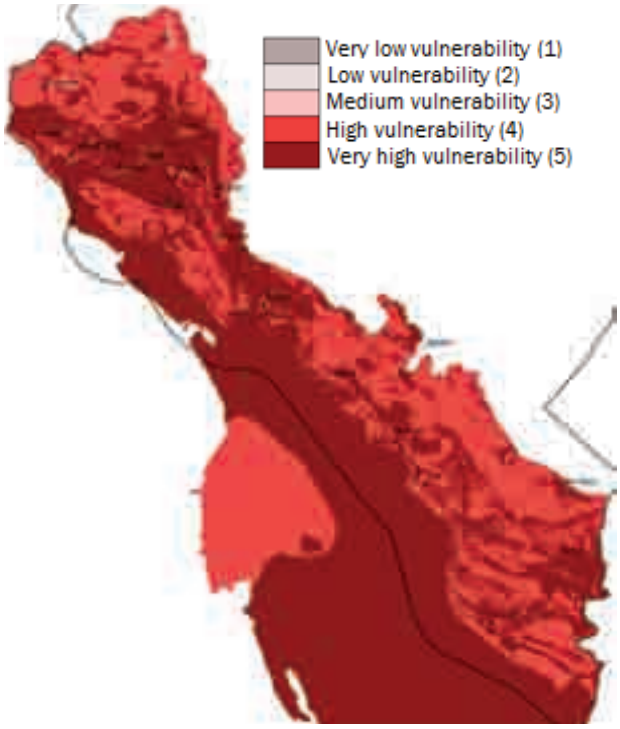
It is however necessary to emphasise that all the combinations are not exhausted by calculating cumulative vulnerability on the basis of these three principles.

3.1.1 The principle of maximum value

According to the principle of maximum value, final value of cumulative vulnerability of each spatial unit (individual cell) is equal to the highest vulnerability obtained in individual models for the same spatial unit. Model of cumulative vulnerability by this principle incorporates all the individual vulnerability models except for the climate one. Even though results obtained in this way are less usable for development of spatial plans because they do not provide for differences in valuation of space that are large enough/ significant, this approach to representing vulnerability is important as it matches scenario of maximum protection which corresponds with constitutional provisions of Montenegro as an ecological state.

Results of the coastal zone's assessment by the principle of maximum value point out to exceptionally high vulnerability of the entire coastal area whereas at least one environmental segment is assessed as having very high vulnerability (grade 5) or high vulnerability (grade 4). This result draws attention to the fact that the concept of sustainable spatial planning, accepted through the adoption of a sequence of relevant national-level strategic documents and sectoral strategies and policies, is fully justified, as well as to the very pronounced probability of conflicts between the concept of sustainable spatial planning and development interests.

Cumulative vulnerability of space by the principle of maximum value is presented on the map 3.1.



Map 3.1: Cumulative vulnerability by the principle of maximum value

3.1.2 The principle of regulated average value

Model of cumulative vulnerability by the principle of regulated average value incorporates all the individual vulnerability models whereas some of them have been previously grouped into joint models comprising individual models by certain topics. In order to prepare joint models by segments, expert evaluation of individual models was performed in a way where each individual model had equal value within joint model for the observed segment, or different values were associated with individual models. In order to prepare model of cumulative vulnerability according to this principle, it was necessary to perform additional valuation of

selected individual and joint models in relation to cumulative vulnerability model. As this kind of valuation should be a result of transparent and objective work, it was done through a survey among members of the expert team. Experts expressed importance of the given sub-model in the model of cumulative vulnerability in a numerical way by using evaluation scale of 1-2.

In the table 3.2, the evaluation principle that was applied at preparation of joint models by different segments is given in the second column. Importance of the given model in the joint one for segments where joint models were done by the principle of regulated average value is given in the third column.

Principle of regulated average value is primarily significant as it offers possibilities to show relative differences in vulnerability of individual parts of space thus enabling optimisation of planned interventions i.e. land uses. Interventions should be directed to those parts of space with lower frequency of more vulnerable elements of the environment.

Cumulative spatial vulnerability by the principle of regulated average value for terrestrial part of the coastal zone is graphically presented on the map 3.2, while as cumulative vulnerability of the sea by the same principle is shown on the map 3.3.

Table 3.2: Application of the principle of regulated average value and its weight in the model of cumulative vulnerability

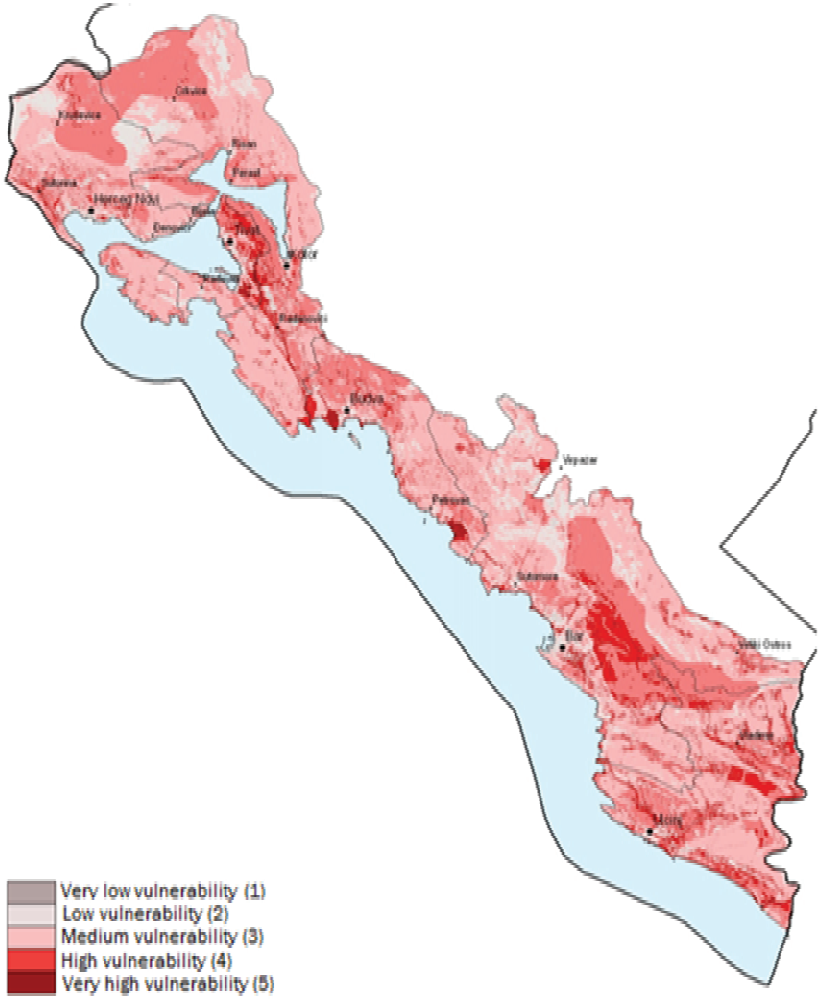
Basic model	Manner in which the joint model was prepared	Importance of the principle of regulated average value in the joint model by segments	Segments of the model used in the joint vulnerability model	Importance of the applied principle in the joint vulnerability model
Environment and human health				
Noise	Principle of regulated average value	1.75	Noise	1.25
Air pollution		2	Air pollution	1.5
Soil pollution		1.5	Pollution of soil at *hot spot* locations	1
Flora and fauna				
Flora and fauna	Principle of maximum value	-	Flora and fauna	2
Protected areas of nature			Protected areas of nature	1.5
Marine biodiversity			Marine biodiversity – Concept 1	*
Soil				
Erosion	-	-	Segment was not used in the joint model**	-
Agriculture and agricultural land	-	-	Agriculture and agricultural land	2
Seismic vulnerability a) Seismic categorisation of space b) Engineering-geological (E-G) categorisation c) Slope	Grades determined based on a combination of grades	-	Seismic hazard (combination of slope, seismic and E-G categorisation)	2

Basic model	Manner in which the joint model was prepared	Importance of the principle of regulated average value in the joint model by segments	Segments of the model used in the joint vulnerability model	Importance of the applied principle in the joint vulnerability model
Water				
Terrestrial surface waters a) Characteristics of surface waters b) Quality of surface waters	Grades determined based on a combination of grades	-	Joint model for terrestrial surface water	1.5
Groundwater a) Hydro-geological characteristics of rocks b) Zones of sanitary protection and springs	Grades determined based on a combination of grades	-	Joint model for groundwater	2
Sea	Principle of regulated average value		4.3 Joint model for the sea	*
a) Bathymetry		1.75		
b) Waves		2		
c) Accidents		1.5		
d) Sea changes (tide)		1.25		
e) Coastal sea quality		2		
f) Bathing water quality		1.75		
g) *Hot spot* locations- sea		1.25		
h) *Hot spot* locations- sediments		1.5		
i) *Hot spot* locations- bio-indicators		1.25		
j) Wastewater		1.75		
Climate, climate change				
Droughts	Grades determined based on a combination of grades	-	Segment was not used in the joint model ***	-
Forest fires				
Strong rains				
Storm winds				
Landscape				
Landscape	-		Landscape	2

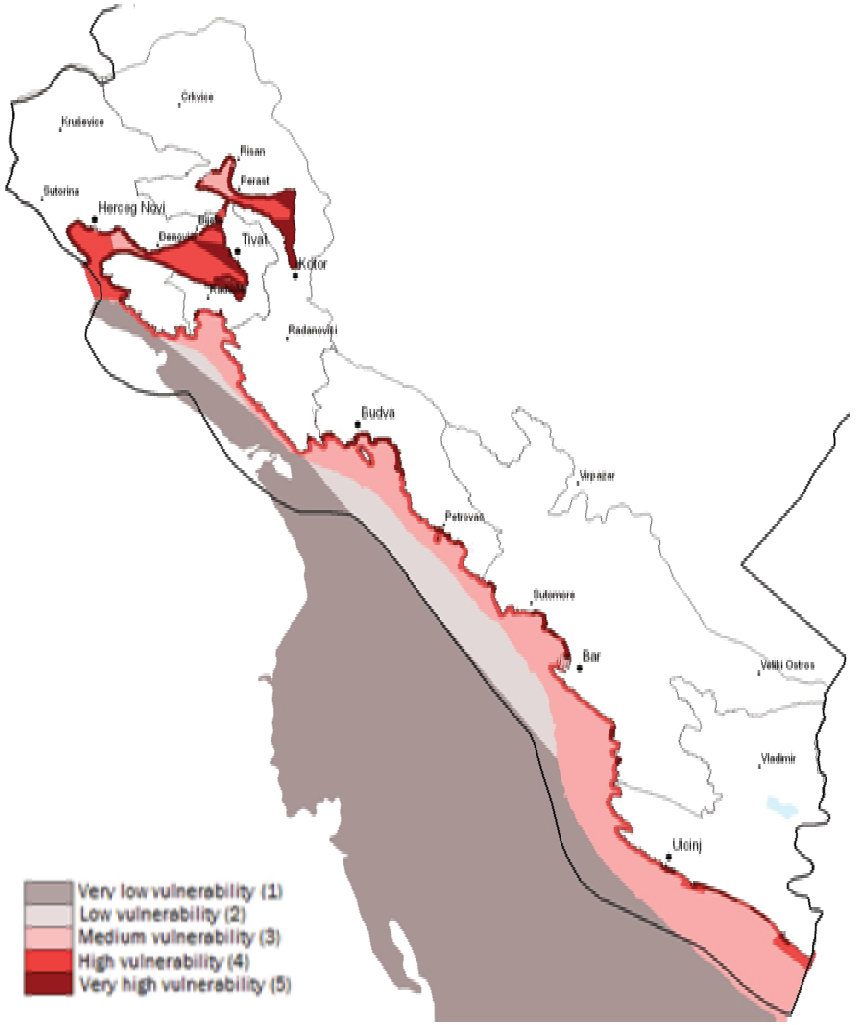
* Vulnerability of marine biodiversity – concept 1 and joint vulnerability model for the sea were joined by the principle of maximum value given the fact that reliable data on marine biodiversity was not available for the same spatial scope that has been analysed for the preparation of joint vulnerability model for the sea; for this reason, average grade would not be relevant.

** Vulnerability due to erosion was not used in the model since it did not entail entire coastal zone but only the areas of significant river catchments – average grade would not be relevant.

*** See introductory explanation.



Map 3.2: Cumulative vulnerability
by the principle of regulated average value for land



Map 3.3: Cumulative vulnerability
by the principle of regulated average value for the sea

3.1.3 The principle of direct valuation of the most significant environmental segments

The model has been prepared for two scenarios:

- model of pronounced protection of the most significant elements (legally protected and areas of very high – grade 5, and high – grade 4, vulnerability) by individual environmental segments; and
- model of the lowest acceptable level of protection of environmental segments – legally prescribed necessary level of protection based on the fact that elements/ environmental segments which are protected under the law can be defined as significant.

Model was prepared by the principle of maximum value, whereas significance of segments/ environmental elements was determined directly through the grades assigned in the matrix. Principle of direct valuation of the most significant environmental segments is shown in the table 3.3. below.

Table 3.3: Application of the principle of direct valuation of the most significant environmental elements

Segment	Categories	Model of pronounced protection of the most significant elements/ segments	Model of the lowest level of acceptable protection of elements/ segments
Life and health	*	-	-
Flora and fauna	Protected plant species	5	4
	Areas of very high vulnerability (5) from the joint vulnerability model for flora and fauna and for protected areas	5	-
	Areas of high vulnerability (4) from flora and fauna vulnerability model	3	-
	Special nature reserves	5	5
	National park	4	4
	Monument of nature	3	3
	Landscape with exceptional features	3	3
	Areas protected through municipal decisions	3	3
	Protected dendrological object	5	4
	National park (potential)	4	4
	Regional park (potential)	4	4
	Monument of nature (potential)	3	3
	Areas of very high vulnerability (5) from the model on marine biodiversity vulnerability – Concept 2	5	-
	Areas of high vulnerability (4) from the model on marine biodiversity vulnerability – Concept 2	4	-
	Areas of very high vulnerability (5) from the model on marine biodiversity vulnerability – Concept 1	-	5
Erosion	Category I – excessive/extreme erosion	3	-
	Category I ab, excessive erosion – abrasion	3	-
	Category II, strong erosion	2	-
Agricultural surfaces	Areas of very high vulnerability (5) from the vulnerability model	5	3
	Areas of high vulnerability (4) from the vulnerability model	4	2
Seismic vulnerability	Index 5 – areas of very high vulnerability from the vulnerability model	5	5
	Index 4 – areas of high vulnerability from the vulnerability model	4	2

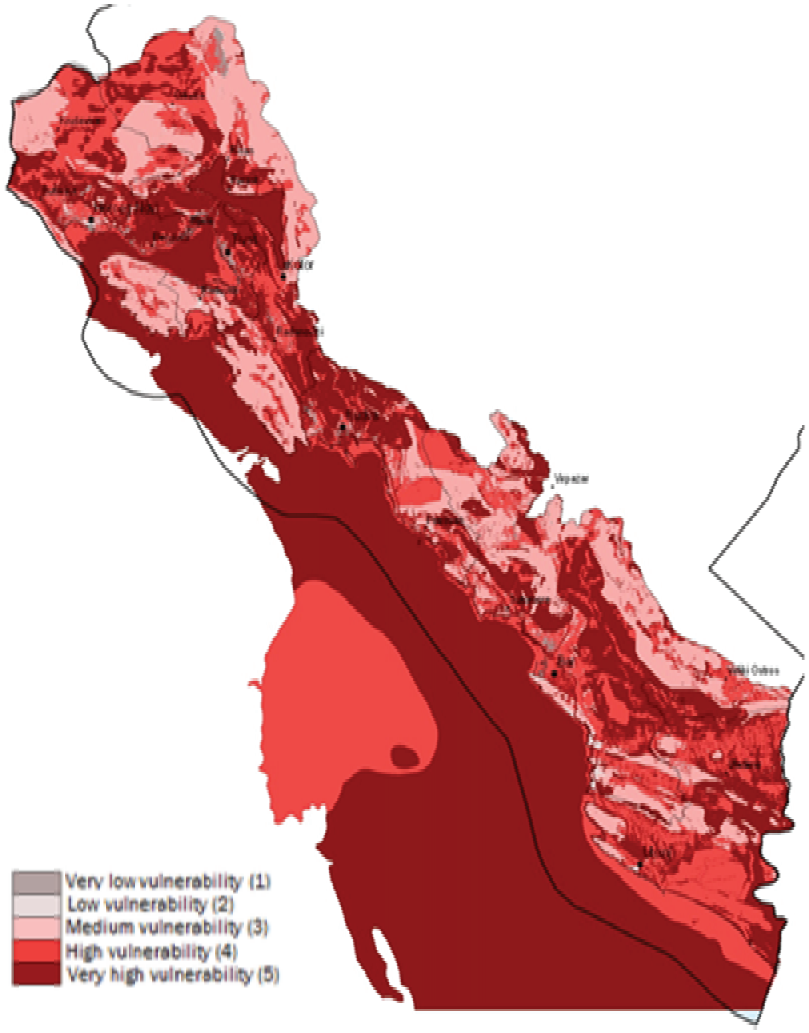
Segment	Categories	Model of pronounced protection of the most significant elements/ segments	Model of the lowest level of acceptable protection of elements/ segments
Surface waters	Permanent watercourses and significant occasional watercourses	5	5
	Occasional watercourses	4	3
	Šasko lake	5	5
	Skadarsko lake	4	4
Groundwater	Zone of supervision – III protection zone (wider protection zone)	3	3
	Zone of limited protection regime – II protection zone (narrower protection zone)	4	4
	Zone of strict protection regime – I protection zone (zone of direct protection)	5	5
	Sanitary protection belt (pipelines belt)	5	5
	Zone of mineral springs	5	3
	Zone of peloid deposits	5	3
	Carbonate rocks of cavernous-cracked porosity and good karstification	2	-
Sea	*	-	-
Floods	Areas of very high vulnerability (5) from the vulnerability model	5	4
	Areas of high vulnerability (3) from the vulnerability model	3	2
Climate	*	-	-
Landscape	Areas of very high vulnerability (5) from the vulnerability model	4	-
	Areas of high vulnerability (4) from the vulnerability model	3	-

Model of pronounced protection of the most significant environmental segments

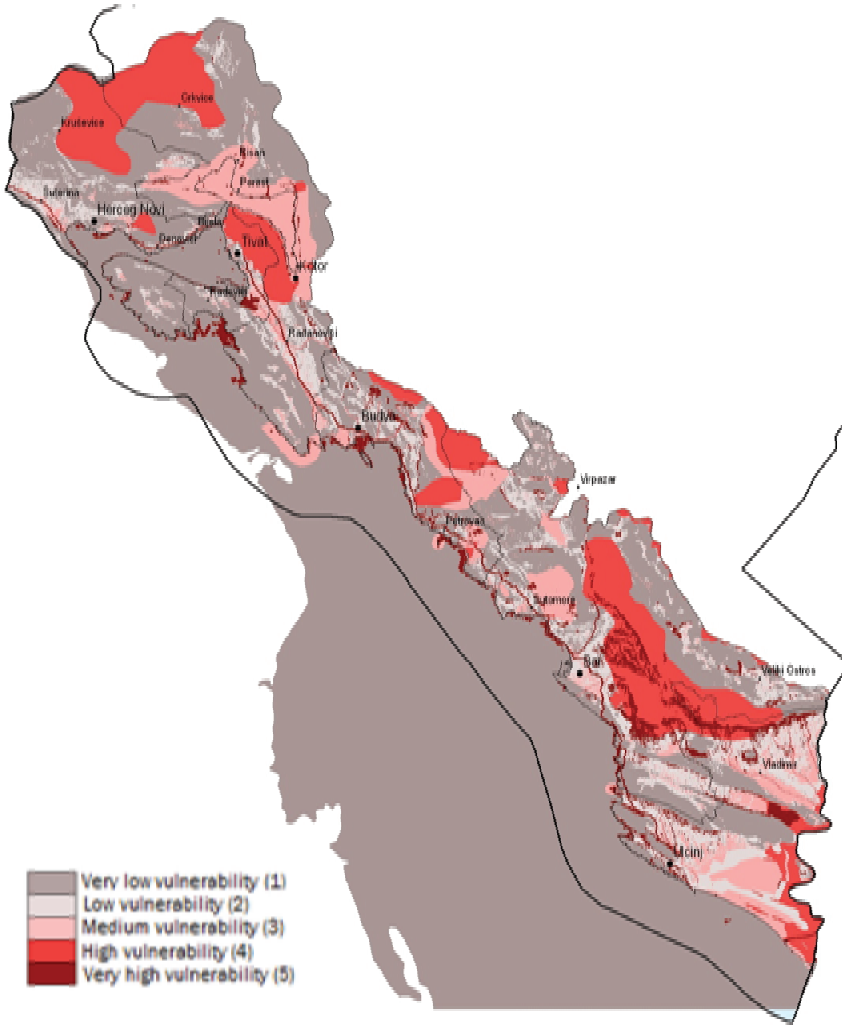
Model of pronounced protection of the most significant elements/ environmental segments matches protection scenarios of spatial development, but unlike the model of cumulative vulnerability under the principle of maximum value it enables definition of relative differences between certain parts of space. In this way a large manoeuvring space is gained for harmonisation of protection and development goals i.e. for identification of those parts of space where in case of an intervention or land use change impact would be significant but still acceptable. Cumulative spatial vulnerability by the principle of direct valuation of the most significant environmental elements based on the model of pronounced protection is graphically presented on the map 3.4.

