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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

CETI	Center for Ecotoxicological Research in Montenegro
MNE	Montenegro
NWMP	The National Waste Management Plan for the period from 2014 until 2020
EIA	Environmental Impact Assessment
ERM	Environmental Remediation
EU	European Union
GHG	Greenhouse Gas
IBA	Important Bird Areas
IPCC	The Intergovernmental Panel on Climate Change
CC	Climate change
KAP	Aluminium Plant Podgorica
MONSTAT	Statistical office of Montenegro
MSDT	Ministry of Sustainable Development and Tourism
NP	National parks
NBSAP	National Biodiversity Strategy and Action Plan for the period 2010-2015
RER	Renewable energy resources
PDP	Physical Development Plan
PUP	Physical and urban planning (scheme)
SEA	Strategic Environmental Assessment
SWOT	Analysis of organizational strengths, weaknesses, opportunities and threats
UNDP	The United Nations Development Programme
IHMS	The Institute of Hydrometeorology and Seismology
MPA	Marine Protected Areas
PA	Protected Areas

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NON-TECHNICAL SUMMARY

This non-technical summary comprises an overview of key assessments and consultations conducted as part of the strategic environmental assessment for the National Waste Management Plan in Montenegro. The summary is divided into seven parts:

1. The objective of the National Waste Management Plan in Montenegro
2. The objectives and steps of the SEA procedure
3. The scope of assessment and methodology
4. Key findings related to certain facilities/plants
5. Key findings related to the options proposed for the waste management system
6. Recommendations on the implementation of the waste management system
7. Recommendations on the implementation of the sewage sludge management system.

1. The objective of the National Waste Management Plan in Montenegro

The main reason for developing and adopting the National Waste Management Plan in Montenegro stems from the requirements under the Waste Framework Directive, and under the Act on Waste Management ("Official Gazette of Montenegro" No. 64/11) on the need to develop a new National Waste Management Plan for the period 2014 -2020 (hereinafter referred to as: NWMP).

The waste management plan for the period 2014-2020 was developed in the period from October 2012 until April 2014 as part of a project funded by the EU (EuropeAid/131273/C/SER/ME), dealing with the preparation of the National Waste Management Strategy, a number of local waste management plans and the implementation of various analytical and capacity building activities concerning waste management in Montenegro. The National Waste Management Plan aims to provide a practical framework for the implementation of the National Waste Management Strategy of Montenegro and to identify priority activities for implementation.

Despite the fact that the preparation of the initial NWMP draft, as part of the said IPA project, included a wide range of consultations with relevant stakeholders, many questions were raised about the financial feasibility of the proposed waste management system during the final presentation of the NWMP draft in March 2014.

Therefore, the UNDP decided to support MSDT by developing a study on alternative scenarios for waste management locations, and later a study on options to modify NWMP. Both studies provided alternative proposals to be taken into consideration.

So as to facilitate decision-making process with regard to available planning options, a strategic environmental assessment procedure (SEA) was initiated in order to assess impact of all main proposals resulting from the EU and UNDP support to MSDT during the planning process of NWMP.

2. The objectives and steps of the SEA procedure

The primary objective of this SEA is to facilitate a transparent discussion on possible environmental implications of different options envisaged by future waste management system in Montenegro. The SEA was initiated by the Ministry of Sustainable Development and Tourism in the summer of 2014 and was funded by the European Union. For this purpose, a team of independent experts was engaged who were not involved in previous discussions about waste management in Montenegro. A Strategic Environmental Assessment of Waste Management Plan was carried out in accordance with the Act on

Strategic Environmental Assessment ("Official Gazette of Montenegro" 80/05 of 28 December 2005, 73/10 of 10 December 2010, 40/11 of 08 August 2011) and the EU Directive on the assessment of the effects of certain plans and programs on the environment (Directive 2001/42/EC, COM/2009/469.)

The SEA team carried out its first activity in the period between 17 until 19 November 2014 when all key stakeholders were consulted, with an aim of defining their key issues. Bearing in mind differences of opinion on the technical and financial suitability of the proposed NWMP, the SEA team concluded that it would be useful to encourage an open discussion about possible alternative options for waste management in Montenegro and to assess, in a transparent manner, possible environmental, technical and economic consequences.

On 15 December 2014, representatives of the MSDT and the SEA team organized a workshop attended by 40 representatives of municipalities, relevant state bodies and non-governmental organisations. The workshop was held during the second visit of the SEA team (14-18, December 2014) and was chaired by MSDT's state secretary. During the workshop, all stakeholders were encouraged to put forward their proposals about projects dealing with waste management facilities, which they found to be economically or technically more feasible than the proposals presented in the NWMP draft. The SEA team also visited the municipality of Nikšić so as to get more detailed information on their proposed facility project - waste-to-energy plant, which is supposed to provide a centralised solution to waste management system in Montenegro. As it was not possible to get more detailed information about this facility, the SEA team agreed with the representatives of the Nikšić municipality that available information on the basic characteristics of the potential facility would be provided.

From 9 February until 13 February 2015, the SEA team made a third visit in order to conclude a discussion on proposed alternatives and to define effects and options which need to be considered in the SEA report. Since most stakeholders experienced some problems when formulating alternative proposals which needed to be considered, the SEA team agreed with the representatives of MSDT and the EU delegation to hire additional expert services which would consider each proposed option and examine their economical and technical characteristics.