Model of the lowest level of acceptable protection of environmental segments

Model of the lowest level of acceptable protection of environmental elements/ segments calls attention only to those parts of space that are protected under relevant regulations. This model, which in fact represents a contrast point to the model of cumulative vulnerability by the principle of maximum value, should be taken into account cautiously, just as an ultimate situation. Cumulative vulnerability of space by the principle of direct valuation of the most significant elements of the environment based on the model of the lowest level of acceptable protections is graphically presented on the map 3.5.



Map 3.4: Cumulative vulnerability by the principle of direct valuation of the most significant environmental segments based on the model of pronounced protection



Map 3.5: Cumulative vulnerability by the principle of direct valuation of the most significant environmental segments based on the model of the lowest level of acceptable protection

3.1.4 Areas with the highest vulnerability

Based on the model of cumulative vulnerability the following areas can be singled out as highly vulnerable ones.

Orjen

Area of preserved natural landscape, significant habitats and species; due to these characteristics, it is defined as potential nature protected area in the category of national parks. Activities and urban solutions need to be adjusted to preservation of the area's natural characteristics.

Sutorinsko field – Igalo

Land in Sutorinsko field is exceptionally vulnerable to pollution given the fact that the site holds geological reserves of medicinal mud for Igalo. It is necessary to prevent further urbanisation in order to maintain water and mud quality in Igalo. Spatial plan for the coastal zone of Montenegro needs to set a basis/ guidelines that will enable comprehensive landscape and architectural arrangement in the belt between the promenade and the beach.

Bay of Boka

Sea water area of the Bay of Boka is highly vulnerable, especially in the narrow part of Kotor Bay, section between Bijela Shipyard and Porto Montenegro harbour, and in Igalo Bay. The Bay is also highly vulnerable in case of accidental pollution (for example oil spills due to maritime accidents). Pollution of the sea is very high and it is clear that urgent remediation measures need to be undertaken for *hot spot* locations and for regulation of sewage systems.

In order to maintain status of Kotor-Risan Bay as an area of the world natural and cultural heritage (UNESCO's World Heritage list), urbanisation needs to be limited to the existing settlements (by using so called internal reserves in settlements) i.e. continuous line of urbanisation needs to be prevented and green breaks between individual settlements or parts of settlements need to be preserved.

Vrmac

Area of preserved natural landscape, significant habitats and species; due to these characteristics, it is defined as potential nature protected area in the category of regional parks. Activities need to be adjusted to preservation of the area's natural characteristics.

Tivatsko filed

Area highly significant for agriculture, where further irrational urbanisation needs to be prevented.

Surroundings of Virpazar, Mala and Velika Gorana

This is an area of preserved cultural landscape and complexes of traditionally cultivated agricultural surfaces. Traditional form of agricultural surfaces needs to be preserved and measures undertaken to prevent overgrowing of agricultural land. Spatial plan for the coastal zone of Montenegro needs to set a basis/ guidelines that will enable implementation of urban solutions for settlements in the context of preservation of typical village character.

Mrčevo field – Jaz beach – Spas hill – Mogren beach

Mrčevo field is of major significance for agriculture. Spatial plan for the coastal zone of Montenegro should set a basis/ guidelines that will enable comprehensive landscape and architectural arrangement of the belt between the field and Jaz beach. Spas hill hosts habitats of protected plant species *Euphorbia dendroides L*. (tree spurge), *Phagnalon rupestre (L.)* DC. (rock phagnalon) and *Cakile maritima DC.* (stokes); it is also a distinct landscape area. Further urbanisation and construction of unsuitable tourist infrastructure should be prevented and natural character of beaches and hinterland preserved.

Buljarica

Buljarica is a complex area of agricultural surfaces of rich biological and landscape diversity. Urbanisation of this area would cause an exceptionally high impact on the environment. In case of construction of tourist capacities, attention needs to be paid to finding urban solutions that would preserve the most important landscape characteristics i.e. elements of the environment.

Barsko field

This area is a high quality agricultural land but degraded through irrational/ unsuitable forms of urbanisation. Further urbanisation needs to be harmonised with the need to preserve agricultural complexes. High seismic vulnerability of the area should be kept in mind at the same time.

Dobre vode

Dobre vode are an area of large landscape distinctiveness and diversity with special relief forms and traditional form of agricultural surfaces. Untypical urbanisation and architecture should be prevented and traditional form of agricultural surfaces preserved.

Rumija

Rumija is naturally preserved area that is defined as potential nature protected area in the category of regional parks. It is necessary to maintain natural character of the area.

Ulcinjsko field

This area is a high quality agricultural land but degraded through irrational/ unsuitable forms of urbanisation. Further urbanisation needs to be harmonised with the need to preserve agricultural complexes. High seismic vulnerability of the area should be kept in mind at the same time.

Šasko field – Anamalsko field

Šasko field – Anamalsko field encompasses agricultural surfaces of exceptional significance. By maintaining the use of this area for the function of agriculture development, their landscape characteristics will be also protected.

Šasko lake

Šasko lake is located in natural, almost unchanged area where there are hardly any pressures. It can be used for irrigation of agricultural surfaces.

Štoj

Agricultural surfaces of Štoj are of major significance. Urbanisation needs to be limited to the existing settlements by using the so called internal reserves. High seismic vulnerability of the area should be kept in mind at the same time.

Velika beach

Taking into account attractiveness of the area intended for development of high quality tourism and possible impact of pollution, which in a transboundary context reaches the area through Bojana river, is transported by sea currents from Drač cove in Albania, or is due to exceedances of beach capacities in the summer period, narrow shallow belt from Valdanos to Bojana river mouth represents the most vulnerable part of the open sea of the coastal zone.

Velika beach area is exceptionally important for biodiversity preservation. Urbanisation of the area is debatable given the fact that it can cause extremely high impact on the environment. Even though guidelines for maintaining authentic landscape and dune vegetation at Velika beach and coastal part of Ada island are provided in the Spatial plan for the special purpose area of public maritime domain (SPSPAPMD), detailed habitat mapping on Velika beach showed that most valuable sites (e.g. dunes) and important natural characteristics in the beach hinterland

were endangered. That is why it is necessary to set a basis/ guidelines in the Spatial plan for coastal zone of Montenegro to enable implementation of urban solutions, in case of construction of new tourism facilities, based on a clear concept of tourism development and preservation of the most important natural and landscape characteristics.

Bojana

Given the importance of the area for water balance and its impact on the sea, Bojana river is highly vulnerable from hydrological aspect. As a cross-border watercourse Bojana carries water from Skadarsko lake as well as communal wastewater and other pollution from Skadar area. There is a large number of diverse and major pollution sources in Bojana's catchment area requiring systematic solutions.

Town settlements

Developed models showed that tourist settlements, beaches and often housing areas of Kotor, Budva, Bar and Ulcinj, as well as areas used for health tourism, such as Igalo, were the most polluted and vulnerable from the environmental aspect. Special attention needs to be paid to setting up of a basis/ guidelines in the Spatial plan of the coastal zone of Montenegro that will mandate, at the level of planning documents of lower order, implementation of urban solutions that decrease environmental impacts (arrangement of by-passes, principle of (non)compatible land uses, buffer zones, noise prevention barriers, protective greenery, etc.).

Natural preserved coast

Special attention needs to be paid to preservation of the most vulnerable parts of landscape i.e. to efforts to avoid new interventions in such areas. This refers to areas of naturally preserved coast, especially of rocky shore (e.g. near Ulcinj) and beaches whose immediate hinterland is not urbanised (e.g. Valdanos and Trsteno), as well as areas of visibly exposed cliffs (e.g. cliffs above Kotor). Set back line i.e. prohibition of construction near the shore needs to be applied as one of the basic measures for preservation of coastal landscape. In the sense of development of tourist capacities, set back line is not a limitation but potential for establishment of good quality landscape and architectural organisation of tourism offer and development of identity for tourist resorts.

A basis/guidelines need to be set in the Spatial plan of coastal zone of Montenegro that will direct activities at the level of planning documents of lower order towards systematic implementation of remedial landscape and architectural solutions along the entire already urbanised coast. Urbanisation needs to be integral and with systematic arrangement of the public areas (promenades, green open areas). It is necessary to ensure preservation of natural characteristics and landscape distinctiveness of individual parts of the coast.

Village settlements

As with naturally preserved coast, Spatial plan of the coastal zone of Montenegro needs to set a basis/ guidelines for preserved village settlements to direct activities at the level of planning documents of lower order towards implementation of landscape and architectural solutions typical for preserved village settlements and for maintenance of their character. Untypical urbanisation and architecture need to be prevented and traditional form of agricultural surfaces around settlements needs to be preserved.

3.2 Total pollution

Model of total extent to which an area is endangered/polluted (for environment and human health) was determined as a synthesis of those areas where pollution already existed. Model of cumulative vulnerability was prepared:

- by the principle of maximum value: final value of the level of pollution for each spatial unit (individual cell) is equal to the highest pollution value obtained in an individual model for the same spatial unit;
- as a representation of the highest grades: only areas with grades 5 (inadmissible impact), 4 (very high impact) and 3 (high impact) were extracted from individual models. Each of the analysed phenomena was shown on its own layer, and areas where individual layers overlapped were considered as generally more polluted/ endangered i.e. as conflicting areas.

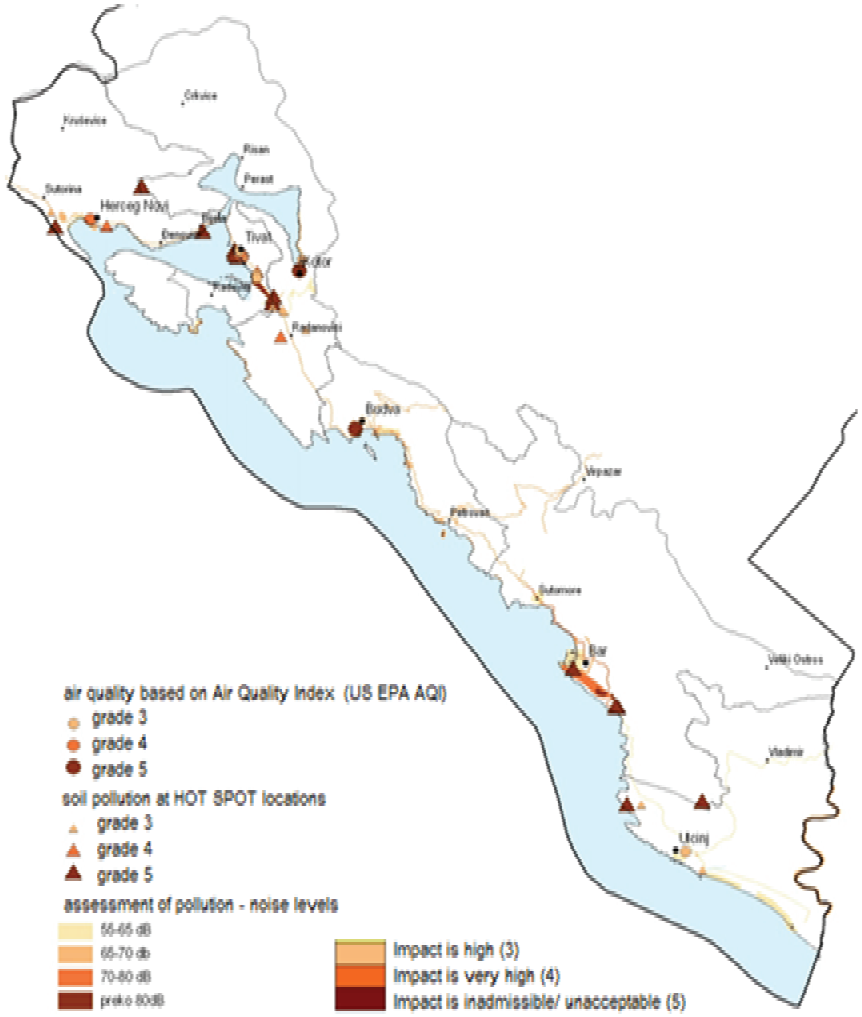
3.2.1 Total pollution of the land

Map of the total pollution/ the extent to which land is endangered (map 3.6) shows particularly high concentration of large and diverse burden in the town settlements of Tivat, Kotor, Budva and Bar:

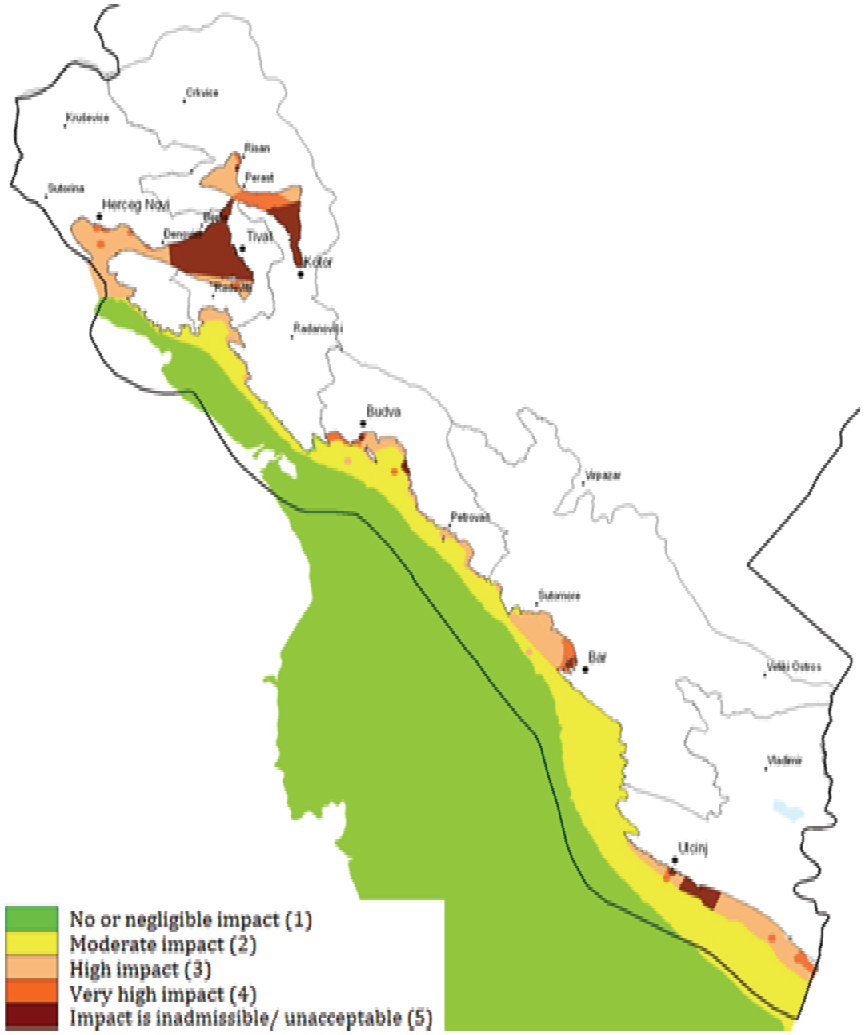
3.2.2 Total pollution of the sea

Map of the total pollution/ the extent to which the sea is endangered (map 3.7) warns that Kotor and Tivat Bays, ports in Budva and Bar, as well as section from Ulcinj to Port Milena are highly endangered. When pollution of the open sea is considered in relation to conditions in the Bay of Boka, situation is much more favourable; for the Bay of Boka it is evident that urgent remediation measures have to be undertaken for *hot spot* locations and for regulating sewage systems in Kotor and Tivat Bays.

Level of pollution at the open sea is lower due to relatively big depth and good mixing of waters. Depths of up to 20 metres are found in the narrow belt along the shore and they make only 1,1% of the total sea water area outside the Bay of Boka. This means that already in the vicinity of the coast depths allow for thermal stratification which has a beneficial impact on diffusion and dilution of wastewaters reaching the sea through sewage discharges.



Map 3.6: Total pollution/ the extent to which the land is endangered: grades 3 (high impact), 4 (very high impact) and 5 (inadmissible/ unacceptable impact)



Map 3.7: Total pollution/ the extent to which the sea is endangered: maximum value

4. Optimisation of land use planning in the coastal zone

Having in mind preparation of the SPSPCZ MNE, primary aim of the assessment of general vulnerability in the coastal zone was optimisation of land use planning so that the least vulnerable areas are chosen for land use categories where basic functions are performed (zones planned for construction and development i.e. construction areas). This type of optimisation in the land use plan can be achieved in two ways:

1. **Future siting decisions** within the land use plan SPSPCZ MNE **are guided** by the vulnerability assessment; and
2. **Existing siting decisions** i.e. spatial planning solutions from valid planning documents in the 6 coastal municipalities **are re-examined.**

The first method is somewhat simpler and is based on the use of synthesis vulnerability maps as baselines for defining new land uses.

The second method requires analysis of the existing planning documents and their re-examination against standard sustainability indicators of the coastal zone use and planning.

These indicators are used to measure and monitor level of urbanisation along the coast as well as the extent to which planning and guiding of future urbanisation are rational; they are aligned with the Protocol's requirements (as well as with good spatial planning practices in general). **Indicator on rationality of planning and use of construction areas** is calculated as a share (usually expressed in percentages) of the construction areas surface in the total surface of a spatial unit such as settlement, coastal zone or municipality. Share of built areas in the total surface of construction areas is also calculated as a rationality indicator. To calculate these indicators for this assessment, synthesis land use map prepared by the RZUP (SPSPCZ MNE developer) was used. Map on built areas in the 6 coastal municipalities was also used, as prepared within the *Analysis of built up surfaces*, CAMP MNE, 2013, the results of which are presented in the table 4.1. The map was prepared based on orthophotos from 2011 (access to orthophotos was enabled through the web page of the Real Estate Administration http://www.nekretnine.co.me/).

Table 4.1: Indicators of the extent of built up surfaces and use of construction areas (CA) by municipalities, situation in 2011 (Source: *Analysis of built up surfaces*, CAMP MNE, 2013)

Municipality	Total surface (ha)	CA (ha)	CA/tot (%)	Built (ha)	Built/CA (%)
Columns	***1***	***2***	***3=2/1***	***4***	***5=4/2***
Bar	50,429	4,326	8.6	1,331	30.8
Budva	12,243	2,628	21.5	535	20.3
Herceg Novi	23,360	7,017	30.0	844	12.0
Kotor	33,575	2,659	7.9	517	19.5
Tivat	4,745	1,339	28.2	519	38.8
Ulcinj	26,105	5,394	20.7	575	10.7
Total	**150,457**	**23,363**	**15.5**	**4,321**	**18.5**

Data from the table above show exceptionally high share of construction areas in relation to population density and surface of built parts of construction areas. Comparison shows that the share of construction areas in the total surface of 6 coastal municipalities in Montenegro is 15.5% while as the same ratio in coastal counties in Croatia varies from 4.0% (Dubrovačko-Neretvanska county) to 7.1% (Splitsko-Dalmatinska county). Consequently, the level to which construction areas are built i.e. used is low. For 6 coastal municipalities, ratio of built up surfaces is just 18.5% while as the equivalent value in e.g. coastal counties in Croatia ranges from 51.8% (Istarska county) to 77.9% (Primorsko-Goranska county). Data calculated on the same basis is available for 31 out of 211 municipalities in Slovenia that had adopted new generation of spatial plans by 2012. Share of construction areas varies depending on the municipal social and geographic characteristics from 1.96% (municipality Loški potok) to 28.29 (city municipality Ljubljana). The extent of use of construction areas ranges from 33.0% (municipality Pivka) to 79.5% (city municipality Ljubljana).

Planning of construction areas that exceed necessary levels by several times represents unreasonable depletion of valuable and non-renewable spatial resources and has numerous negative consequences including:

- dispersed construction that requires significantly longer transport network and more expensive development of communal infrastructure for construction land;
- unnecessary consumption of other categories of land, especially of valuable agricultural and forest land and of areas with high biodiversity;
- higher energy and fuel costs i.e. stronger pressures on the environment;
- loss of traditional physiognomy of settlements and disturbance of traditional landscape values;
- in an economic sense and over a long term, this trend leads to decreased income from tourism and lowering of the destination's rating.

That is why it is necessary for the SPSPCZ MNE to achieve land use rationalisation in the coastal zone in the context of intentions to achieve sustainability concept by applying the approach "conservation through concentration of urbanisation". Implementation of this approach needs to be primarily focused on an analysis of possibilities to reduce the scope of construction areas while increasing their concentration in all the conflict areas identified by overlapping vulnerability assessment results and the analysis of built up surfaces in the coastal zone.

Low ratio of built up surfaces (just 18.5%) in the 6 coastal municipalities in Montenegro means that there are large reserves within construction areas. Total surface of non-built construction areas is 19,042 ha. Reserves of some 13,000 hectares of mixed purpose settlements means that additional 600-800,000 inhabitants could live within limits of the existing construction areas (assuming population density of 45-60 persons/ha). Similarly, reserves within tourism and zones for tourism apartments amount to some 4,600 ha which would enable construction of capacities for around 230,000 new beds (assuming minimum density of 50 beds/hectare). If more frequently applied standard of at least 80 beds per hectare is taken into account for this type of land use, it would be possible to have around 350,000 new beds in the reserve areas.

Conducted analysis and calculated indicators highlight the fact there is a possibility and need to optimise land use in the coastal zone by decreasing the scope of construction areas. Planning of construction land is among other provisions regulated under Article 77 of the *Rulebook on a more precise content and form of planning document, land use criteria, elements of urban regulation and unique graphic symbols*. This article also requires decrease if the existing level of built up surface is below 50% in the given construction area.

A question that arises in a situation of mandatory reduction of construction areas is what criteria can be used to select zones or their parts where cancelation of construction area status should be proposed. While respecting other criteria, especially inherited rights in a situation when for a given zone development of detailed planning documentation is underway (with known investors), assessment of general vulnerability of the coastal zone can be especially useful. By overlapping synthesis vulnerability map and the map of built up surfaces in the 6 coastal municipalities with indicated zones of non-built construction areas, it is easy to spot parts where corrections of construction areas are justified.

Comparison of non-built construction areas and of the results from general vulnerability assessment – cumulative vulnerability, model of pronounced protection of the most significant elements – is shown in the table 4.2 and on the map 4.6.

Analysis shows that the share of highly vulnerable areas within non-built construction areas is very high. **80% of all non-built surfaces of construction areas coincides with locations of high (grade 4) and very high (grade 5) vulnerability.** Points to be paid special attention are:

- on the territory of Herceg Novi municipality, a large share of vulnerable surfaces comes out of the scope of presented planned land uses, that is out of the large and comprehensive stretch of space north from Sutorina and Herceg Novi designated (in plans) for settlements/ housing; moreover, these surfaces overlap with biodiversity conservation zones (areas with widespread forest community *Orno-Quercetum ilicis* which is of special importance for biodiversity of coastal zones in the Mediterranean), quality agricultural surfaces and smaller areas of very high seismic vulnerability;
- on the territory of Budva municipality, a substantial share of vulnerable areas comes out of several large zones (e.g. Buljarica) planned for tourism and tourism settlements, which at the same time overlap with highly vulnerable, naturally preserved sections of the coast;
- on the territory of Ulcinj municipality, surface of highly vulnerable areas partly comes out of presented land uses for Ulcinj salt works, whose border belt is defined as "surface intended for industry"; at the same time, it is necessary to warn about the large scope of surfaces for tourism and tourism settlements in the vulnerable area of Velika beach and large areals designated (in plans) for settlements on quality agricultural land.

Despite the fact that surfaces of vulnerable areas and shares of highly vulnerable areas in total surfaces in other municipalities are somewhat lower compared to Herceg Novi, Budva and Ulcinj, they are still high.

Table 4.2: Vulnerability of space in non-built construction areas by municipality and vulnerability grades taking into account cumulative vulnerability – model of pronounced protection of the most significant elements

Grade	Very low vulnerability (1)		Low vulnerability (2)		Moderate vulnerability (3)		High vulnerability (4)		Very high vulnerability (5)	
Municipality	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**
Bar	72	2	109	4	570	19	1,516	51	726	24
Budva	77	4	14	1	187	9	747	36	1,067	51
Herceg Novi	156	3	110	2	1,014	17	2,827	47	1,845	31
Kotor	86	4	34	2	516	25	856	41	600	29
Tivat	44	5	41	5	317	39	242	30	172	21
Ulcinj	23	>1	37	1	244	5	3,211	67	1,303	27
Coastal zone	**458**	**3**	**345**	**2**	**2,848**	**15**	**9,399**	**50**	**5,713**	**30**

Grade	Non-built / conflicting				
Municipality	**Total non-built (ha)**	**Settlements, mixed non-built (ha)**	**Tourism settlements non-built (ha)**	**Tourism non-built (ha)**	**Total conflicting***
Bar	2,995	1,863	487	300	972
Budva	2,093	1,295	471	327	823
Herceg Novi	6,173	5,143	4	1,023	2,896
Kotor	2,142	1,199	5	795	163
Tivat	820	435	-	346	199
Ulcinj	4,819	2,951	150	700	1,194
Coastal zone	**19,042**	**12,886**	**1,116**	**3,489**	**6,247**

* Description of conflicts between non-built construction areas and areas of highest vulnerability is provided below. Detailed presentation of the scope of conflict zones is given in the table 4.3.

4.1 Areas of conflict between non-built construction areas and the most vulnerable spaces

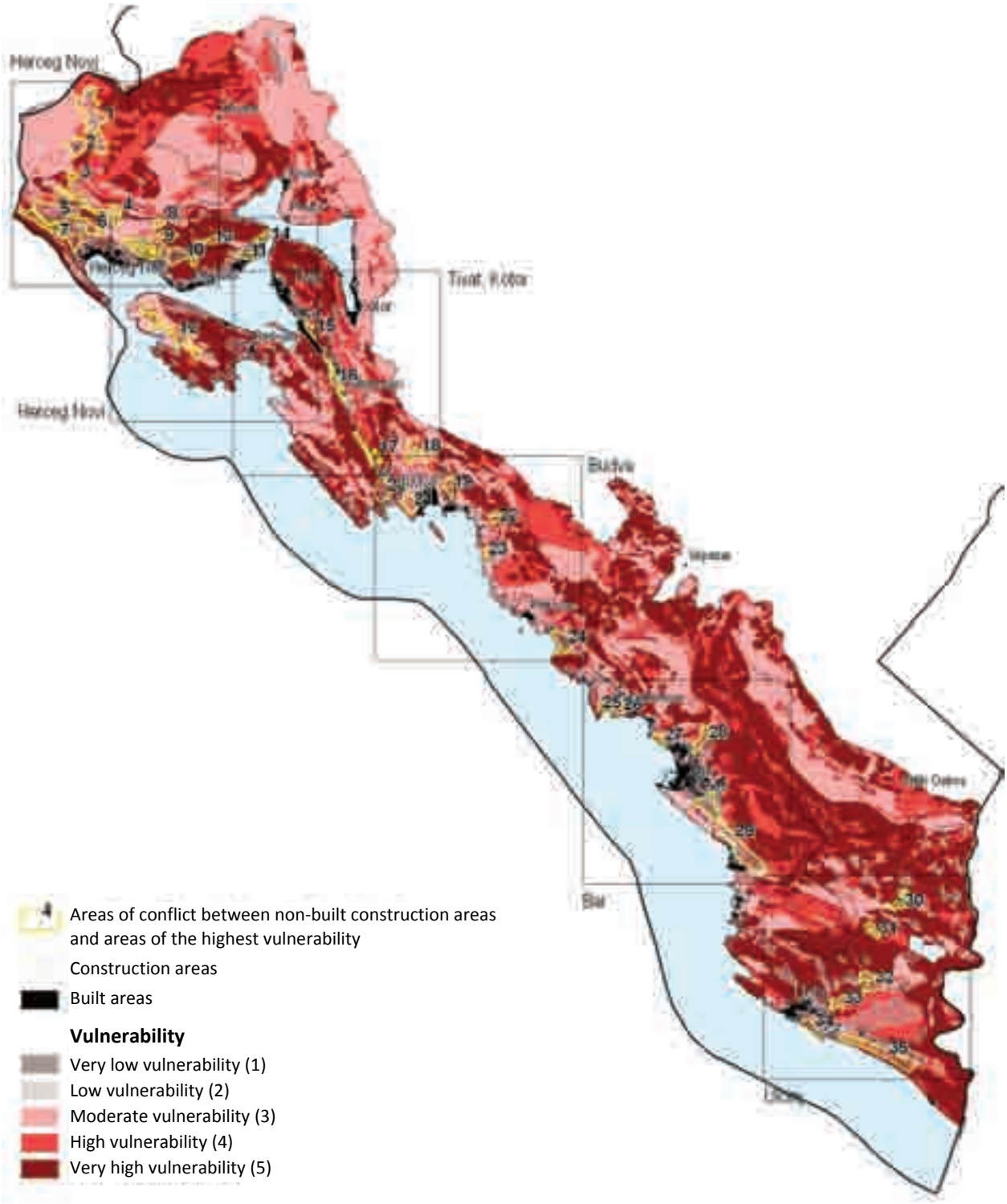
Comparative analysis of highly vulnerable areas, existing planned land uses and existing extent to which the space is developed allowed for identification of areas with conflicts between non-built parts of construction areas and the most vulnerable spaces. Results of the *Analysis of attractiveness and suitability for agriculture* prepared within CAMP Montenegro (CAMP MNE, July 2013) were also used in defining non-built construction areas that are in conflict with areas that have potential for agriculture development and in determining the scope of such conflict areas. Attractiveness and suitability for specific branches of agriculture/ varieties was analysed (including olive and citrus growing and vineyards). Areas with potential for agriculture development were defined based on this analysis. Areas where surfaces with potential for agriculture development overlapped with large stretches of non-built construction areas were considered as conflict areas even if they had not been determined as highly vulnerable based on the assessment of general vulnerability. So far practices of defining areas for settlements in a way that also encompasses large areas of surrounding agricultural surfaces inevitably leads to splitting of agricultural land into smaller surfaces and to dispersed construction. It is therefore recommended to limit construction areas in these zones to smaller units.

Selected areas of conflict between non-built construction areas and areas of the highest vulnerability with surfaces of more than 50 ha are described in the following paragraphs; for these areas, it is recommended to consider decrease of construction areas in the zones of high vulnerability. This does not mean that correction of construction areas is not necessary/reasonable in other zones. For the needs of the SPSPCZ MNE and of the municipal plans, calibration of all the construction areas should be performed in relation to:

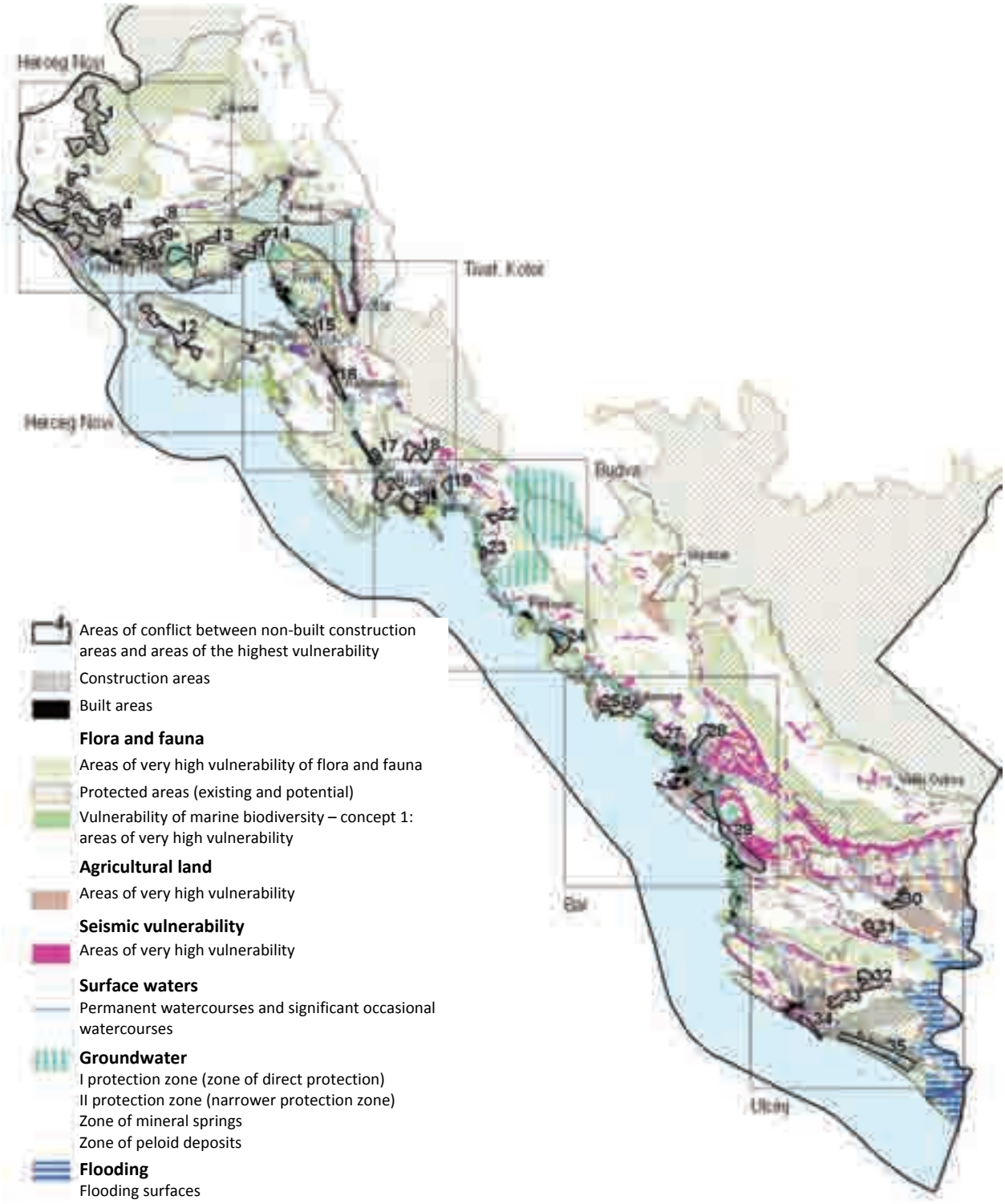
- the need of preserving wholeness of the remaining representative coastal (seaside) forests (Luštica, Rumija slopes, specific sites of Dubovica, Crni rt and similar);
- the need of preserving wholeness of quality agricultural surfaces;
- areas of very high seismic vulnerability the use of which for planning and construction of objects is absolutely not recommendable;
- areas of significant landscapes, especially along the coast (to this end it is necessary to prepare detailed landscape study).

The subsequent maps contain graphic presentation of the areas of conflict between non-built construction areas and areas of the highest vulnerability. Respectively, the maps show cumulative model of general vulnerability of the area, the most significant characteristics, and depiction of land uses.

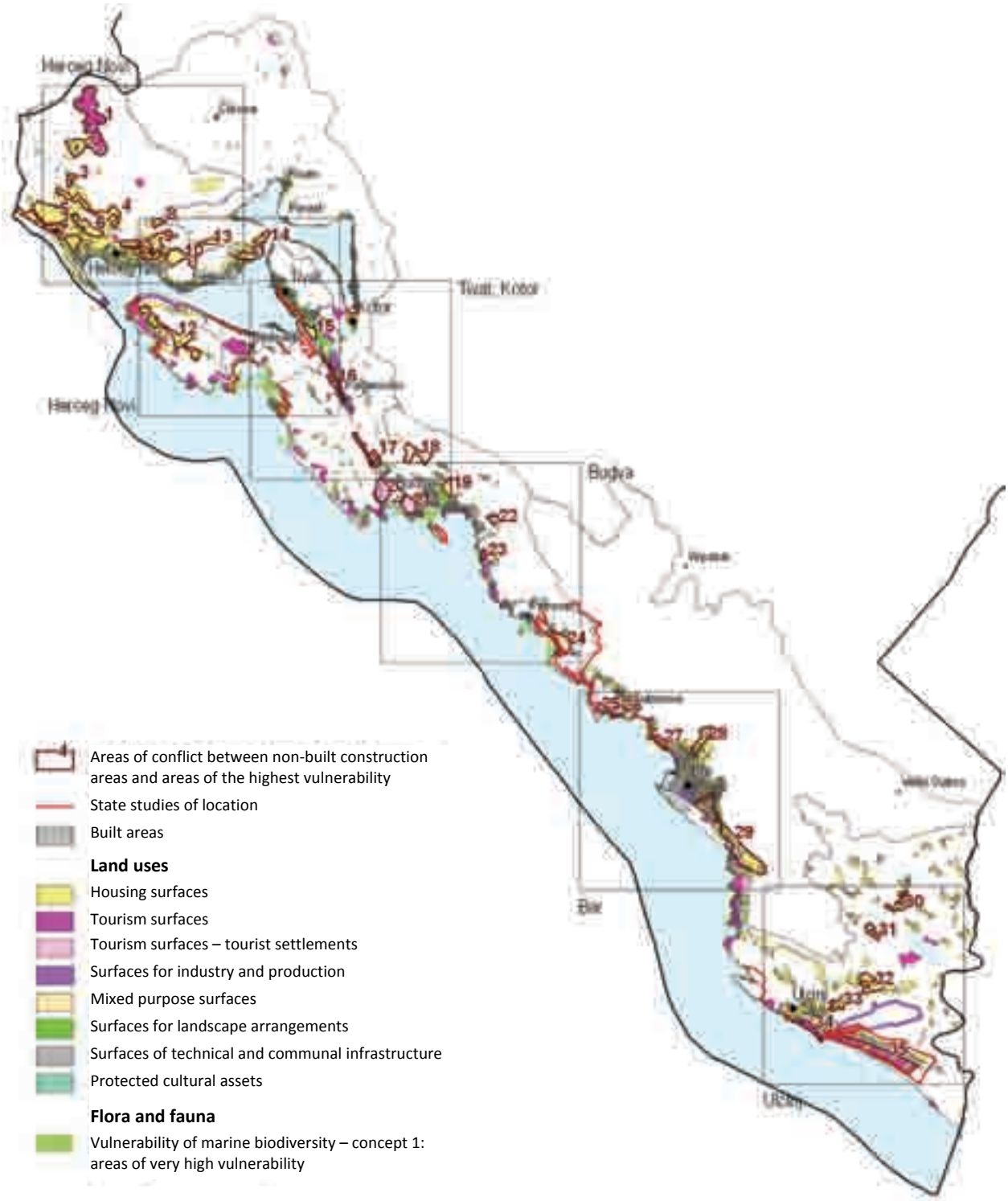
Analysis and graphic presentations have been prepared based on the land use synthesis map developed for the purpose of preparing the SPSPCZ MNE (version v.9 from 17/07/2013, RZUP, July 2013).