On 24 March 2015, during the fourth visit of the SEA team, MSDT organised a workshop attended by 27 representatives of relevant stakeholders, with an aim of holding a discussion on alternative proposals contained in the NWMP, which were developed by the UNDP with the support of MSDT. The workshop was chaired by MSDT's state secretary. The workshop also presented preliminary frameworks, developed by the SEA team, for analysis of economical and environmental implications of the proposed options. During this visit from 23-26 March 2015, the SEA team visited the representatives of the municipalities of Bijelo Polje, Nikšić and Herceg Novi and conducted a field survey and consultations about the status of the planned waste management facilities.

The fifth visit made by the SEA team (5-8 May 2015) included workshops, held on 7 May, intended for municipalities (26 participants) and non-governmental organisations (6 participants). Both events, chaired again by the MSDT's state secretary, provided an opportunity to discuss draft proposals for alternative options of NWMP, developed as part of UNDP project, and to also discuss preliminary findings made by the SEA team on their technical, financial and environmental implications.

Based on the results of those consultations, a SEA report and a report on economic and technical implications of the proposed options for waste management were completed on 28 May 2015. Both documents were subsequently submitted to the MSDT in order to initiate an official procedure of wider public consultations with competent bodies and the public.

3. The scope of assessment and methodology

During the strategic environmental assessment procedure, the comments obtained during the workshop with relevant stakeholders, on 15 December 2014, were taken into account as well as the consultation results obtained during the second and third visit of the SEA team, in particular workshops and additional consultations, so the SEA team and MSDT representatives decided to include the following possible impacts and risks into the assessment scope:

- Air (air emissions, unpleasant factors such as smell, dust and noise; greenhouse gas emissions, possible cross-border impacts)
- Water (risks of pollution of surface waters, pollution of underground waters, pollution of sea waters, flooding)
- Land, soil (reallocation of the current land use, soil contamination)
- Biodiversity and landscape (loss and fragmentation of the habitat, loss of ecological network area, loss of protected areas, disturbing of protected, rare and threatened species)
- Population health (risks of chemical contamination, hazardous materials, microorganisms, pollution of drinking water, cumulative risks to public health)
- Material assets (pressure through reconstruction or construction of the new accompanying infrastructure, changes in value and ownership)
- Cultural heritage (damage to possible archaeological sites or other objects of cultural heritage, other interferences).

The SEA is first and foremost focused on key decisions with regard to the following four options for waste management system:

- Initial proposal based on the first NWMP draft 2014: This option recommends that 5 waste management regions with 5 sanitary landfills be constructed. It includes the existing landfill in Podgorica, Ulcinj/Bar and proposed landfills in Berane, Nikšić and Herceg Novi as well as a development of accompanying infrastructure for continuous operation.
- Alternative proposal NWMP - option 1: This option recommends that 5 waste management regions with 5 sanitary landfills be constructed - it includes 2 existing landfills in Podgorica, Ulcinj/Bar and proposed landfills in Bijelo Polje, Nikšić and Herceg Novi. It also includes necessary investments in the accompanying infrastructure necessary for system operation.
- Alternative proposal NWMP - option 2: This option recommends that 3 waste management regions with 3 sanitary landfills be constructed - it includes 2 existing landfills in Podgorica, Ulcinj/Bar and one proposed landfill in Bijelo Polje for the north region area. It also includes necessary investments in the accompanying infrastructure necessary for system operation.
- Alternative proposal NWMP - option 3: This option recommends 1 waste management region which would cover the entire country and it would also include a thermal waste treatment plant (waste-to-energy plant), which would most likely be located in Nikšić. The proposal includes necessary investments in the accompanying infrastructure necessary for the system to operate across the country.

The strategic assessment was focused on impacts of proposed new facilities and activities and did not take into consideration facilities already in use (landfill in Podgorica and Bar). As these options propose different numbers of new facilities and require different needs in terms of waste transport, the strategic assessment provided a broader insight into possible risks to environment with regard to transport requirements for every option.

The assessment of the mentioned options included a review of existing information on the environment (national and municipal physical development plans, state of environment reports, thematic studies and primary data provided by the relevant bodies), a review of specific characteristics of proposed locations for the waste management facilities, a compilation of relevant maps and spatial data in the GIS and assessment of possible risks and impacts of proposed planning options based on expert evaluation. The assessment included risks associated with regular operation, as well as the risks associated with possible accidents. The assessment also determines their relevant significance. The results were visually presented through matrices which outline identified risks and effects of every option under consideration. The results were visually presented as table matrices which include identified risks and effects of every option.

The assessment did not include constraints resulting from greater uncertainties, except those resulting from strategic nature of planning documentation. The only significant uncertainty stems from the lack of detailed information on possible thermal waste treatment plant (waste-to-energy plant) because, at the moment, there is no detailed information neither on specific technologies which may be used nor on possible locations for such a facility and accompanying infrastructure. Another uncertainty stemming from the lack of more comprehensive knowledge is a complex hydrogeological situation on Duboki Do location and contradictory requirements laid down in relevant regulations (Ordinance on determining and maintaining zones and areas of sanitary protection of water sources and limitations in those zones ''Official Gazette of Montenegro'', No. 66/09 of 2 October 2009 and *Ordinance on more detailed location characteristics, construction conditions, sanitary and technical conditions, operation manner and closure of the landfill (''Official Gazette'', No. 31/13 of 5 July 2013),* with regard to landfill location in sanitary protection zones.

4. Key findings related to certain facilities / plants

Various waste management options that have been considered pose varying degrees of environmental risk and are summarized in the table below.

As can be seen from the table, sanitary landfills on locations of Ramčina and Zaton (Bijelo Polje) and Budoš (Nikšić) seem the least potentially problematic facilities for waste management system. These locations are further away from settlements, they have a relatively good access in terms of waste transport (in comparison with other landfills), stable geological conditions, lower risk of possible pollution of surrounding watercourses and low environmental vulnerability of local area.

Other alternative locations of Goja and Kumanica (Bijelo Polje) are also acceptable in terms of environmental protection. These locations are potentially risky due to the vicinity of surface water courses and ecological network areas and their visual exposure. However, these risks can be reduced to an acceptable level by applying protection and mitigation measures provided in the project's environmental impact studies and by applying good environmental management during the operation of landfills.

The location of the sanitary landfill Duboki Do (Herceg Novi) is a more problematic facility of the waste management system. This site is risky because of its complex geological structure, distance of the area with an extremely large amount of precipitation in the wider Mediterranean region and the immediate vicinity of the future national park and UNESCO's World Heritage area of the Kotor - Risan bay. This location is also characterised by the risk of possible pollution of the water wells in the area in case of an accident (leakage or spillage from the landfill during extreme rainfall).

Table 1. Overview of key impacts/risks to the environment of the proposed options

Impact / risk	INITIAL PROPOSAL						OPTION 1						OPTION 2		OPTION 3	
	Sanitary landfill - Vasov Do (Berane)		Sanitary landfill - Budoš (Nikšić)		Sanitary landfill - Duboki Do (Herceg Novi)		Sanitary landfill - Bijelo Polje (Ramčina, Zaton)		Sanitary landfill - Budoš (Nikšić)		Sanitary landfill - Duboki Do (Herceg Novi)		Sanitary landfill - Bijelo Polje (Ramčina, Zaton)		Thermal treatment (incineration)	
	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Regular operation	Accident
Air																
Climate factors																
Water																
Land, soil																
Biological and landscape diversity																
Population, public health																
Cultural heritage																
Material assets																

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

A very risky option is the current proposal for facilities for thermal waste treatment (waste to energy plant) in Nikšić. This proposal is at an early stage of initial design idea hence any further parameters of this facility remain unknown. From what can be inferred about the possible project[1], this option could face several significant risks both during its regular operation, and during accidents. Most significant question is those of the possible impacts and risks to the quality of air, soil and water, and consequently human health.

Finally, the locations of the sanitary landfill in Berane (Vasov Do) and Bijelo Polje (Čelinska Kosa 1 and 2) do not represent a favorable option because they pose a potential risk to the environment. The site Vasov Do is located along a watercourse and causes the existing water pollution; the site Čelinska Kosa 1 is on an intermittent watercourse in the vicinity of an ecological network, while the site Čelinska Kosa 2 is located within the ecological network.

5. Key findings related to the options proposed for the waste management system

When comparing environmental impacts of the four options for waste management system in Montenegro - the initial proposal (2014) and three options proposed in the revised draft NWMP, the strategic assessment reached the following conclusions:

- The least risky alternative proposal is Alternative Option 1 which includes two rather unproblematic proposals for sanitary landfills in Bijelo Polje and Nikšić and one potentially problematic sanitary landfill proposed in Duboki Do. This system is characterized by transport of waste on a relatively short distance. The option includes the possibility of a limited risk of accidents both on-site and during transport. The only problematic proposal, the location of Duboki Do - to be implemented as the last possibility within this option - and only after clarification of all uncertainties related to a possible conflict situation involving the sanitary protection zones in the area. If possible serious risks of pollution of the water supply system of the Morinje springs are confirmed, it will be necessary to look for alternative locations for the sanitary landfill area of Herceg Novi.
- A risky proposal is the Alternative Option 2, which includes many of the same features as Option 1 but does not include the location of the sanitary landfill Budoš (Nikšić) which is considered unproblematic. This option involves greater transport requirements that are associated with higher risks during waste transport. Therefore, the strategic assessment ranked this option as second favorable.
- The most risky proposal is Alternative Option 3, which includes a centralized facility for thermal waste treatment (waste to energy plant) in Nikšić. Since more detailed information on this potential project is still missing at this moment, this option may, at best, be characterized as having moderately significant adverse impacts in terms of quality of air, soil and water as well as significant for risks associated with the transport of waste. This plant is very vulnerable when it comes to mistakes in management of the facility which can easily lead to an accident with serious consequences. Option 3 may have an adverse effect due to a number of possible

[1] Despite the contacts that were established with representatives of the municipality of Nikšić on several occasions, the SEA team was unable to get material with design data and the features of such a plant. Suggestions on the SEA report were obtained from the municipality of Nikšić on 26 May and they stated as follows: "Bring the Report on SEA in line with Article 15 of the Act on Strategic Environmental Assessment", which specifies the content of the strategic assessment report. The part that describes the impact of the landfill must take into account that this is a technology that significantly affects all segments of the environment during the operation of the landfill. The environmental impact will remain great even after closure of the landfill, which implies decade-long monitoring. We believe that it is necessary to find a solution in the modern technologies that are applied in the EU countries (Germany, Sweden, etc.) in order to protect the environment."

accidents (during operation of the plant, during disposal of residual waste after the thermal treatment and the transport of waste over long distances). Moreover, a centralized solution will make the whole waste management system of Montenegro reliant on continuous and uninterrupted operation of one single thermal waste treatment plant and it is impossible to predict what could happen in case of a shutdown of thermal waste treatment plant due to routine maintenance, or as a result of possible accidents, or due to other factors (such as economic, legal, etc.). Taking into account all the risks, it is recommended to approach this option with extreme caution.