Map 4.1:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – cumulative model of general vulnerability



Map 4.2:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – the most significant characteristics



Map 4.3:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – depiction of land uses

Herceg Novi Municipality

1. Vrbanj:

- Surface intended for tourism and housing (development of nature based tourism);
- Dynamic development is in conflict with biodiversity preservation (Orjen – potential protected area);
- The zone is too large – it should be concentrated to smaller surface i.e. to provision of surface intended for a complete tourism project or individual construction within smaller entities in a way as to prevent dispersed construction.

2. Kruševice:

- Surface intended for housing;
- The zone is too large/ comprehensive, it is sensible to limit construction area to the outer border of the field so that the middle part of the field would remain for agricultural use.

3. Kruševice (south from the settlement) and 4. Mokrine – Kameno:

- Surfaces intended for housing;
- Zones are in conflict with biodiversity preservation; there are parts of the area with forest community *Orno-Quercetum ilicis* which is significant for biodiversity of the coastal – Mediterranean region of Montenegro.
- The zone is too large and it encompasses different spatial units and land uses; it is sensible to concentrate construction area to the existing settlements in a way as to preserve stretches of agricultural land and forest communities.

5. Prijevor – Mojdež and 6. Ratiševina – Trebišinj:

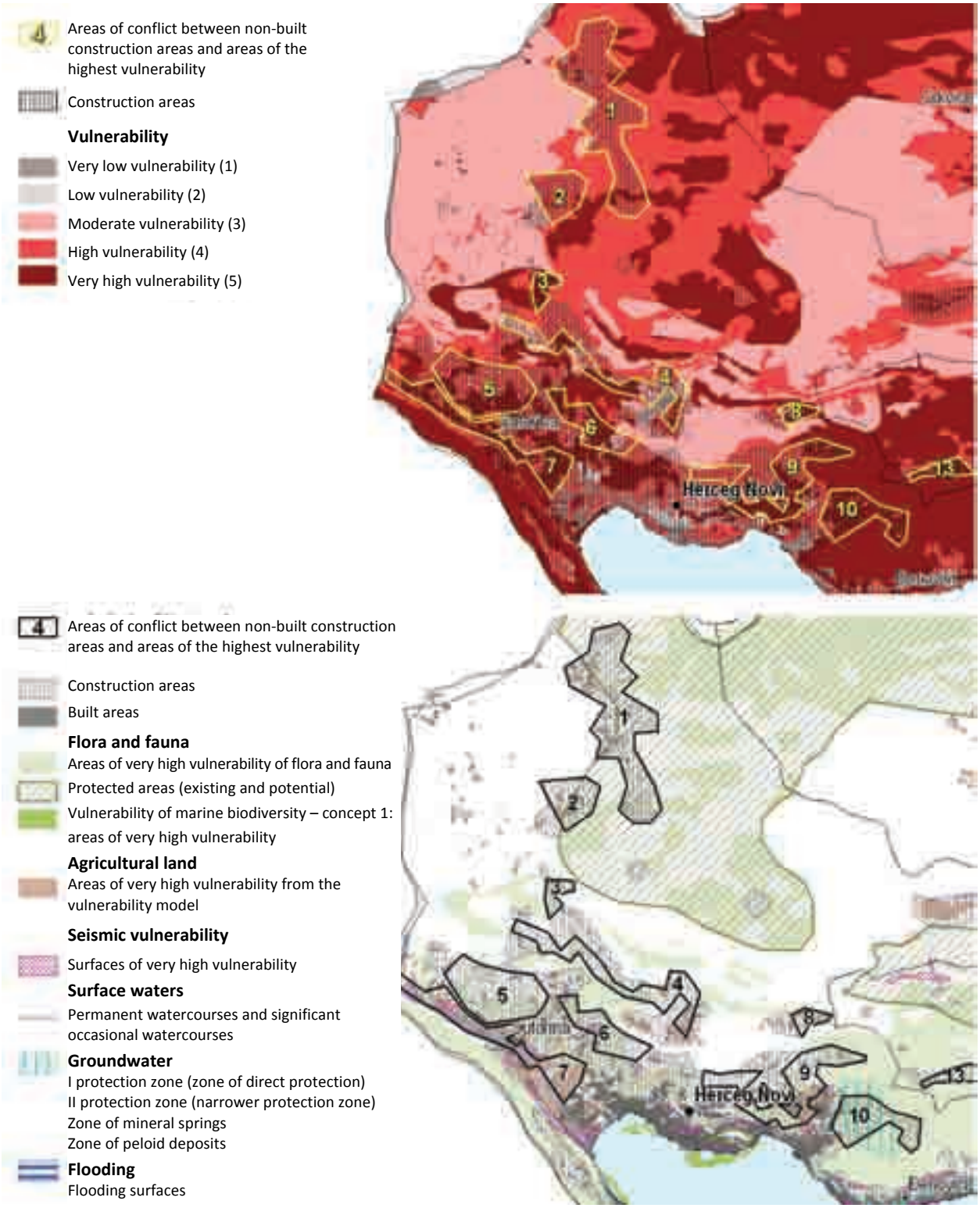
- Surfaces intended for housing;
- Zones are in conflict with biodiversity preservation; there are sections with *Orno-Quercetum ilicis* forest community in this area (between the settlements), which is significant for biodiversity of the coastal – Mediterranean region of Montenegro.
- Within the scope of this zone there are smaller areas of very high seismic vulnerability the use of which for planning and construction of objects is absolutely not recommendable;
- Zones are too large and encompass various spatial units and the existing land uses, therefore it is not justified to open new areas where there are currently no settlements; construction area should be concentrated to the existing settlements in a way as to preserve stretches of agricultural land and forest communities.

7. Sutorina:

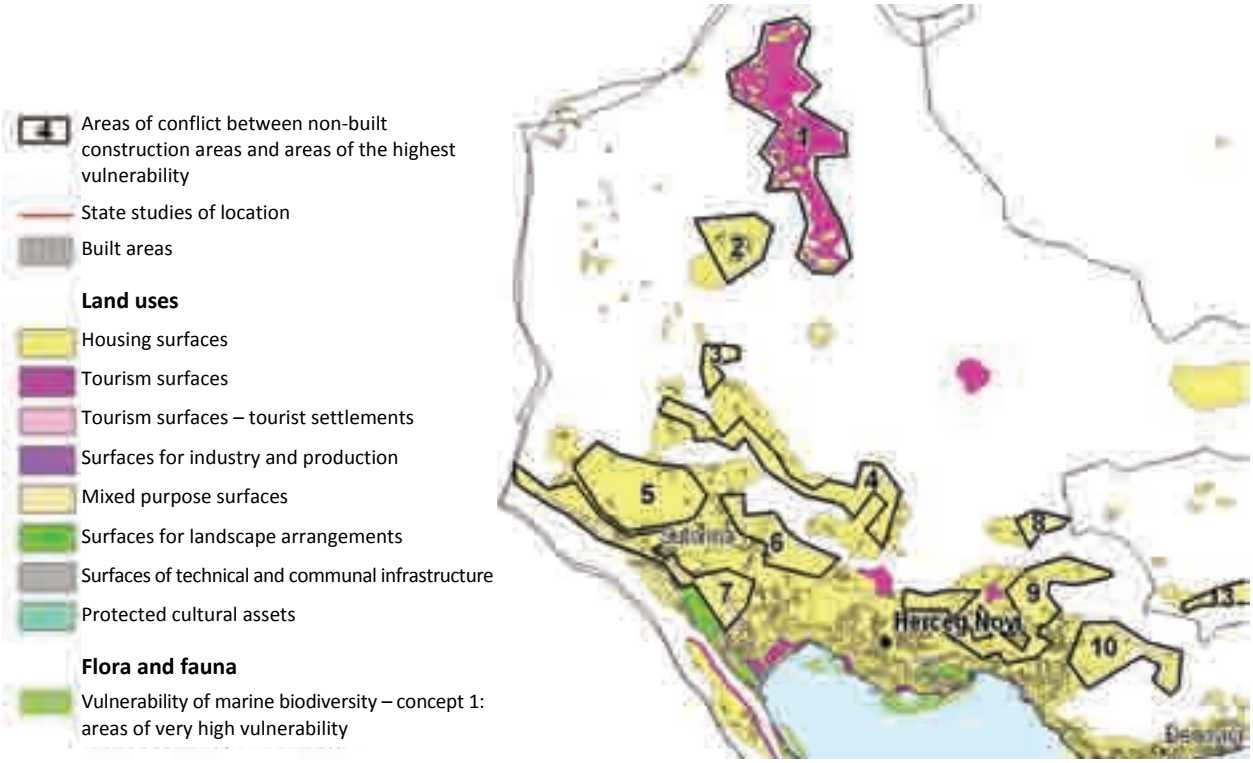
- Surface intended for housing and mixed purposes;
- Area of high vulnerability with potential for agriculture – its preservation for agricultural purposes would be a sensible choice; construction area should be concentrated to the existing settlements in a way as to preserve stretches of agricultural land;
- In the scope of this zone there are smaller areas if very high seismic vulnerability the use of which for planning and construction of objects is absolutely not recommendable.

8. Žlijebi and 9. Podi – Šašovići – Kudi:

- Surfaces intended for housing;
- Zones are in conflict with biodiversity preservation due to presence of forest community *Orno-Quercetum ilicis* (area around Žlijebi), which is significant for biodiversity of the coastal – Mediterranean region of Montenegro and acts as a limiting factor for expanding the zone's scope towards hinterland with preserved nature; it is justified to limit construction area to smaller units;
- Zone Podi – Šašovići – Kudi is partly in conflict with potential for agriculture.



Map 4.4:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Herceg Novi



Map 4.5:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Herceg Novi (land uses)

10. Kuti:

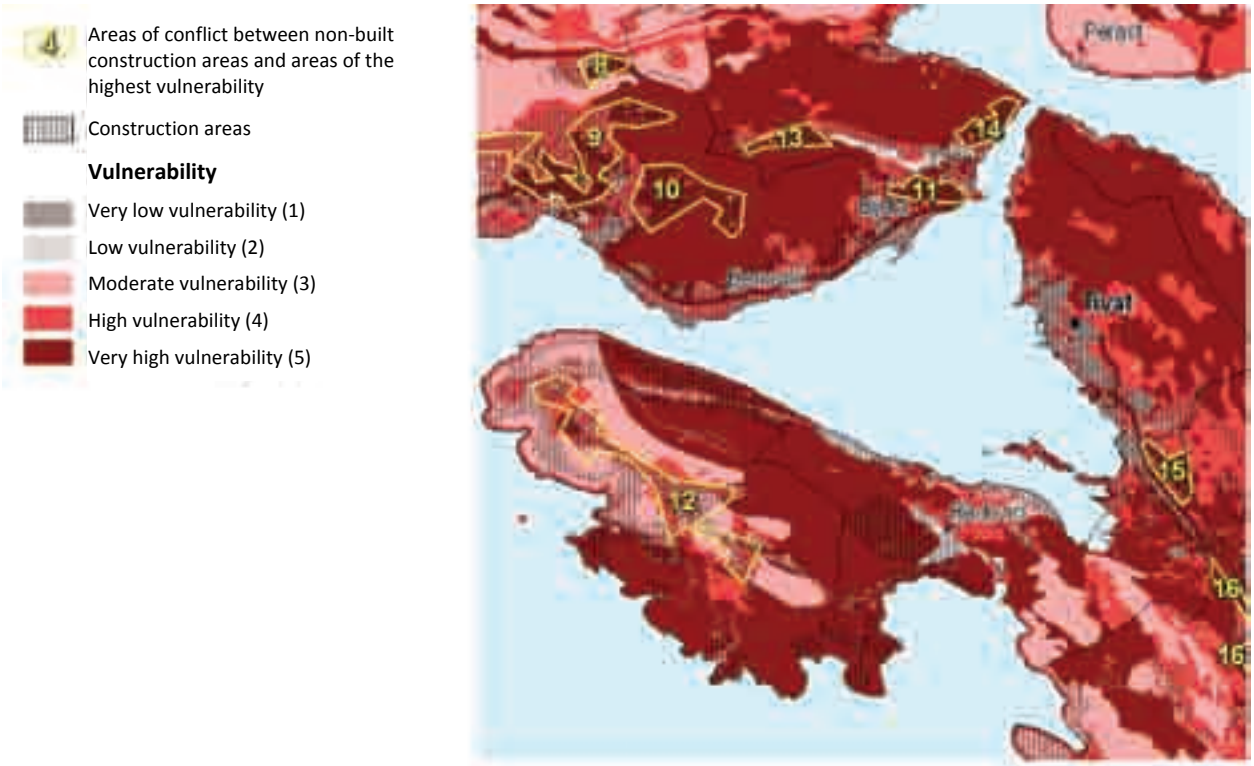
- Surface intended for housing;
- Zone above II zone of sanitary protection for Opačica spring – land use regime in this area should be checked;
- The zone is in conflict with biodiversity protection due to presence of forest community *Orno-Quercetum ilicis* which is significant for biodiversity of the coastal – Mediterranean region of Montenegro and acts as a limiting factor for expanding the zone's scope towards hinterland with preserved nature;

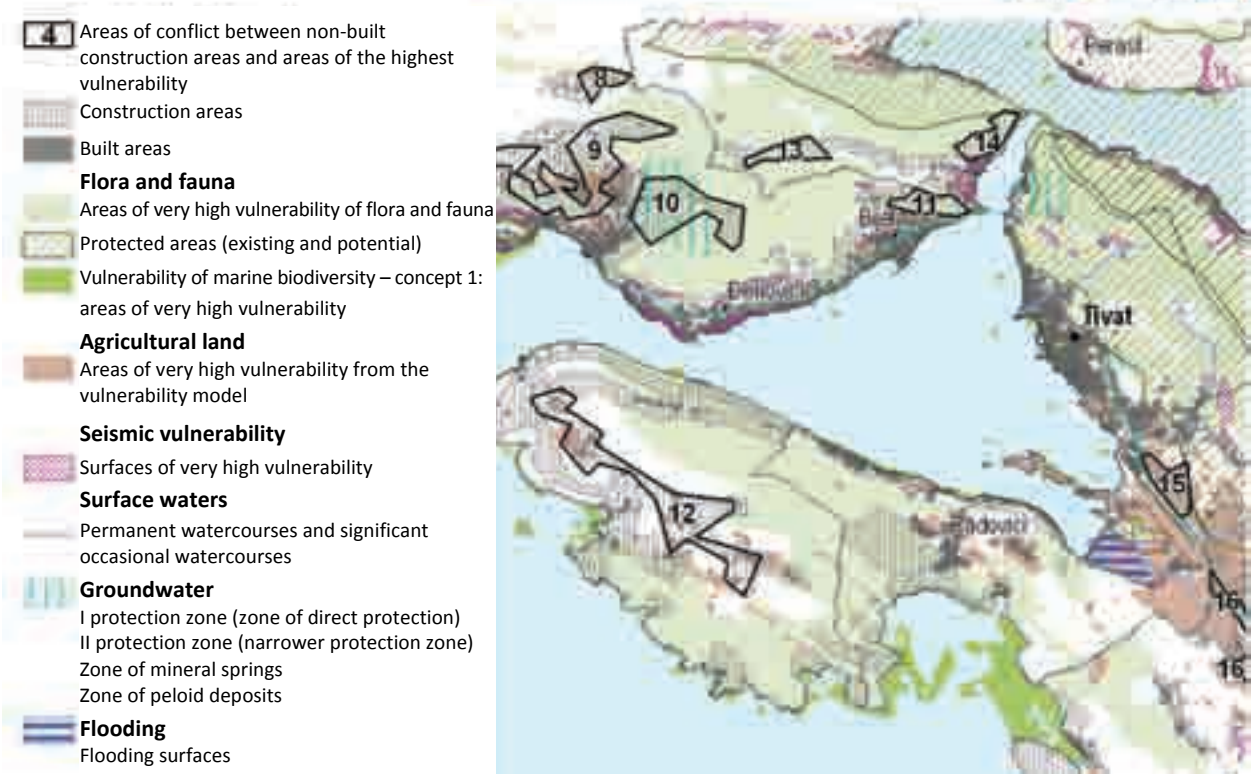
11. Bijelske Kruševice, 12. Biljela – Jošice and 13. Đurići:

- Surfaces intended for settlements;
- Zones are in conflict with biodiversity preservation due to presence of forest community *Orno-Quercetum ilicis* which is significant for biodiversity of the coastal – Mediterranean region of Montenegro and acts as a limiting factor for expanding the zone's scope towards hinterland with preserved nature; it is justified to limit construction area to smaller units.

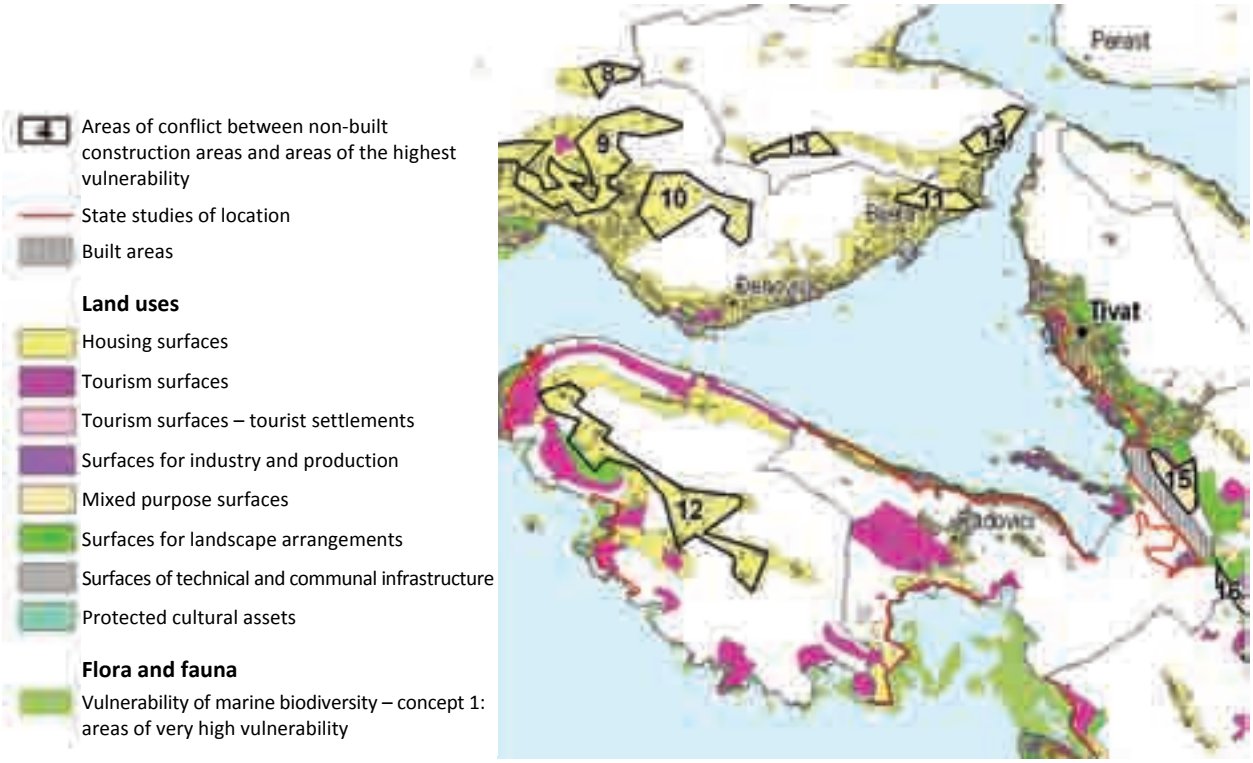
14. Luštica:

- Surface intended for housing;
- Surface intended for housing encompasses a large section, construction area should therefore be concentrated to existing settlements in a way as to preserve stretches of agricultural surfaces.