6. Recommendations on the implementation of the waste management system

The goal of Montenegro is to develop as ''democratic, welfare and environmentally friendly state'', which is also stated in the Constitution. The country boasts areas of great environmental significance and extreme beauty. Environmental protection is one of the prerequisites of fast growing tourism industry which is becoming one of the pillars of national economy.

According to a report made by the World Travel & Tourism Council, one third of total capital investment in the county is channeled into travel and tourism industry and total investments are expected to grow significantly in the next ten years. Good prospects in tourism, however, may be put at risk because of waste management system which, to date, has been only partially developed. Littering is becoming more widespread, both along the roads and in urban areas while the number of dumpsites is also increasing - according to Ozon NGO there are more than 200 dumpsites across the country. In this context, it is becoming necessary to find a cost-effective management system which would provide a practical, economical, environmentally and technically suitable solution.

Bearing in mind environmental protection and having considered risks associated with proposed options for future facilities of waste management system, the following is recommended:

1. **Urgent** establishment of the basic system which will ensure that all waste is collected, source waste separation is optimised and will also ensure a collection of hazardous waste from household waste. These basic components of waste management system provide several benefits such as:
    a. relatively simple operation and management and high degree of self-sustainability,
    b. laying down basic conditions which will allow for EU recycling objectives to be achieved, and
    c. reduction of operating costs associated with management of residual household waste.

2. **A short-term priority is** the setting up of sanitary landfill(s) and reduced transport of municipal waste to the only two existing sanitary landfills in Montenegro. The following specific recommendations are:
    a. primary attention should be directed to the feasibility studies for a sanitary landfill in the municipality of Bijelo Polje; locations Ramčina and Zaton as the most suitable for a further detailed design elaboration,
    b. the construction of a sanitary landfill at the location of Duboki Do should be continued only if the results of hydrogeological research which are in progress, exclude the risk of a possible entry of the leachate from the landfill into water wells of Morinjski izvori (springs) for the water supply of the population. The project must include the construction of landfills, a robust and user-friendly system of collecting rainwater during the possible occurrence of extreme rainfall, as deterioration of the situation, due to predicted climate change, is expected in the future. It is recommended to postpone a decision on the final adoption of a

sanitary landfill site until the contradictory requirements of relevant regulations are clarified (Ordinance on the determination and maintenance of zones and areas of sanitary protection of sources and limitations in those zones "The Official Gazette of Montenegro", no. 66/09 of 2 October 2009 and the Ordinance on the detailed characteristics of the location conditions for construction, sanitary and technical conditions, mode and closing landfills ("Off. Gazette of Montenegro", no. 31/13 of 07.05.2013) related to the location of a sanitary landfill in the area of sanitary protection zones.

c. the municipality of Nikšić is advised to keep the planned sanitary landfill on the location Budoš in its documents for physical development planning. This option may prove useful for the Municipality in the context of future decisions regarding the facility for the thermal treatment of waste (waste-to-energy plant) because of the practical need to find safe locations for waste disposal generated by any of these facilities (except for the plasma technology which does not offer a cost-effective option in the current economic situation of Montenegro). The region of Nikšić is of a very complex geological structure, facing the problems of water pollution and high risk of flooding which may become more serious with the changes in climatic conditions. At the same time, the location of Budoš is one of the best sites for sanitary landfills, currently available in Montenegro. The location can be used for waste disposal for short-term needs of the system of waste management, as well as for the future disposal of residual waste generated at the waste-to-energy plants, if such a plant should be built in the area of Nikšić.

3. The above mentioned facilities should be able to provide service for emergency and short-term needs of the waste management system in Montenegro. **The long-term** planning for waste management system in Montenegro will at the same time significantly benefit from the two planned simultaneous plans:

a. facilitated planning of additional sanitary landfills in the North region that could provide opportunities to reduce transport requirements and operating costs of the waste management system. Additional sites also allow a more competitive environment on the market of waste disposal in Montenegro. In this regard, it is useful to encourage municipalities to identify appropriate locations and transparently compare their profitability using, for example, the criteria to determine the location of sanitary landfills (MSDT). During such a process, the municipalities should be encouraged to take into account, to the greatest extent possible, the existing polluted (industrial) sites, which due to their features can offer a better solution for the location of facilities for waste management system than the current locations, which are often found at significant distances from the villages in intact natural environment.

b. making a detailed feasibility study for the thermal waste treatment plant (waste -to-energy plants) in Montenegro. This document is required due to the lack of any supporting project documentation for the planned plant - waste-to- energy plant in Nikšić. Such a document should examine the possible technological options (e.g. the technologies involved in option 2 as well as the possibility of using mechanical and biological treatment, which was left out of the current discussion) for this kind of facility as well as possible locations for the plant. Ideally, a feasibility study should consider alternative locations that can offer an optimal solution in terms of transport requirements and the vulnerability of potentially endangered environment.