Map 4.6:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Herceg Novi and Tivat



Map 4.7:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Herceg Novi and Tivat (land uses)

Tivat Municipality

15. Mrčevac:

- Surface intended for mixed purposes;
- Area of agricultural surfaces of major importance (the area should however be considered in the context of very limited space for development of Tivat).

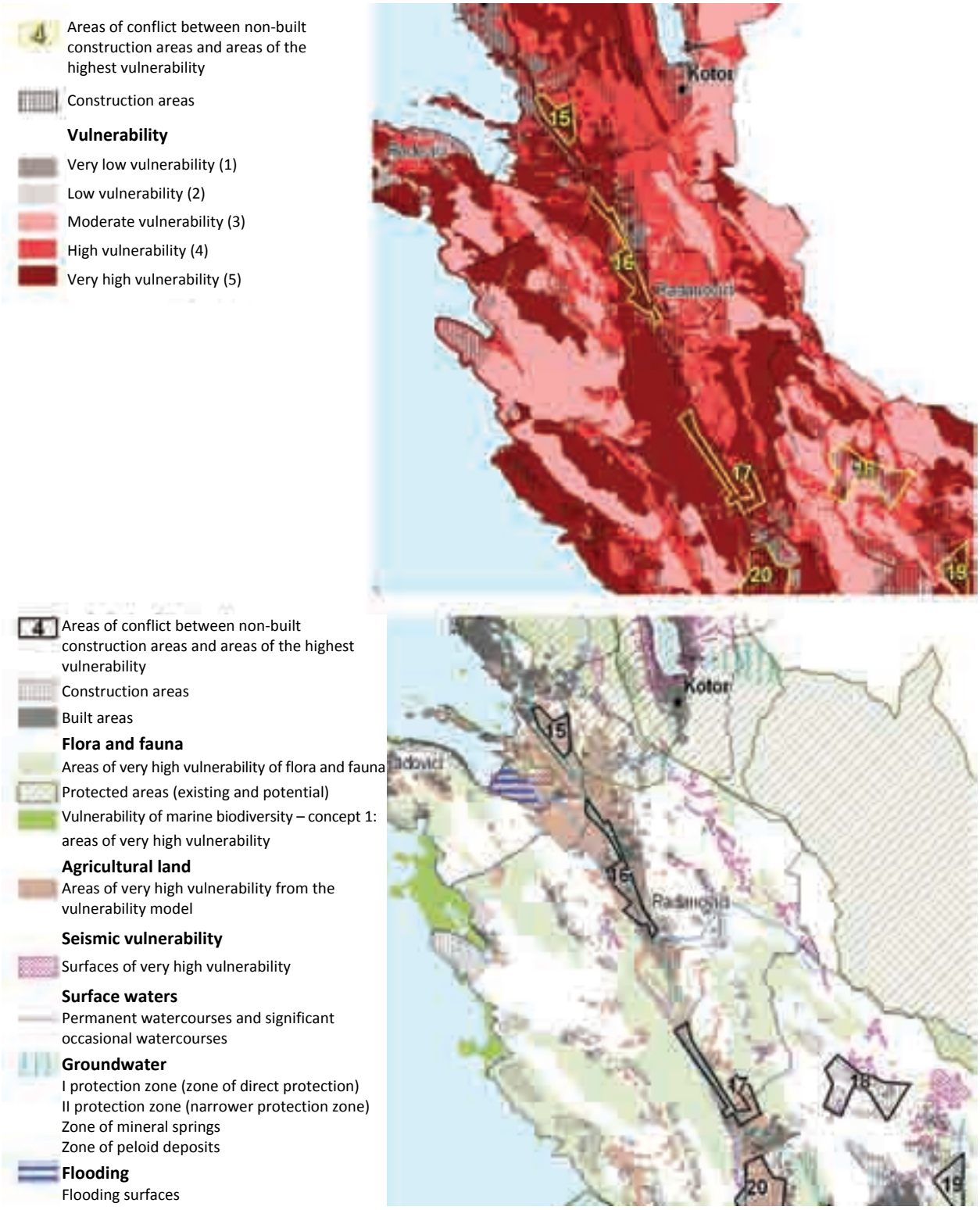
Kotor Municipality

16. Radanovići:

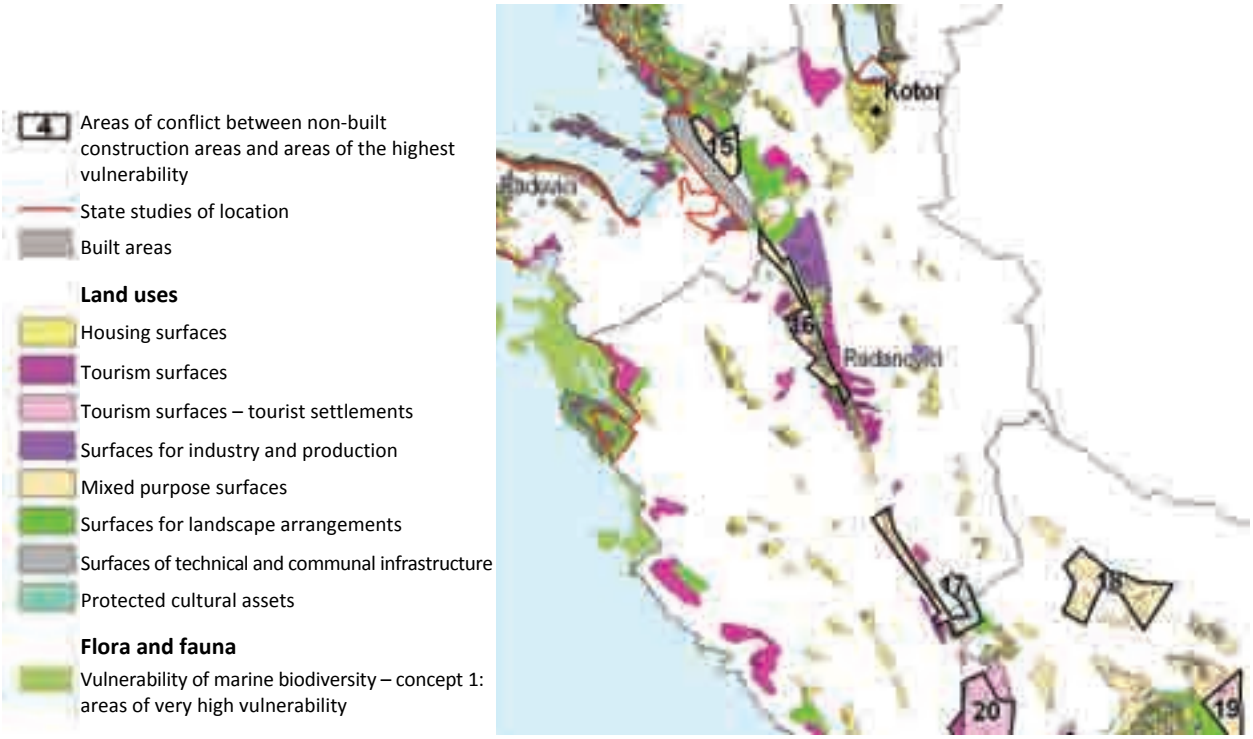
- Surface intended for housing, mixed purposes and tourism;
- Area of agricultural surfaces of major importance, it is sensible to preserve wholeness of Tivatsko field and concentrate construction areas along the field's boundaries.

17. Gorovići – Lastva Grbaljska:

- Surface intended for housing, mixed purposes, tourism and technical infrastructure;
- Area of agricultural surfaces significant for agriculture; it is justified to preserve wholeness of Tivatsko field and concentrate construction areas along the field's boundaries.



Map 4.8:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Tivat and Kotor



Map 4.9:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Tivat and Kotor (land uses)

Budva Municipality

18. Pobori and 19. Ostrog:

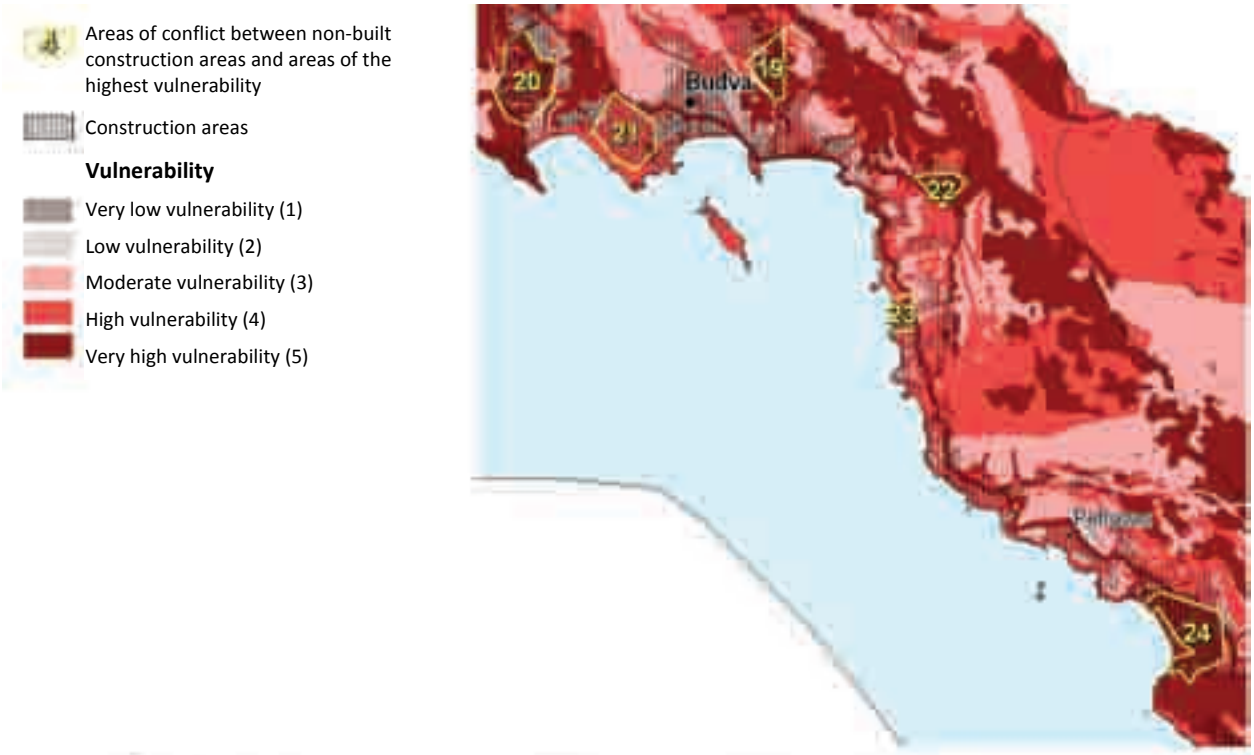
- Surface intended for mixed purpose;
- Zones are in conflict with biodiversity preservation due to presence of forest community *Orno-Quercetum ilicis* which is significant for biodiversity of the coastal – Mediterranean region of Montenegro. Besides limitations for expanding the scope in the part of hinterland with preserved nature, Pobori zone is in conflict with areas that have potential for agriculture on traditional terraces. That is why limitation to confine construction areas to smaller units is justified.

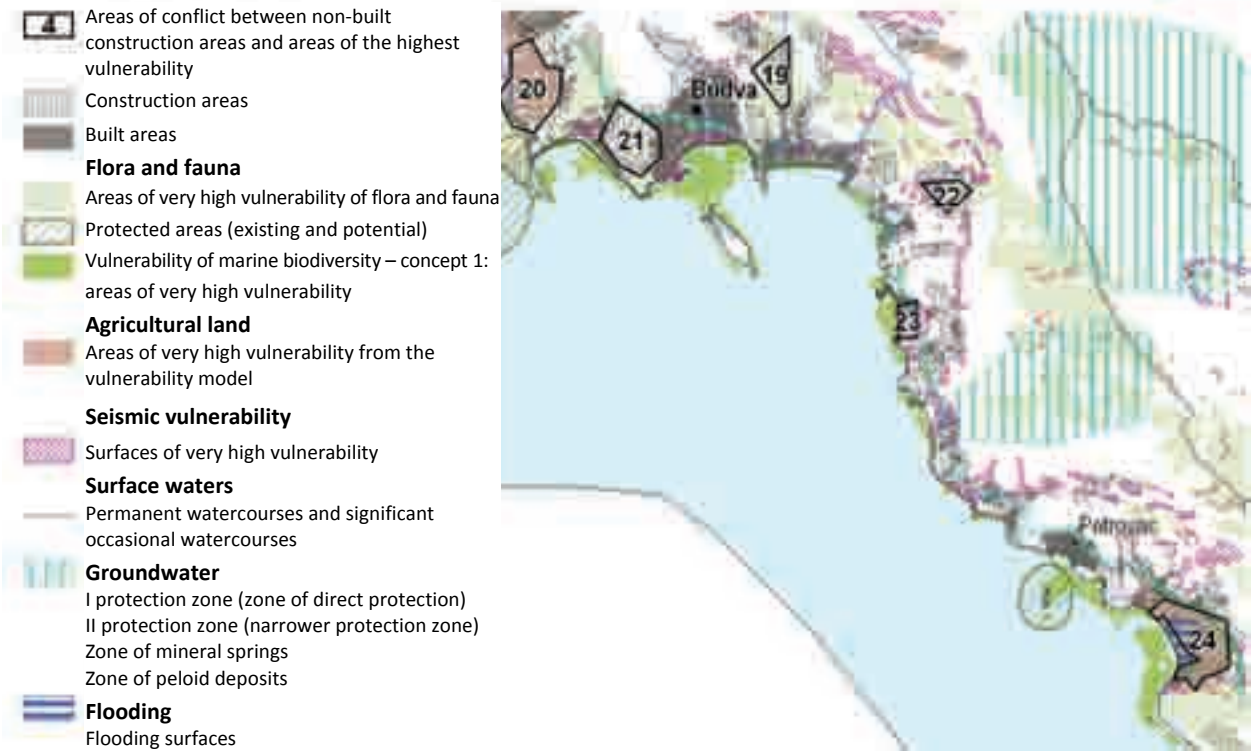
20. Mrčevo polje:

- Surface intended for tourist settlement;
- Investment area of national importance;
- The zone is in conflict with an area of agricultural surfaces of special importance, which is a limitation for construction in this area.

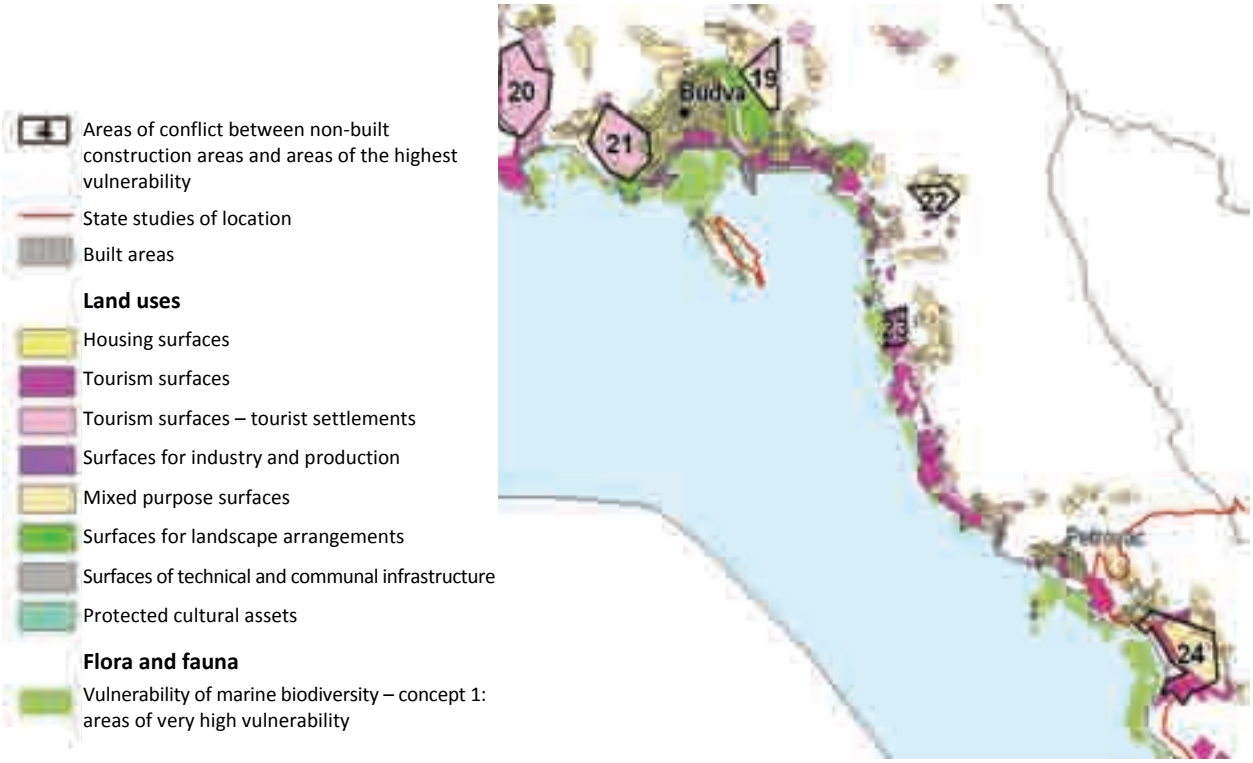
21. Prijevor:

- Surface intended for tourist settlement;
- Within the boundaries of this area, which encompasses part of Spas hill, there are significant biodiversity sections (habitats of protected plant species – *Euphorbia dendroides* (tree spurge) and *Phagnalon rupestre* (L.) DC. (rock phagnalon)) which are located on the western slope of Spas hill down to Jaz beach; Spas hill and Jaz beach are also nature protected areas (monuments of nature); the zone is in conflict with biodiversity preservation and is therefore justified to limit construction area to smaller units where there are no protected species.