The next stage in the planning of waste management in Montenegro, which should realistically start in 2018 or 2019, should transparently compare the implications of the planned proposals which were put forward in both of the above mentioned "plans". In order to ensure that the practical proposals come in

time in order to take into account the planning of NWMP for the period after 2020, it is advisable to mobilize the available resources of financing and start with both "plans" during 2016.

7. Recommendations on the implementation of the management system for sewage sludge

As a short-term solution it is recommended to use sludge to recultivate the polluted areas. As a medium-term proposal (after re-cultivation of all landfills) a treatment with the production of biogas (anaerobic digestion) is recommended and the system for the remaining sludge treatment on reedy fields. The long-term solution of the sludge treatment may represent a continuation of the previously mentioned treatment options or a part of the centralized concept which involves incineration in the plant for thermal treatment of waste (waste-to- energy plant), provided that the authorized inspection efficiently ensures the transport of sludge to the final thermal treatment plants.

Notes on the additional technical and financial assessment

The above mentioned recommendations are formulated solely based on the examination of possible environmental impacts. In this regard, the advice to readers is to review the report, "Technical and financial evaluation of the proposed options," which is available as a separate document in this SEA report. It should be noted that the preparation of the technical and financial evaluation have proved to be a very useful addition to the SEA procedure which can significantly encourage consultations with the relevant stakeholders.

1. OVERVIEW OF CONTENTS AND MAIN OBJECTIVES OF THE WASTE MANAGEMENT PLAN AND ITS RELATION TO OTHER RELEVANT PLANS AND PROGRAMS

1.1. CONTENTS AND MAIN OBJECTIVES OF THE WASTE MANAGEMENT PLAN

Waste Management Plan of Montenegro for the period 2014 - 2020 (2014)

The plan deals with developing options proposed in the National Waste Management Strategy by 2020 (draft completed in February 2013), as well as defining the data of the current situation on the basis of more precise indicators, as well as the presentation of more accurate and valid technical, statistical and financial projections of the conditions for a longer period of time. Data for the whole territory of Montenegro is taken into consideration as well as data relating to the individual municipality. NWMP accepts and confirms the assessment set out in the Strategy and analyzes the option of setting up five (5) regional centers - Center 1, Center 2, Primorje 1, Primorje 2, North 1.

Waste Management Plan proposes the study of additional options which can be compared with the option that is elaborated as the only solution in the Plan (5 regional centers). Additional analysis has taken into account more detailed and more accurate information about the potential funding resources, including the amount of potentially available financial resources, quantities of waste and the projected amount for all types of waste, potential sites for the construction of facilities (sanitary landfills, transfer stations, recycling yards). Also, additional analysis revised the data on investments (e.g. for regionalization and equipment for the collection), for option with 5 regions and for additional options (1, 2 or 3 waste management regions).

Based on the analysis of investment costs, it is concluded that the investment costs for the option with a single region are higher than for the option with 5 regions and for the option of two regions lower than for the option with 5 regions. Investment costs for the option with three regions are lower compared to option with 5 regions. The analysis showed that the most profitable in terms of investment options is the one with two regional landfills. Before the final decision, the operational costs for each option should be taken into careful consideration in order to choose an optimal and long-term sustainable solution.

Waste Management Plan of Montenegro for the period 2014 - 2020 (2015)

Montenegro with all its relief and other specifics, presents a serious challenge when it comes to setting up and operating of the waste management system. The amount of waste generated annually in this country, the municipalities and number of people who live and work here, as well as the currently relatively low level of development of infrastructure in this area, indicates that a single centralized system, as opposed to a large number of currently not successfully established centers of regional systems, could solve the problem and raise the level of efficiency, with clearly defined rules and strategic responsibilities of all system stakeholders. On the other hand, a solid but far from excellent road infrastructure across the country, significant relative distance of municipalities from potentially possible centers of unified management, the negative performance of the public utility companies which should be able to handle the centralization in a more organized and stable level, as well as other factors, indicate that redefining previously planned regions and the establishment of a system of regional governance is a safer way to a successful waste management in this country.

Based on a detailed analysis of the overall situation in the field of generation and waste management in Montenegro, and in accordance with the current clear trends, needs and capabilities of the state within new time frames, the Plan proposes three (3) possible management options in this area. Of the three proposed options, the first two relate to the proposal of setting up differently defined regions within the

system of regional management, while the last option relates to the unique centralized waste management system.

As part of the potential of regional waste management system, the following options are proposed (the names of local self-governments that are meant to be regional centers are underlined):

- **Option 1:** The formation of five (5) regional centers for waste management
  - Region Center 1 - includes Podgorica, Cetinje and Danilovgrad;
  - Region Center 2 - includes Nikšić, Plužine and Šavnik;
  - Region North - includes Bijelo Polje, Mojkovac, Kolašin, Pljevlja, Žabljak, Berane, Rožaje, Plav and Andrijevica;
  - Region Primorje 1 - includes Bar and Ulcinj;
  - Region Primorje 2 - includes Herceg Novi, Kotor, Tivat and Budva.

- **Option 2:** The formation of three (3) regional centers for waste management
  - Region Center - includes Podgorica, Cetinje, Danilovgrad, Nikšić, Plužine and Šavnik;
  - Region North - includes Bijelo Polje, Mojkovac, Kolašin, Pljevlja, Žabljak, Berane, Rožaje, Plav and Andrijevica;
  - Region Primorje -includes Bar, Ulcinj, Herceg Novi, Kotor, Tivat and Budva.