Map 4.10:
Areas of conflict between non-built construction areas and areas of the highest vulnerability –Budva



Map 4.11:
Areas of conflict between non-built construction areas and areas of the highest vulnerability –Budva (land uses)

22. Kuljače:

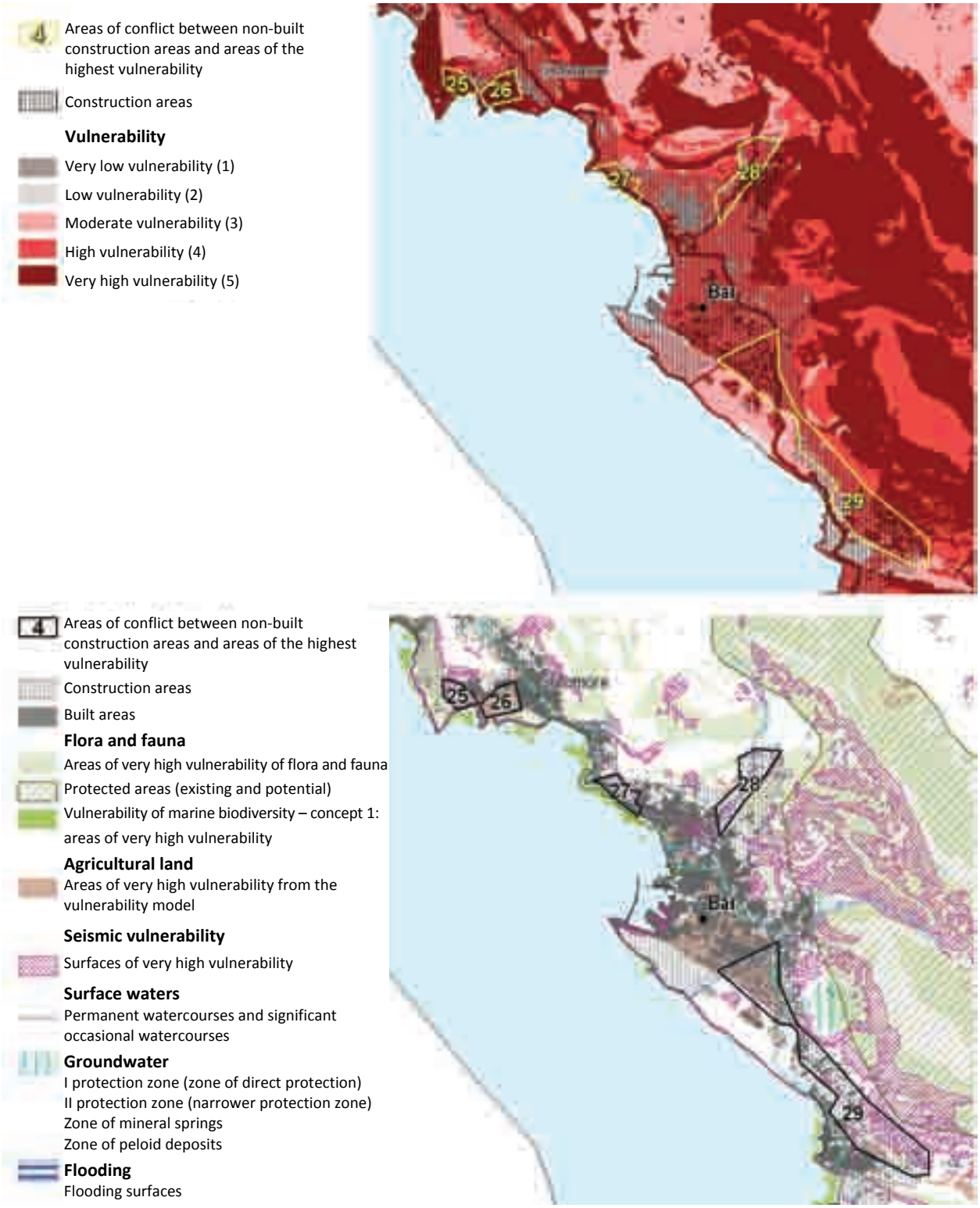
- Surface intended for mixed purposes;
- The zone is in conflict with biodiversity preservation; in this area (outside the settlements), there are sections with forest community *Orno-Quercetum ilicis* which is significant for biodiversity of the coastal – Mediterranean region of Montenegro and acts as a limiting factor for expanding the zone's scope towards hinterland with preserved nature.

23. Sveti Stefan:

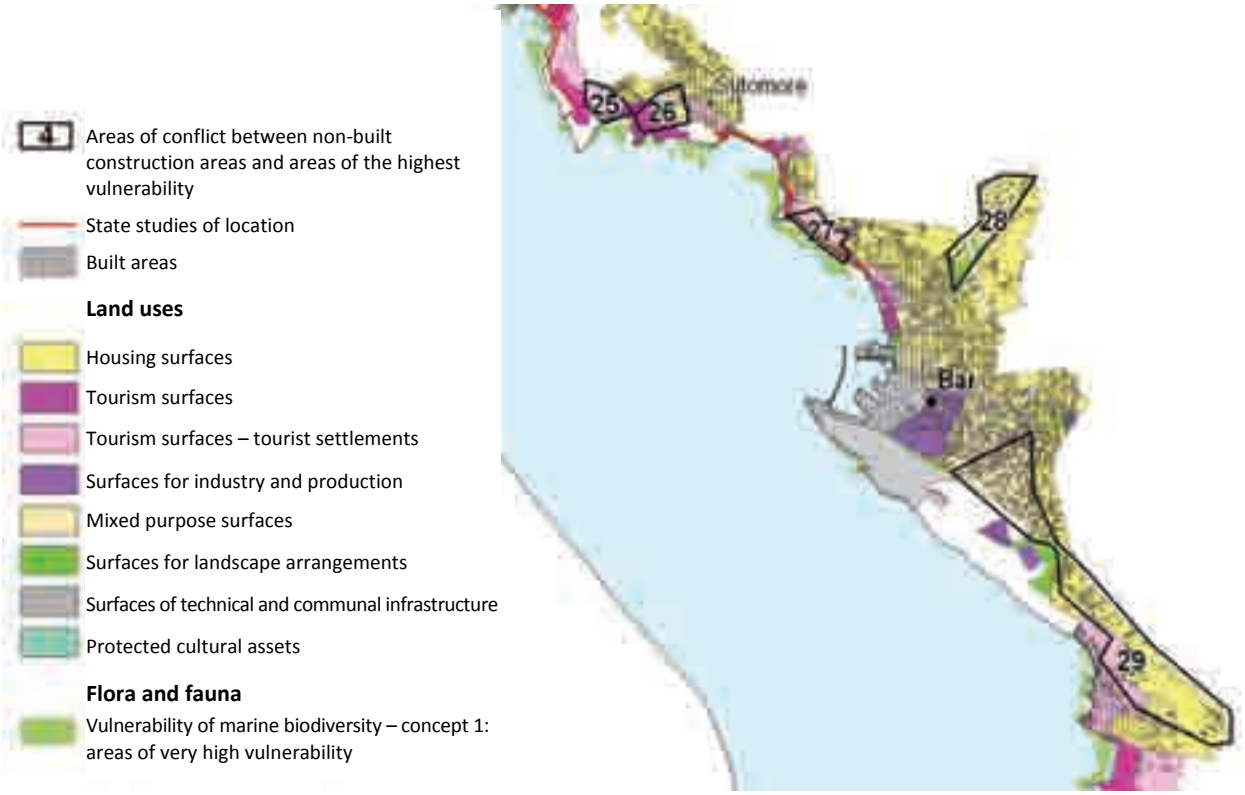
- Surface intended for tourism;
- Area significant from nature protection aspect (Sveti Stefan beach is monument of nature);
- Area of very high seismic vulnerability which is not recommendable for being used for planning and construction of objects.

24. Buljarica:

- Surface intended for tourism and mixed purposes;
- The zone is in conflict with preservation of nature and biodiversity protection since it is a wetland area designated for pronounced protection zone under the Article 10 of the ICZM Protocol and in line with Ramsar Convention;
- The zone has potential for agriculture;
- It is an area where there is high likelihood of significant impacts due to sea level rise;
- Related to this, the planned scope of the area (180 ha) should be reconsidered in case of construction of new tourism capacities having in mind necessity of preservation of the most significant natural and landscape characteristics.



Map 4.12:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Bar



Map 4.13:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Bar (land uses)

Bar Municipality

25. Zagrađe:

- Surface intended for tourism and tourist settlement;
- Area of very high seismic vulnerability which is absolutely not recommended to be used for planning and construction of objects.

26. Spičansko field (Sutomore):

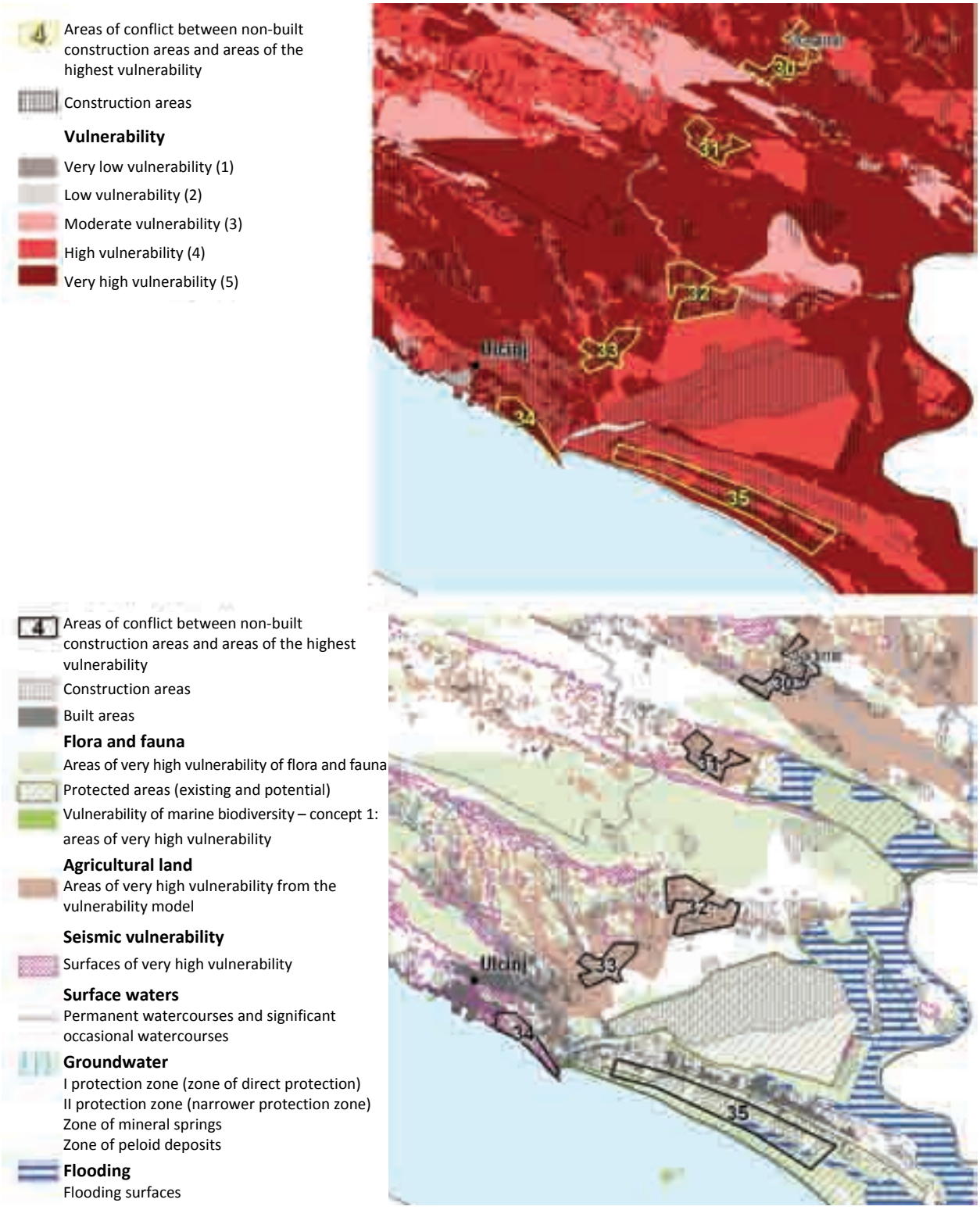
- Surface intended for tourism and housing;
- Area of high vulnerability and potential for agriculture (however, the area needs to be considered in the context of development of Sutomore).

27. Šušanj:

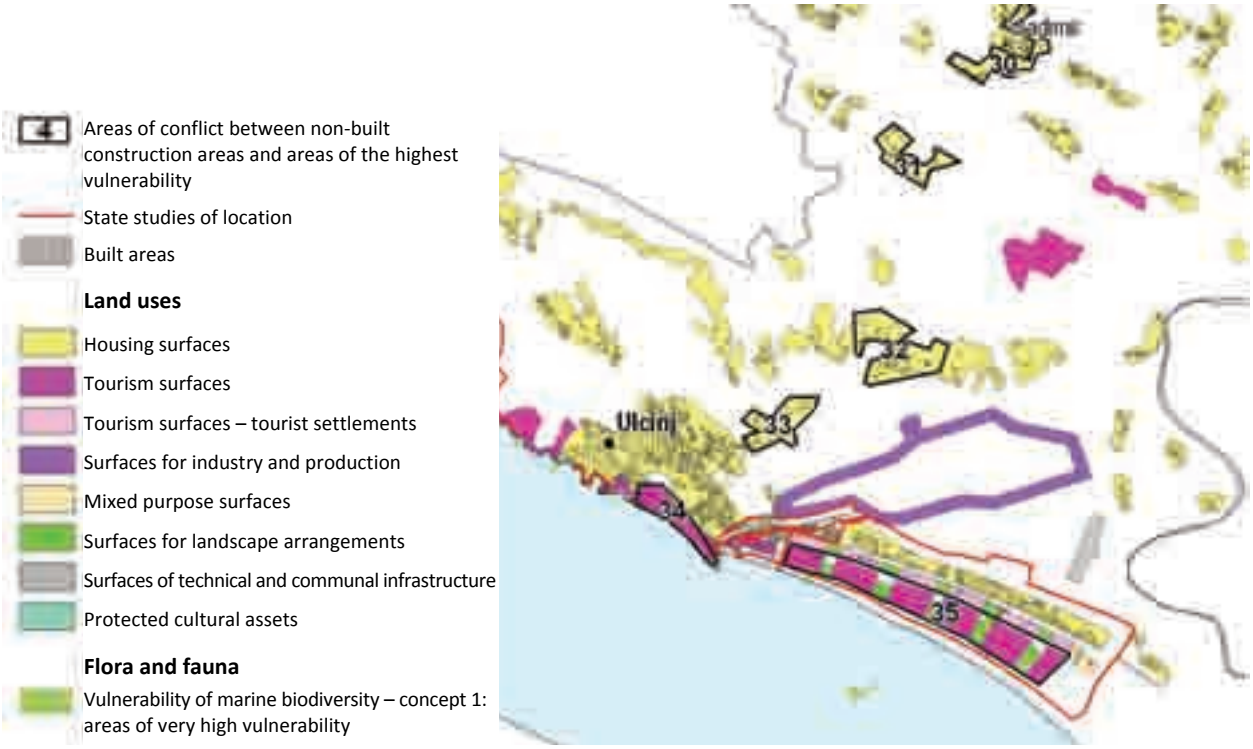
- Surface intended for tourist settlement;
- Area important from nature protection aspect (Ratac with Zukotrlica is monument of nature);
- Area of very high seismic vulnerability which is absolutely not recommended to be used for planning and construction of objects.

28. Župci and 29. Barsko polje – Dobre vode:

- Surfaces for mixed purposes and housing;
- Barsko field and its border areas are characterised by dispersed construction which entirely fragmented agricultural land of otherwise good quality; nevertheless, it is justified to decrease construction areas in border zones of Barsko filed, especially in the stretches towards Dobre vode (there are large reserves for new developments in a way of filling the gaps – rounding up of the existing construction areas).



Map 4.14:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Ulcinj



Map 4.15:
Areas of conflict between non-built construction areas and areas of the highest vulnerability – Ulcinj (land uses)

Ulcinj Municipality

30. Vladimir, 31. Donja Klezna, 32. Žoganj and 33. Kodre – Kolonza

- Housing surfaces;
- Area of agricultural surfaces of exceptional importance;
- Construction area should be limited in a way as to prevent further fragmentation of agricultural surfaces, construction should be directed towards border areas of unbroken parts of agricultural land;
- These guidelines apply to other settlements of Ulcinjsko, Šasko and Anamalsko fields too.

34. Ulcinj

- In the scope of this zone there are minor areas of very high seismic vulnerability which are absolutely not recommended to be used for planning and construction of objects.

35. Velika beach

- Surface intended for tourism and tourist settlement;
- Investment area of national importance;
- Area with high likelihood of significant impacts due to sea level;
- Area significant from nature protection aspect and for biodiversity preservation (sand dunes with halophyte vegetation, grassland and coastal forest habitats) which acts as a limit for interventions in the planned scope and manner;
- Coastal zone is a zone of high seismic vulnerability, covered with thick, soft, untied sandy sediment; during the 1979 earthquake, this zone manifested pronounced dynamic instability;
- Northern part of the area is also attractive for agriculture;
- Related to this, interventions of the planned scope and manner intended for construction of new tourist capacities should be re-examined, given the fact that necessity of preserving the most significant natural and landscape characteristics should be kept in mind.

Total surface of conflict zones is 6,246 ha. Taking into account that the total surface of non-built parts of construction areas is 19,042 ha, it can be concluded that some 33% of non-built construction areas is in conflict with the areas of high and very high vulnerability i.e. with the conflict areas' environmental protection objectives.

Detailed presentation of the scope of conflict zones is provided in the table 4.3.

Table 4.3: Vulnerability of space in the conflict zones

Grade	Very low vulnerability (1)		Low vulnerability (2)		Moderate vulnerability (3)		High vulnerability (4)		Very high vulnerability (5)		
Areas of conflict	ha	%	ha	%	ha	%	ha	%	ha	%	Total (ha)
HERCEG NOVI											
1. Vrbanj	0	0	1	0	11	6	142	85	13	8	168
2. Kruševice	7	1	1	0	44	7	551	85	49	8	652
3. Kruševice	1	2	0	0	4	9	3	7	39	82	48
4. Mokrine – Kameno	6	2	1	0	6	2	52	20	198	75	263
5. Prijevor – Mojdež	2	1	0	0	1	0	123	37	207	62	332
6. Ratiševina – Trebišinj	4	2	1	1	6	4	35	22	117	72	163
7. Sutorina	3	1	0	0	0	0	69	26	193	73	265
8. Žlijebi	0	0	0	1	1	2	0	1	41	96	42
9. Podi – Šašovići – Kudi	2	1	2	0	11	3	84	25	235	70	334
10. Kuti	0	0	0	0	0	0	25	11	202	89	228
11. Biljela – Jošice	1	1	0	0	1	2	1	2	57	94	61
12. Luštica	0	0	17	5	74	22	223	66	26	8	340
Total	**26**	**1**	**23**	**1**	**159**	**5**	**1,308**	**45**	**1,377**	**48**	**2,896**
TIVAT											
13. Bijelske Kruševice	0	0	0	0	1	1	4	8	50	91	55
14. Đurići	0	0	0	0	0	0	3	5	59	95	62
15. Mrčevac	1	1	0	0	0	0	17	21	64	78	82
Total	**1**	**>1**	**0**	**0**	**1**	**>1**	**24**	**12**	**173**	**87**	**199**
KOTOR											
16. Radanovići	2	3	0	0	1	3	27	56	19	38	49
17. Gorovići – Lastva	1	1	0	0	0	0	13	11	101	88	114
Total	**3**	**2**	**0**	**0**	**1**	**>1**	**40**	**24**	**120**	**74**	**163**
BUDVA											
18. Pobori	1	0	2	1	1	1	29	17	143	81	176
19. Ostrog	1	1	0	0	1	0	2	3	69	95	72
20. Mrčevo polje	7	4	0	0	12	7	51	28	112	62	182
21. Prijevor	3	2	0	0	0	0	20	14	121	84	144
22. Kuljače	0	0	0	0	2	4	4	9	42	87	48
23. Sveti Stefan	0	1	0	0	3	9	19	58	10	32	33
24. Buljarica	0	0	0	0	2	3	5	6	75	91	168
Total	**12**	**1**	**2**	**>1**	**21**	**3**	**130**	**16**	**572**	**70**	**823**

Grade	Very low vulnerability (1)		Low vulnerability (2)		Moderate vulnerability (3)		High vulnerability (4)		Very high vulnerability (5)		
Areas of conflict	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**Total (ha)**
BAR											
25. Zagrade	0	0	0	0	5	9	42	83	4	7	50
26. Sutomore	2	3	0	0	11	15	10	14	47	68	70
27. Šušanj	1	2	0	0	3	5	24	43	29	50	57
28. Župci	6	4	0	0	26	18	85	60	27	19	144
29. Barsko polje – Dobre vode	5	1	24	4	54	8	355	54	214	33	651
Total	**14**	**1**	**24**	**2**	**99**	**10**	**516**	**53**	**321**	**33**	**972**
ULCINJ											
30. Vladimir	1	1	3	3	0	0	31	29	72	67	106
31. Donja Klezna	0	0	0	0	0	0	13	13	85	87	98
32. Šasko lake	0	0	0	0	10	12	0	0	78	88	89
33. Žoganj	2	1	0	0	4	2	100	43	124	54	230
34. Kodre – Kolonza	0	0	0	0	0	0	34	29	83	71	118
35. Ulcinj	0	0	0	0	1	1	57	57	41	41	100
36. Velika beach	0	0	0	0	0	0	394	87	59	13	453
Total	**3**	**>1**	**3**	**>1**	**15**	**1**	**629**	**53**	**542**	**45**	**1,194**
TOTAL	**59**	**1**	**52**	**1**	**296**	**5**	**2,647**	**43**	**3,105**	**50**	**6,247**

Conflicts between future marinas, ports and other activities in the coastal zone and vulnerable areas in the narrow coastal belt and in the sea

It is necessary to determine conflicts between future marinas, ports and other activities in the narrow coastal zone and vulnerable areas **in the narrow coastal belt** and in the sea. Conflicts exist or can be created in construction areas defined in municipal spatial plans as well as within the scope of construction areas determined in the adopted studies of location.