Within possible centralized waste management system, the following option is proposed:

- **Option 3:** The formation of a single region (1) for waste management
  - Single region - includes waste from all municipalities, and a regional center would be located in Nikšić.

Waste Management Plan of Montenegro for the period 2014 - 2020 defines the basic and specific (long-term and short-term) goals related to the waste management sector.

The basic legal and institutional long-term goal is **development of a sustainable waste management system** in order to protect human health, nature and reduce environmental pollution.

The main objectives in terms of selection of waste, reuse and recycling, can be classified into the following:

- It is necessary to reduce the amount of the generated municipal waste which has to be disposed in landfills;
- Treatment of recyclable materials as resources and their use as a way to preserve the existing natural resources, where it is important to successfully separate these materials from the total waste generated in the simplest and quickest way, and before its disposal in the mixed municipal waste;
- Selection of other products that have their value or which must be isolated and treated separately because of the nature or their structure;
- Energy saving in the production as well as the imperative of sustainable and responsible business practices;
- Cost reduction in the production of finished goods with the achievement of the above mentioned objectives;
- Job creation as a result of achievement of the above objectives;

– Protection of the environment and human health as a result of realization of the above objectives, etc.

1.2. THE PLAN IN RELATION TO OTHER RELEVANT STRATEGIES, PLANS AND PROGRAMS

The relation between the objectives of the Plan and the objectives of strategies, plans and programs at the state level are analyzed below (Table 1.2-1.)

The following documents were analyzed:

- The strategy and master plan for waste management at the level of the Republic (Proposal)
- The National Strategy for Sustainable Development of Montenegro (2007)
- The National Strategy for Air Quality Management and Action Plan for the period 2013-2016 (2013)
- Assessment of technological needs for climate change mitigation and adaptation for Montenegro - A National strategy with an Action Plan (2012)
- Strategy for ecoremediation in Montenegro with Action Plan for the period 2014-2020 (2014)
- Action plan to combat land degradation and to mitigate the effects of drought in Montenegro (2014)
- National Biodiversity Strategy for the period from 2010-2015 (2010)
- Energy Development Strategy of Montenegro by 2030 (2012)
- Health Care Development Strategy of Montenegro by 2020 (2003)
- Tourism Development Strategy of Montenegro by 2020 (2008)
- The National Strategy for Employment and Human Resource Development for the period 2012 - 2015 (2012)
- Physical Development Plan of Montenegro by 2020 (2008).

Table 1.2-1. The Plan in relation to other relevant strategies, plans and programs

STRATEGY, PLAN, PROGRAM	THE PLAN IN RELATION TO OTHER RELEVANT STRATEGIES, PLANS, PROGRAMS
The National Waste Management Strategy of Montenegro for the period 2014-2020	
• Accession to the European Union • EU requirements in the area of waste management • Transposition of these requirements into the legal framework of Montenegro • EU requirements in other areas relevant for waste management • The key cross-sectoral issues for Montenegro	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objectives of the Strategy.
National Strategy for Sustainable Development of Montenegro	
• Promote faster economic growth and development and reduce regional development disparities, • Reduce poverty, provide equal access to services and resources, • **Ensure efficient pollution control and reduction, and sustainable management of natural resources**, • Improve management system and public participation, involve all stakeholders and build capacities at all levels, • Preserve cultural diversity and identities	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objective of the Strategy: - Ensure efficient pollution control and reduction, and sustainable management of natural resources.
The National Strategy for Air Quality Management and Action Plan for the period 2013-2016	
• The establishment of a policy-making framework, starting from the initial four-year period (2013-2016) it covers, through the monitoring of the implementation of established measures and their effects in order to ensure better long-term air protection from the pollution • Establishing possible measures and response scenarios when prescribed air quality standards are exceeded • Establishing measures for protection and preservation of air quality when this quality is within prescribed standards • **Preventing air quality degradation by careful planning of sustainable development, particularly in sectors causing significant pollution**	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objectives of the Strategy and Action Plan: - Prevent air quality degradation by careful planning of sustainable development, particularly in sectors causing significant pollution.

• Combining objectives of protection and improvement of air quality contained in other planning and strategic documents in this area and related to compliance of Montenegro with international requirements, particularly in terms of prevention of cross-border pollution, protection of ozone layer and adaptation and mitigation of adverse effects of climate change	
Assessment of technological needs for climate change mitigation and adaptation for Montenegro - A National Strategy with an Action Plan	
General objective: • Identify the best technological options for development with low emissions and lower vulnerability to climate change The objectives of development priority for the environment: • **Efficient control and reduction of pollution** • Protection of the sea and coastal area, protection of biodiversity • Adaptation to climate change • **Environmental protection in terms of regional development; special support for areas lagging behind** • Sustainable Energy Development • Minimizing the adverse effect of the transport infrastructure development and of transport on the environment • Protection and improvement of all components of biological diversity and their sustainable use • Achievement of long-term resilience and productivity of forests and related ecosystems • Strengthen the role of forests in emission reduction and adaption to CC	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objectives of the Strategy and Action Plan: - Efficient control and reduction of pollution. - Environmental protection in terms of regional development; special support for areas lagging behind.
Strategy for ecoremediation in Montenegro with Action Plan for the period 2014-2020	
The following is to be implemented: • ERM solutions to water drainage and waste water treatment • **Sewage sludge treatment on reed fields** • ERM solutions for protection of drinking water source • **ERM solutions to degraded areas** • ERM measures for watercourses • ERM measures for protection of environment and national parks • ERM measures for protection of bodies of standing surface water • ERM measures for tourist areas	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the solutions of the Strategy: - Sewage sludge treatment on reed fields. - ERM solutions to degraded areas.

• ERM training grounds	
Action plan to combat land degradation and to mitigate the effects of drought in Montenegro	
• Improve the living conditions of affected population • **Improve the situation in threatened ecosystems** • Produce global benefits through efficient implementation of UNCCD • Use resources to support the implementation of the Convention by establishing effective partnerships between national and international agents	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objective of the Action Plan: - Improve the state of threatened ecosystems.
National Biodiversity Strategy for the period from 2010-2015	
• Address the root causes of biodiversity losses by integrating it into organisation of state and local authorities and society • **Reduce direct pressures on biodiversity and promote sustainable use** • Improve implementation through participatory planning, knowledge management and capacity building	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objective of the Strategy: - Reduce direct pressures on biodiversity and promote sustainable use.
Energy Development Strategy of Montenegro by 2030	
• Energy Supply Security • The development of a competitive energy market • Sustainable Energy Development 13.2.2 RER for heating and cooling Mixed solid municipal waste: The ERICO study[2], completed in 2011, indicates a possibility of burning solid fuels from light (flammable) fractions of mixed municipal waste (to be produced without plastic, paper, textile and waste wood from mixed waste in Montenegro) after 2020 in the amount ranging from 50 000 to 60 000 tonnes annually, in the heat and power plants. Due to the prevalent share of natural materials, the Strategy classifies such waste as biomass and thus, this type of energy generating material is considered as RER. Such facilities would have 40 MWth of input thermal power. Practice shows that	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objective of the Strategy: - Sustainable Energy Development.

[2] ERICO: A study on the assessment of need for revision of the Strategic Master Plan for Waste Management in Montenegro and recommendations for organizing the activities of waste management in the period until 2030, November 2011

such a facility, operating basically 7 000 hours per year, would produce around 70 GWh (25%) of electrical energy (with average power of 10 MWel) and around 112 GWh (40%) of thermal energy while total losses, resulting from transformation, are estimated at 35%. Indicative costs: EUR 80 million The decision on such a facility depends on the waste management policy where energy production is a possible by-product. It would also be necessary to undertake all the necessary feasibility studies for such a project with the aim of determining a location, power and the number of facilities, as well as the pace of the construction. The Strategy supports the use of municipal waste for energy purposes and it also recognizes a variety of uncertainties in relation to waste management in future as well as the fact that no feasibility study has been done. The Strategy envisages a waste incineration facility as of 2020 onwards, at a still unknown location. Utilization percentage for the facility would at the first be 50%, then 75% in 2025 and 100% in 2030. The fuel used (mixed solid municipal waste) is an integral part of biomass energy balance, and the generated electrical and thermal energy for remote heating are integral parts of energy balances. So as to choose adequate heat users, an appropriate study should be done. Incineration of certain municipal waste fractions in industrial facilities is an alternative solution.	
Health Care Development Strategy of Montenegro by 2020	
• Extending life expectancy • **Improving the quality of life in relation to health** • Reducing health disparities • Financial risks insurance	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objective of the Strategy: - Improving the quality of life in relation to health.
Tourism Development Strategy of Montenegro by 2020	
• Creation of the necessary tourism and accompanying infrastructure with a view to achieving the strategic objective **(Measure 1.7. Establishing a ''clean image'' of Montenegro)** • Montenegro is creating a special unique sales offer • Montenegro is famous for and seen as ''year-round'' tourist destination • Institutional and legal framework meets the requirements of successful and sustainable tourism development • Local population is getting more involved in tourism economy (‘internal marketing’)	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objectives of the Strategy: - Creation of the necessary tourism and accompanying infrastructure with a view to achieving the strategic objective (measure 1.7. Establishing a ''clean image'' of Montenegro)

Physical Development Plan of Montenegro by 2020	
The most important issues in the first five-year program are as follows: • improvement of transport network, • **improving environmental conditions,** • setting up and/or improving central functions, • development of water supply and sewerage systems in towns and settlements, • development of energy system and • development of high class tourist complexes. Priority activities: • Integral Development of the Northern Region, which comprises traffic connections, energy development and fostering new, innovative and long-term promising economic branches in accordance with human resources; • Improving the environment by introducing infrastructural utilities changes such as a construction of wastewater treatment system, **construction of inter-municipal sanitary landfills for solid waste** and reduction of air pollution, by large industrial systems; • An agreement between Montenegro and the neighbouring countries on traffic routes, joint protection of the environment and construction of energy systems; • Implementation of the Plan's guidelines with detailed determinants in detailed physical planning documents and sectoral planning documents	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objectives of the Plan: - Improving environmental conditions.
The National Strategy for Employment and Human Resource Development for the period 2012 -2015	
• Increase employment and reduce unemployment rate, • Improve the knowledge, skills and competencies, • Promote social inclusion and poverty reduction.	The main long-term objective of the Plan - **development of a sustainable waste management system** with a view to protecting human health, nature and reducing environmental pollution is in line with the objective of the Strategy: - Increase employment and reduce unemployment rate.