Some of the areas that fall within the scope of adopted studies of location encompass areas with *Posidonia oceanica* fields and/ or submarine caves (for example cave Pećin, Kraljičina beach, Mamula, Trašte bay, part of promenade and Slovenska beach up to Zavala hill (parts included in sectors 43 and 45), and Valdanos). In case of construction of marinas or ports, it is required that necessary measures be undertaken to prevent destruction of these exceptionally vulnerable habitats. Some of these areas within the scope of state studies of location encompass sites with preserved nature and landscapes which are therefore highly vulnerable (e.g. Mamula, Valdanos, Velika beach and Ada Bojana).

In order to avoid or mitigate impacts on marine biodiversity and still preserved parts of the coast, **systematic and detailed planning of the narrow coastal zone needs to be undertaken, which entails coordination and control in the preparation of spatial plans**. Special attention needs to be paid to:

- defining a clear **concept for construction of marinas and ports** in a way as to preserve the most significant parts of the coast in terms of valuable landscapes and biodiversity, including **acceptability assessment and defining of adjustment measures for already planned marinas, ports** and other activities in the coastal zone;
- consistent, without exceptions, **prohibition of construction for marinas, ports, sea walls and other built structures within sea water area of sand and gravel beaches** given the fact that these parts of the coast have exceptional significance both for preserving the environment and for tourism offer; it is therefore unreasonable and unjustified to destroy them to build nautical infrastructure that may as well be developed at other locations along the coast;

- **determination of zones of limited or prohibited construction along the coast in line with the ICZM Protocol** i.e. definition of those parts of the coast where conditions for expanding the coastal set back exist as well as those where adaptation (regardless of already accepted construction areas) in the sense of decreasing the coastal set back is not possible due to high environmental vulnerability i.e. due to significant impacts on the environment (proposal of these zones will be included in the *Vulnerability assessment of the narrow coastal zone* and in the *Analysis of guidelines for introduction of the coastal set back*);
- preventing interventions in the areas/ on sites where **pronounced protection of marine habitats is proposed, primarily for *Posidonia oceanica* and submarine caves, and where establishment of marine protected areas is planned and proposed** (vulnerability of marine biodiversity – concept 1, in line with results of research conducted within the project "Start-up of Katič MPA in Montenegro and Assessment of marine and coastal ecosystems along the coast"): 1. Luštica: from Mamula to Mačka cape; 2. stretch from Trašte cape to Platamuni (with a zone of exclusive protection from Žukovac cape to Kostovica cape); 3. zone of the proposed first marine protected area – Katič (including zoning proposal with various levels of protection); 4. stretch from Volujica cape to Dobre vode; 5. stretch from Komina cape to Old Ulcinj peninsula; 6. Stretch from Valdanos cove to Velika beach; 7. Stretch from Đeran and southern part of Velika beach to Bojana river delta.

4.2 Recommendations for Spatial Plan development and for rehabilitation measures

In the *Assessment of general vulnerability*, special attention is paid to recommendations for development of the Special Purpose Spatial Plan for the Coastal Zone of Montenegro (SPSPCZ MNE) and to rehabilitation measures.

Due to substantial pollution that causes high environmental vulnerability, it is necessary for the SPSPCZ MNE to pay particular attention to solutions related to those activities that affect the level of pollution including:

- transport, especially public transport along the coast;
- treatment of communal waste;
- sewage system arrangements; and
- arrangements for marinas and industrial facilities along the coast.

In the local level spatial plans, particular attention needs to be paid to:

- recommendations related to the sites used for mariculture;
- urban solutions that decrease environmental impacts (arrangements for road bypasses, principle of (in)compatible land uses, buffer zones, barriers against noise, protective greenery, etc.).

It is justified to prepare integral operational programme of rehabilitation (with defined responsibilities, financial and dynamic plan) measures as a part of the SPSPCZ MNE or as a separate document. **Rehabilitation of the environment is not just an obligation *per se* but also a precondition for introduction of new activities in the areas where parts of the environment have already been polluted above legally permitted levels or to the extent where new interventions would increase pollution above legally permitted level. Impacts of interventions i.e. of land use changes should be considered as inadmissible unless rehabilitation measures for the existing pollution are implemented.**

5.
Use of results from the assessment of general vulnerability

5.1 Introduction

In addition to other objectives, CAMP was implemented in order to introduce principles and techniques of coastal planning that are based on the necessity of decreasing pressures on the environment, nature and natural assets, and are taking into account natural hazards and climate change. This purpose was to a large extent achieved through development of the general vulnerability model intended to provide guidance for siting decisions in the SPSPCZ MNE in line with the principles of the Protocol on Integrated Coastal Zone Management in the Mediterranean. Through the assessment of general vulnerability, the most valuable spatial units that need to be preserved from future degradation were determined. **Basic purpose of the vulnerability assessment is to determine parts of space where it is less suitable or unsuitable to plan certain activity or intervention.** Results of the vulnerability assessment require two principles of data processing in the spatial plan, which emanate from two basic principles of integrating environmental protection into spatial planning:

1. Results of the vulnerability assessment require spatial and siting improvements in the sense of changing location for a given intervention and defining alternative solutions for determined land uses. Implementation of environmental protection goals is enabled in this way by searching for the least burdening spatial position. Decrease of the existing large construction areas in the zones of high vulnerability can be considered as a special form of spatial improvement too.
2. If it is not possible to avoid solutions that cause spatial vulnerability, results of the vulnerability assessment should serve as a basis for defining possibilities for technological improvements, changes of the existing technologies and introduction of advanced technological alternatives and/ or spatial solutions. By searching for technologies, technological processes or individual activities that are the least burdening for the environment, i.e. by searching for spatial solutions that mitigate negative impacts of a given intervention on the environment, fulfilment of environmental protection goals is enabled.

Assessment of general vulnerability of the coastal zone has been prepared through development of several models, whereas each of them contains specific information and matches various environmental protection scenarios. Different models of cumulative vulnerability of the coastal zone suppose/enable different manoeuvring spaces for harmonising environmental protection goals with development goals. Having in mind **sustainable development** concept and goals, harmonisation should be done gradually by applying the approach where **searching for suitable spaces for development (land use change) is firstly done based on the model/ scenario of maximum/pronounced protection. If harmonisation is not possible, less protective (from the aspect of preserving the environment) models/scenarios should be used in the next step. At the very end of harmonisation process, searching for suitable spaces can be done, very cautiously, based on the model of the lowest level of acceptable protection of environmental elements/segments.**

Assessment of general vulnerability is a complete process whose results are prepared in way that can be used for other purposes in preparing the SPSPCZ MNE. The assessment contains recommendations to guide decision making on siting, as well as rehabilitation measures that need to be included in the SPSPCZ MNE. Even though vulnerability model is exclusively based on expert arguments, it should be mentioned that it is a partly flexible tool which had to be calibrated in the given context.

Montenegrin coastal zone is not *tabula rasa*, but to a significant degree urbanised area with several valid planning documents that plan numerous new interventions in addition to the existing ones, especially for tourism development. That is why application of undertaken assessments and models was necessarily limited by the existing conditions and various inherited rights. In order to be able to propose valid answers to some significant questions, it was important to have more specific information on the number and characteristics of typical situations. In this context, analysis of developed/ built up surfaces and finalisation of the synthesis land use map for the coastal area with all the planned zones were of the outmost importance (specifically, the synthesis map was overlapped with vulnerability and maps of developed areas).

Related to this and in line with planning practices and standards, including GIS standards, suggestions were forwarded and technical assistance provided from the CAMP expert team to the SPSPCZ MNE developers. The objective was to prepare land use synthesis map that can be used for calculation of selected indicators on sustainability of the coastal zone's planning and use. Once synthesis analysis of land uses was finalised by the SPSPCZ MNE developer and CAMP team was additionally engaged to analyse selected elements of the extent to which the space was developed, an annex was prepared to the cumulative vulnerability of the coastal zone and to the analysis of total pollution/ the extent to which the environment was endangered. This was done based on calibration of the assessments' results with complete land use analysis for the coastal zone of Montenegro.

It was only after comparison of the previously mentioned analyses (general vulnerability, land use and the extent to which the space was built up) that a summary overview of possible conflicts between development and protection aspirations was obtained. Afterwards, it was possible to provide integral proposals of possible solutions with a view to necessary preservation of certain zones from further urbanisation, and identify areas where there are no obvious conflicts in space for planning of development activities i.e. where it will be possible to define criteria for applying the coastal set back. Furthermore, summary analysis is also important due to clarity of message to the team for preparation of strategic environmental assessment (SEA) for the SPSPCZ MNE which is now entering active phase, whereas performed analyses represent significant input data for the SEA. Work of the team engaged for the SEA and of the planning team will require adoption of sensitive decisions. That is why it is important to enable (through summary analyses) testing of implications of various approaches for the entire coastal zone (especially when it comes to adaptation of the coastal set back) and their alignment with requirements of the Protocol on Integrated Coastal Zone Management in the Mediterranean.

In this way, the SPSPCZ MNE developer is enabled to, among other things, do the following in the SPSPCZ MNE, in line with the Protocol's requirements:

- Define zones where urban development and other activities are limited, or, where necessary, prohibited;
- Determine planning approach to limit linear spread of urban units;
- Define solutions to limit/ control new transport infrastructure along the coast, including consideration of possible alternative forms of organising public transport;

- Define solutions for providing free access to the sea shore along the coast;
- Exclude planning of unacceptable/ disallowed facilities in the sea where sensitive/protected areas of nature are located;
- Exclude planning of unacceptable/ disallowed facilities in the specially valuable coastal ecosystems , such as wetlands and river estuaries;
- Set up planning solutions to enable implementation of protection and conservation measures for marine and coastal habitats;
- Set up planning solutions for special protection of a small number of islands in the coastal area of Montenegro
- Define zones for mariculture;
- Define zones for port areas;
- Define zones for submarine activities;
- Define zones for agricultural activities and irrigation concept;
- Set up planning solutions for protection of the coastal zone's special aesthetic, natural and cultural values together with bases/ guidelines that require/ enable implementation of integral landscape and architectural arrangements along the coast;
- Set up planning solutions for protection of the coastal zone's special architectural values, together with bases/ guidelines that require/ enable implementation of quality architectural solutions;
- Set up planning solutions for protection of cultural heritage along the coast, including submarine cultural assets;
- Define planning solutions and prevention, rehabilitation and adaptation measures for natural disasters and risks (e.g. climate change, including sea level rise, seismic risk, erosion processes etc.);
- Define instruments for implementation of the planning solutions listed above.

5.2 Additional synthesis valuation of space

Assessments of cumulative vulnerability and pollution/ the extent to which the environment is endangered were prepared in various manners, whereas each approach contains specific information and corresponds with various scenarios of environmental protection and spatial development. In the process of spatial plan preparation, additional synthesis valuation of space might be needed – based on differently defined priorities, significance of individual environmental segments/ elements or the need to resolve specific spatial planning problems. Data in active digital form enable such additional analyses and/ or calibration of models. This said, it should be stressed that vulnerability assessment was based on the use of official data, transparent work and modelling methodologies officially accepted in scientific literature and practical use. Adherence to these principles must be also ensured in case different models are prepared by the SPSPCZ MNE developer or the team preparing strategic environmental assessment for the SPSPCZ MNE.

5.3 Suitability assessment

Results of the general vulnerability assessment can be used for suitability assessment. Basic principle of preparing suitability assessment is shown in the illustration 5 below. Assessment can be done by simple overlapping of maps or by using a mathematical model in an arbitrary GIS programme.

5.4 Strategic environmental assessment

Vulnerability assessment exceeds the needs in the context for preparing strategic environmental assessment based on expert views, which to a certain extent entails subjective expert positions. The assessment

serves as an optimisation tool in searching for spaces where new interventions or activities can be implemented, which gives higher operational value to the requirements of the Directive 2001/42/EC on preparation of environmental assessment in the course of the plan's development. A more objective evaluation of the plan's acceptability for specific area is enabled, together with comparison between the level of acceptability of a specific area and other potential areas for implementing certain intervention. At the same time, definition of a spatial scope of a given intervention/ activity is enabled, taking into account areas with various levels of vulnerability i.e. acceptability.

Vulnerability assessment indicates acceptability of individual interventions (elements of the regional plan) in the context of the entire planning area. However, it is not only the impacts on the "affected" area that are analysed in the assessment – potential impacts that may cause consequences in another part of the considered area are also examined.

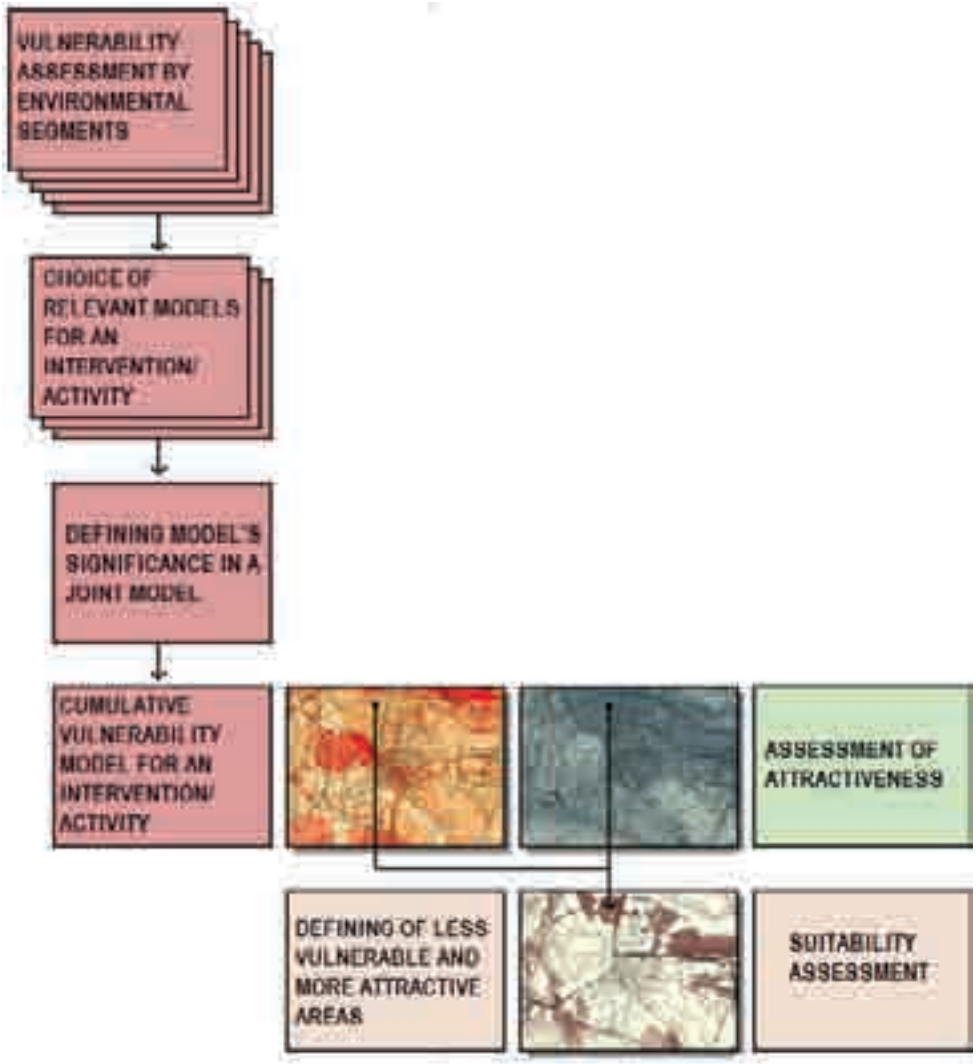


Illustration 5.1: Principle of preparing suitability assessment based on the results of general vulnerability assessment

6.
Overview of sources for maps

Map of the Montenegrin coastal forest communities

- Overview map of the basic forest communities of Montenegro scale 1:300,000; Nature Protection Institute of Montenegro, Podgorica

Protected areas in the Montenegrin coastal region, existing and planned

- Vukić Pulević, Vasilije Bušković, Gojko Nikolić, *„Atlas of biodiversity maps of Montenegro*" scale 1:200,000; USAID-IRD; Podgorica Office (Muhamed A. Latif, USAID Regional Director for the European Union and East Asia, and Teri Hart, Project Manager – CHF IRD); Ministry of Environment of Montenegro; Podgorica; 2005

Protected plant species in the Montenegrin coastal region

- Vukić Pulević, Vasilije Bušković, Gojko Nikolić, *„Atlas of biodiversity maps of Montenegro*" scale 1:200,000; USAID-IRD; Podgorica Office (Muhamed A. Latif, USAID Regional Director for the European Union and East Asia, and Teri Hart, Project Manager – CHF IRD); Ministry of Environment of Montenegro; Podgorica; 2005

Protected dendrological objects in the Montenegrin coastal region

- Vukić Pulević, Vasilije Bušković, Gojko Nikolić, *„Atlas of biodiversity maps of Montenegro*" scale 1:200,000; USAID-IRD; Podgorica Office (Muhamed A. Latif, USAID Regional Director for the European Union and East Asia, and Teri Hart, Project Manager – CHF IRD); Ministry of Environment of Montenegro; Podgorica; 2005

Seismic categorisation of space

- Map of seismic hazard for Montenegro and regions (2000 – 2011)
- Map of seismic micro-regions for all the coastal municipalities (1984 – 1987)
- Map of seismic regions of Montenegro (1985)
- Map of expected maximum seismic intensities in Montenegro (1987)
- Seismological database on temporary and historical seismic activity on the territory of Montenegro
- Basic engineering-geological map 1:100,00o, sheets Budva and Kotor

Corine Land Cover CLC 2006

- European Environment Agency http://sie.eionet.europa.eu/CLC2006

Vulnerability matrix for surface waters from the aspect of their characteristics

- Topographic baselines from 1:25,000 to 1:100,000
- HMZCG hydrological documentation
- Water resources basis of RCG
- Published scientific and expert articles

Matrix of pollution i.e. the extent to which surface waters are endangered

- MPMnt
- MntHMI
- MPMnt
- CETI
- MPMnt – MED POL; Monitoring 2008 – 2009, EPAM, UNEP MAP
- MntHMI – Monitoring the coastal sea water quality, Hydro-meteorological Institute Podgorica, 1983 – 2011
- CETI – Measurements of the Centre for eco-toxicological surveys, Podgorica
- Document *Water quality class and category of water body*, according to the Decree on classification and categorisation of Surface and groundwater (Sl.l.CG br. 2/07) – Regulation III

Matrix of locations with sea eutrophication

- MPMnt08 – MED POL Monitoring 2008, EPAM, UNEP MAP
- MPMnt09 – MED POL Monitoring 2009, EPAM, UNEP MAP
- MPMnt10 – MED POL Monitoring 2010, EPAM, UNEP MAP
- ** *Water quality class and category of water body*, according to the Decree on classification and categorisation of Surface and groundwater (Sl.l.CG br. 2/07) – Regulation II

Soil vulnerability and pollution matrix at *hot spot* locations

- Annual reports on the implementation of programmes of surveying for hazardous and

harmful substances in soil of the Republic of Montenegro 1999 – 2011 **
- SMPSW
- MORT
- CETI report based on Environmental Inspection request
- CETI report based on Environmental Inspection request and results of investigations performed for the EIA preparation for the PM site

Communal waste disposal sites and industrial waste

- SMPSW – Strategic Master Plan for Solid Waste Management, GOPA, project number EAR/03/MTGOI/04/02
- MORT- Data from the Ministry of Sustainable Development and Tourism

Hot-spot locations sea – bioindicators

- Monitoring programme on the state of ecosystems in the coastal sea of Montenegro 2008 – 2011 – Bio-monitoring programme: Analysis of toxicants in shells and red mullets
- Overview of results from eco-toxicological analysis of sediments, grit and soil and biological material in Bijela Shipyard from 2000, 2002 and 2005
- MYTIAD – UNEP project, 2008: Surveying bio-accumulation of heavy metals and POPs in shell fish at Bar, Kotor and Bijela locations
- Programme of systematic monitoring of radionuclides in Montenegro 1999 – 2011: Results of research on the content of natural and artificial radionuclides in shell fish in the Bokokotorski bay

Matrix of the coastal sea vulnerability to wastewater discharged into natural recepient

- Study SS-AE 05.05 Water Resources, prepared for the development of Spatial Plan of Montenegro by 2020 (pp. 48-63), 2007

  Surface and submarine discharges were covered, including industrial wastewater from metal industry Kotor, Port of Bar, Primorka Bar and Shipyard Bijela

  'Existing conditions' from 2007 is also provided and needs to be updated with more recent data
- Results of the analyses of wastewaters near hotel Fjord in Kotor from 2005 – CETI
- Results of the analyses of wastewaters near Pine in Tivat from 2005 – CETI
- Information on submarine and sewage outlets for the Montenegrin coastal region from 1997 (Brano Stjepčević)
- Analysis of Kotor, Tivat, Budva, Cetinje, Bar and Ulcinj wastewaters from June 2007, done by CETI for DHV
- JPMD information from 2002 on sea water pollution, erosion of beaches and unpermitted use of space
- Final technical report for Ulcinj, H. Novi, Kotor, Tivat, Budva, Bar and Cetinje from 2004
- Feasibility study for waste waters in the coastal region, volumes I – IV from 2004

  Vol I: 2003 – 2028 – Main Report

  Vol II: Project description, Phased investment plan

  Vol III: Book I and II interim report, and

  Annexes – impacts on the environment,

  Vol IV: GIS Methodology.

  It is necessary to update some of the data from the period 2003 – 2012
- CETI report from 2005 for Port Milena
- Results of CETI analyses on wastewater quality in Ulcinj, for Velika and Mala beach outlets in 2007 and 2008, done for the needs of ADRICOSM STAR project
- GEOPORTAL WATER ANALYSIS: Waste water analysis for 2007 and 2008 (Ulcinj Velika and Mala beaches); 2009 CETI data for Bar, Sutomore, Kotor, Ulcinj, Risan, Budva, Sv. Stefan, H. Novi, Tivat and Petrovac
- Programme MED POL and Monitoring the state of ecosystems of the coastal sea of Montenegro 2008 – 2011 – entry through effluents. Programme was implemented by CETI for the Montenegrin Environmental Protection Agency. Data contain complete analyses of wastewater from main outlets twice a year with measurements of flow and filed data:

  2008: Hotel Galeb in Ulcinj, Velika and Mala beaches

  2009: Forte Mare – H. Novi, Tivat – Kaliman, Kotor – Pelužica, Budva – Zavala, Bar – main outlet, Ulcinj and Bar main outlets

  2010: Forte Mare – H. Novi, Tivat – Kaliman, Kotor – Pelužica, Budva – Zavala, Bar – main outlet, Ulcinj and Bar main outlets
- Results of surveying wastewater quality on sewage outlets in 2008 implemented by CETI for the needs of DHV: Kotor, Tivat, Budva, Sutomore, Sv. Stefan, Bar, Ulcinj, Petrovac.
- Data from sectoral studies for EIA for PORTO MONTENEGRO from 2007:

  Scheme of the main Tivat outlets

  Sewage system plan, Appendix of the Report IV

Sewage system plan, Appendix of the Report II

Report 1: Feasibility study for the wastewater system rehabilitation

Report III: Main project of the main collector

Report I: Wastewater and atmospheric-rain water – maps

- CETI expert reports from 2007 and 2008:

  Results of surveys for waste waters from Lovanja landfill – Kotor

  YU Briv – Kotor, analysis of waste water and soil

  Waste water Betonjerka H. Novi,

  Waste water from Ulcinj salt works

  Waste water Dinamik Company Kotor

  Analysis of waste water prepared for Dahlem Consulting Engineers, outlets Forte Mare in H. Novi and Bar outlets at 6 locations
- CETI expert reports from 2010:

  Waste water Keka–Komerc Bar

  Waste water Trade Uniq Budva

  Waste water Luk Oil Jaz – Budva

  Waste water ZIB Bar

  Waste water Hotel Avala Budva
- CETI expert reports from 2011:

  Waste water Hemosan Bar

  Waste water Daly Tours – Ulcinj

  Waste water Monteput – Sozina tunnel

  Waste water Sam Komerc – Tivat,

  Kotor and Tivat waste water prepared for Tahal-Fideco, quality, field data and flows

  Waste water Trajan – Bar
- CETI expert reports from 2012:

  Waste water Daido Metal – Kotor
- Materials prepared within ADRICOSM STAR project, Podgorica meeting 2008:

  SGI-Bettin: Modelling of Ulcinj Canalization Scarcini: Urban waters, sediment transport (2009),

  SGI-Bettin: Boka Kotorska model Map of urban discharge of Tivat and Kotor,

  Bettin: Urban monitoring protocol.
- Water resources basis of Montenegro from 2003
- Master plan for collection and treatment of wastewaters for the Coastal region of Montenegro and Cetinje municipality, Main report, February 2004

Hot-spot locations sea – sediments

- Monitoring programme for ecosystems in the coastal sea of Montenegro at *HOT SPOT* locations for toxicants content and granulation. There are coordinates of locations:

  2008: Fraskanjel, Boka Kotorska, Ada Bojana, Port Milena, Bijela, Luka Bar, Valdanos, Luštica(RF) and Dobrota

  2009: Sediments analysis twice a year: Bijela, Barski bay, Arsenal-Tivat, Budva, Kotor, Risan

  2010: Sediments analysis twice a year: Ulcinj, Bar, port of Bar, Budva, Tivat, Kotor, Risan, H. Novi, Bijela, Luštica-Mamula (RF), Arsenal-Tivat, Bijela

  2011: Sediments analysis twice a year: Bar, Porto Montenegro, Bijela, Dobrota, Luštica and Fraskanjel.
- Overview of results for toxicological analyses of sediments, grit and soil and biological material in Bijela Shipyards from 2000, 2002 and 2005
- Porto Montenegro

  Report XVI – submarine investigations

  Chapter 10 – water and sediments – sea

  Chapter 9 – water and sediments – land
- Materials prepared within ADRICOSM STAR project:

  ISMAR-BO: Grain size of surface sediments(2009),

  SGI-Scarcini: Urban waters, sediment transport. (2009),

  IMB: Heavy metals in sediments XRF Method.
- Data on sediments from 2007: IAEA Cruise on Adriatic Sea for heavy metals, organic pollutants, radioactivity and granulations

  Locations 1 m from Bojana river mouth and entrance to Boka Kotorska in front of Mamula (CETI); there are coordinates of locations

Existing areas and objects with noise

- Programme for monitoring environmental noise in 2004. Crossroads in the coastal towns in summer and winter periods: H. Novi, Tivat, Bar, Kotor, Ulcinj, Budva; noise in the vicinity of public institutions: kindergartens etc.; noise at Budva beaches; noise besides railroad in Bar; noise besides airport runway in Tivat and noise besides establishments in Ulcinj.
- Programme for monitoring environmental noise in 2005. *During summer and wither periods:* H. Novi, Tivat, Bar at 3 measuring points (m.p.), Kotor 2 m.p., Ulcinj, Budva 2 m.p. In the vicinity of hospitals: Risan, Kotor and Igalo hospitals; background noise during tourist season in front of establishments: in H. Novi in front of Aquarius, Utjeha – Bar, Baošići, Sutomore, Veliki pjesak – Bar, and Budva.

- Programme for monitoring environmental noise in 2009. Noise in settlements on the main crossroads: Budva, Bar, Kotor, Tivat, Ulcinj, H. Novi during summer period; noise at Tivat airport on 5 m.p.; noise on beaches during summer period at 36 beaches.
- Programme for monitoring environmental noise in 2011. Measurements of noise at crossroads: in Bar at 6 m.p. and in Budva at 5 m.p.; on the main road M2 Tivat – Budva at Radanovići; noise on beaches at 14 m.p.
- CETI report from 2007 for Tivat: measurement of noise at crossroads, Tivat urban and suburban parts; Seljanovo urban and suburban parts; Tivat airport.
- Porto Montenegro: Report XL and annexes 24, 25, 26, and impacts of marina and the main road M2. Model for urban and suburban parts of Tivat and Seljanovo.
- Kala-Longa, H. Novi
- Basketball playground, H. Novi

Air quality zones

- Air quality is observed through the Monitoring programme on air quality in Montenegro 1998 – 2012

  Monitoring programme is implemented by CETI for the environment Ministry and EPA
- 1999, 2000, 2001 and 2002 programmes:

  The following quality parameters are monitored at permanent stations through 24 h samples: SO_2, NOx, O_3, NH_4, H_2S, formaldehyde, suspended particles (SP), smoke and soot, particulate matter (PM), and heavy metals and PAH in PM and SM. Stations are: Bar, Budva, Kotor, Tivat, Ulcinj and Herceg Novi.

  Precipitation is collected on the same locations and is monitored through monthly samples; they are analysed for quality and heavy metals. Impact of motor vehicles: measurements are performed based on 24 h samples by an automatic monitoring vehicle in Bar at the Post Office location, Budva at the Post Office, Kotor at IBM, H. Novi at the Post Office, Tivat at the Health Centre, Ulcinj at Water Utility. The following parameters are monitored twice a year: O_3, SO_2, NOx, NO, NO_2, CO, CH_4, suspended matter, BTX, PM_{10} and meteorological data.

  2003: Air monitoring programme is the same but without Ulcinj locations and without part of the programme referring to measurement of motor vehicle impacts. In the 2004 programme, Ulcinj, Tivat, Budva and motor vehicles were left out.

  2005, 2006, 2007 and 2008: Programme was realised based on 24 h samples in Bar, Kotor and H. Novi with measurements of precipitation for the same parameters in air and precipitation.

  2009: Air quality is monitored based on 24 h samples in Bar, Budva, Kotor, Tivat, H. Novi, Ulcinj for SO_2, NOx, O_3, smoke and soot, total suspended particles (TSP), total particulate matter and content of heavy metals and PAH in TSP and PM. Impact of motor vehicles: monitored in 7 days cycles by mobile monitoring vehicle for SO_2, NO, NO_2, CO, PM_{10}, O_3, BTX and meteorological data.

  2010 and 2011: Automatic monitoring station in Bar is established as a part of the State network of monitoring stations; at the station, measurements for SO_2, NO_2, NO, NOx, PM_{10}, O_3, PAH in suspended particles and meteorological parameters are performed.

  2012: Automatic measurement station in Tivat started operation as a part of the State network of monitoring stations.
- Imission measurements of harmful and hazardous substances in air done for the EIA for Porto Montenegro in 2007 (CETI): Concentration of SO_2, NOx, CO, THC and PM_{10} in ambient air at the following locations: crossroads of the Adriatic main road and N. Đurkovića street; crossroads of the Adriatic main road and 21st November street; crossroads of the Adriatic main road and the entrance road to Tivat airport; and Tivat airport – standing platform. Measurements are done by mobile automatic station.
- Study for Porto Montenegro EIA, CUW- UK – Report XX. Air Quality models for:

  Emission of pollutants from line transport sources along local road network;

  Emission of pollutants from surface transport sources in larger towns in Boka Kotorska;

  Impact of the marina construction itself;

  Impact of marina's operation that primarily refer to air pollution due to yacht activities along supposed maritime route (line pollution source) as well as in manoeuvring regime (surface pollution source).
- Cadastre of polluters in the Coastal region – measurements of emissions at pollution sources (CETI):

  Measurements of emissions from ZIB Bar, quarry and grinder

  Gugi Komerc Budva

  Haj-Nehaj quarry

  Krušo – H. Novi

  Dinamic Company Kotor

JKP Kotor

Tujko Kotor

Bathymetry matrix

- Maritime maps scale 1:25,000
- Topographic maps scale 1:25,000 (TK25)
- Multi-beam survey in the ADRICOSM project

Vulnerability matrix – bathymetry

- Maritime maps scales 1:25,000, 1:100,000 and 1:300,000
- Topographic maps scale 1:25,000 (TK25)

Waves, Vulnerability matrix – waves

- Data from tide station in front of Boka Kotorska
- Data from tide station in front of Dubrovnik
- Studies and scientific articles of HIJRM SFRJ experts

Accidents, Vulnerability matrix – accidents

- Montenegrin Law on the Sea
- Protocol on temporary delineation on the sea between Croatia and Montenegro
- Maritime maps of sea water area
- UN Convention on the Law of the Sea (UNCLOS)

Vulnerability matrix – sea changes

- Record from permanent mareograph in Bar (1996 – 2012)
- Record from permanent mareograph in Dobra Luka (2001 – 2005)
- Record from permanent mareograph in Kotor (2010 – 2012)
- Record from transferable mareograph: Herceg Novi, Budva (2012)
- Studies of HIJRM SFRJ experts
- Record from permanent mareograph in Bar (1996 – 2012)
- Record from permanent mareograph in Dobra Luka (2001 – 2005)
- Record from permanent mareograph in Kotor (2010 – 2012)
- Record from transferable mareograph: Herceg Novi, Budva (2012)
- Studies of HIJRM SFRJ experts

Quality of the coastal sea

- MPMnt08
- MPMnt09
- MPMnt10
- PPEBK
- MPMnt – MED POL Monitoring 2008-2009-2011, Monitoring CETI 1998 – 2002, Adricosm 2007 – 2009, EPAM, UNEP MAP
- MntHMI – Monitoring of the coastal sea quality, Hydro-meteorological Institute Podgorica, 1983 – 2011

Matrix of the sea eutrophication locations

- MPMnt08
- MPMnt09
- MPMnt10
- MPMnt08 – MED POL Monitoring 2008, EPAM, UNEP MAP
- MPMnt09 – MED POL Monitoring 2009, EPAM, UNEP MAP
- MPMnt10 – MED POL Monitoring 2010, EPAM, UNEP MAP

Paedology

- Biotechnical Institute of Montenegro (2012)
- Atlas of paedological maps of Montenegro 1:50,000
- Paedological maps of Montenegro (updated and amended by B. Fuštić 2012)
- Sheets: Ulcinj, Bar, Kotor, Budva

Basic engineering-geological map

- 1:100,000 – Sheets: Budva i Kotor

Basic geological map for SFRJ

- 1:100,000 – Sheets: Ulcinj, Bar, Budva, Kotor, Dubrovnik

Tectonics/faults in the Montenegrin coastal region

- Basic geological map of SFRJ 1:100,000 – Sheets: Dubrovnik, Kotor, Budva, Bar i Ulcinj

Water springs/sanitary protection zones in the Montenegrin coastal region

- Cadastre of water occurrences

Sanitary protection belt – stripe around the regional water supply system pipeline, MNE coastal region

- Regional Water Supply project – derived situation (.dwg)

Water springs – chemical traits

- Geological Institute of Montenegro – database

Peloids in the Montenegrin coastal region

- Shape files provided by experts

Digital terrain elevation model

- DMT Aster (pixels 27m 30m) – MTOR (2012) GIS team digital preparation

- GIS baseline – scanning, geo-referencing, digitalisation of the content of table attributes (ID number)
- Isohypses at 50 m (38 hypsometric layers)
- Slope %
- Aspect
- URL 1: USGS(2006). US Geological Survey, http://edcdaac.usgs.gov/gtopo30/README.asp, (1.3.2012)
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- URL3: ETOPO2 Global Topography, www.ngdc.noaa.gov/mgg/fliers/01mgg04.html , (1.3.2012)
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Topography map

- Topographic map of Montenegro UZNCG (Real Estate Administration) 1:25 000 digital map
- Topographic maps – applications of the Real Estate Administration of Montenegro (www.nekretnine.co.me). Geoportal of the Real Estate Administration prepared in line with the EU INSPIRE Directive (see www.geoprtal.co.me and www.geoportaluzn.me)
- Web site of the Real Estate Administration provides two i.e. three web applications:
  - Digital map of Montenegro;
  - Digital topographic map TK 25000;
  - Spatial units – application done for the needs of the Statistical Office of Montenegro – MONSTAT (www.monstat.org).
- Digital map of Montenegro (2009) – encompasses standard scale series that covers the entire territory of Montenegro (mosaic of DKP, topographic and overview-topographic, satellite, DMT and relief models and orthophotos).

  The application has layer structure of vector and raster data for:
  - Montenegrin boundaries with border crossings;
  - Names;
  - Road network and ferries;
  - River network (rivers, streams and hydro technical objects) and major river courses;
  - Railroad network and objects (bridge, tunnel);
  - Important objects;
  - Objects;
  - Lakes;
  - Settlements;
  - Categorisation of surfaces;
  - National parks;
  - Municipal boundaries;
  - Digital terrain model;
  - Shaded terrain model;
  - Satellite image;
  - Relief.
- The application has services for data searches:
  - By address (street, settlement);
  - By object – categories (all, commercial building, school, monument, market, kindergarten, health institutions, theatres, hotels, industrial facility, sacral object, faculty, museum, cinema, sport ground, shopping centre, public institution, vine cellar);
- The map has max enlargement up to the scale 1:2500, and it is possible to define and/or check some of the offered scales (1:5000, 1:25 000, 1:50 000, 1:100 000, 1:300 000, 1:500 000, 1:1 000 000).

Borders of Montenegro

- 1:50 00 shp file MTOR CG Podgorica (2012)

Erosion

- Biotechnical Institute Podgorica
- Atlas of paedological maps of Montenegro
- Topographic maps 1:25 000 Sheets: Bar, Ulcinj, Kotor

Montenegrin coastal region – watersheds

- HMZ Crne Gore
- Raster and vector 1:25 000
- 13 watersheds and Adriatic sea catchment

Coastal region of Montenegro – fishing outposts

Maximum 24 h in the MNE coastal region, precipitation, relative humidity, temperature, fires, winds

- Database and HMZCG documentation (2012)

7.
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CAMP Montenegro is a programme implemented jointly by United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP) and the Montenegrin Ministry of Sustainable Development and Tourism (MSDT), with the involvement of local governments from the project area and of other relevant institutions.

The main objectives of the CAMP Montenegro include:

- creation of necessary mechanisms that can help achieve sustainable development of the coastal area;
- support for the implementation of national policies and the ICZM Protocol of the Barcelona Convention;
- promotion of integrated and participatory planning and management in the coastal area;
- development of national and local capacities for ICZM and raising awareness of the importance of the coastal area, complexity and fragility of its ecosystems and of the need for integrated approaches in managing them;
- facilitation of the transfer of knowledge on ICZM tools and approaches.

The main output of the programme is the ICZM Strategy and the Plan for Montenegro.