2. THE CURRENT STATE OF THE ENVIRONMENT AND ITS POSSIBLE DEVELOPMENT WITHOUT IMPLEMENTATION OF THE PLAN

2.1. CLIMATE CHANGE

2.1.1. Global climate change

Climate characteristics of each area are defined by mean state of the atmosphere and average deviation from this condition, the so-called variance. We may speak of a climate anomaly, that is, of a climate deviation/change where certain atmosphere or oceanographic parameter demonstrates significantly higher or lower values than the usual (mean) value over several decades (mostly 30 years). Climate change may take place over shorter or longer periods. The most probable projections of climate changes in the next hundred years include, at the same time, a change in the mean state (e.g. temperature increase) and average deviation (variance). Climate changes result in both spatial redistribution of flora and fauna and people migration to areas less affected by climate change.

Meteorological data confirm that the Earth's global temperature has been increasing since the beginning of the 20th century. The atmosphere naturally gets warmer both as a result of the direct heat from the Sun and by absorbing, as do the clouds, long-wave radiation from the Earth's surface and emitting it in all directions. Part of this re-radiation is back towards the surface and it leads to further temperature increase of the lower layer of the atmosphere, which is called greenhouse effect. Water vapour and carbon dioxide (CO_2), followed by methane (CH_4), nitrous oxide (N_2O) and ozone (O_3) are some of the most important gases naturally found in the atmosphere, which absorb the Earth's long-wave radiation. Many studies have confirmed a rapid increase of greenhouse gas concentrations in the atmosphere since the beginning of the industrial revolution. The burning of fossil fuels, urbanization, deforestation and agricultural development are just some of the anthropogenic impacts that alter the composition of the atmosphere, thus resulting in increased greenhouse gases concentrations.

Some estimates indicate that if the current trend of greenhouse gas emissions into the atmosphere continues, by the year 2100 global temperature is expected to have increased by 1.4 to 5.8 ° C. The temperature increase in Europe will amount to 0.1 to 0.4 ° C per decade and the greatest warming is predicted in southern and north-eastern Europe. As a result of temperature rise, the snow line and the upper-limit of tree line will move up to higher altitudes which will have an impact on living organisms.

Temperature rise has also led to rise in global mean sea level. Sea level rise is a result of two main reasons: 1) warming of the surface which causes thermal expansion of sea water and 2) warming of the Earth's atmosphere, which causes rapid melting of the Earth's ice covers and the alpine glaciers. The scenario predicts sea level rise of between 9 and 88 cm (average of 48 cm) by 2100.

In 2011, the Intergovernmental Panel on Climate Change (IPCC[3]) issued a detailed estimate of increase in frequency of extreme events, emphasizing that measures should be undertaken promptly to reduce greenhouse gas emissions and to implement measures in order to adapt to already changed climate conditions.

[3] IPCC - Intergovernmental Panel on Climate Change

2.1.2. Climate characteristics in Montenegro

The upward trend in air temperature in the second half of the twentieth century is evident in most of the territory of Montenegro. According to available data, i.e. a series of measurements in 1949, and at some stations since 1958, it is evident that extreme heat has been recorded more often since 1998, especially during August. The trend of mean annual and extreme mean monthly temperatures at the measuring stations over the past 20 years was mostly stable except for fluctuations during the period 2000-2005 and 2006-2008.

Rainfall is one of the most important climate parameters that determine a region's climate. Annual average precipitation in the territory of Montenegro is very heterogeneous, with a very pronounced rainy and less rainy region. Rainiest regions have almost 6 times the average annual rainfall compared to the least rainy regions. The highest average annual rainfall is in the south-western part, the area of Orjen, with 3000-5000 mm. The lowest rainfall is found in the north-eastern and far northern parts. There, an average annual precipitation amount is between 700 and 1000 mm. Over the previous 20 years, there was an upward trend in annual amounts of rainfall in the central and southern parts of Montenegro, with the exception of 2011 where a sudden drop was recorded. In northern regions, during the period 1990-2011, rainfall varied, although the overall trend is mainly stable.

Data from 2001-2010 decade estimates that rainfall regime becomes more extreme (2010 has the highest amount of annual precipitation in mountain region (above 1000 m)).

Greenhouse Gas (GHG) Emissions

Direct greenhouse gas emissions, covered by the Kyoto Protocol (CO_2, N_2O, CH_4, etc.) are gaseous constituents of the atmosphere that absorb and retransmit the infrared radiation and get into the atmosphere naturally or as a result of human activities. In Montenegro, in the period 1990-2009, after the downward trend in emissions until 1994, there is an upward trend, with the exception of 2009, when a significant decrease of about 20% was recorded compared to the previous year as a result of reduced energy production in the Thermal Power Plant Pljevlja due to repairs and closing of the power plant at the Aluminium Plant Podgorica (KAP).

GHG emissions are monitored based on emissions of certain pollutants and especially those that cause climate change at the global level. This monitoring is based on emissions data from major sources classified by major emitting sectors (IPCC nomenclature) with 1990 as the baseline year, namely: energy (supply and use of energy), transport, industrial (process not including emissions from the fossil fuels combustion process for energy use), agriculture, waste and other (non-energy sectors). In the reporting period, as a clear consequence of the crisis in early 90s of the last century, emissions were reduced by over 50% over a 5-year period.

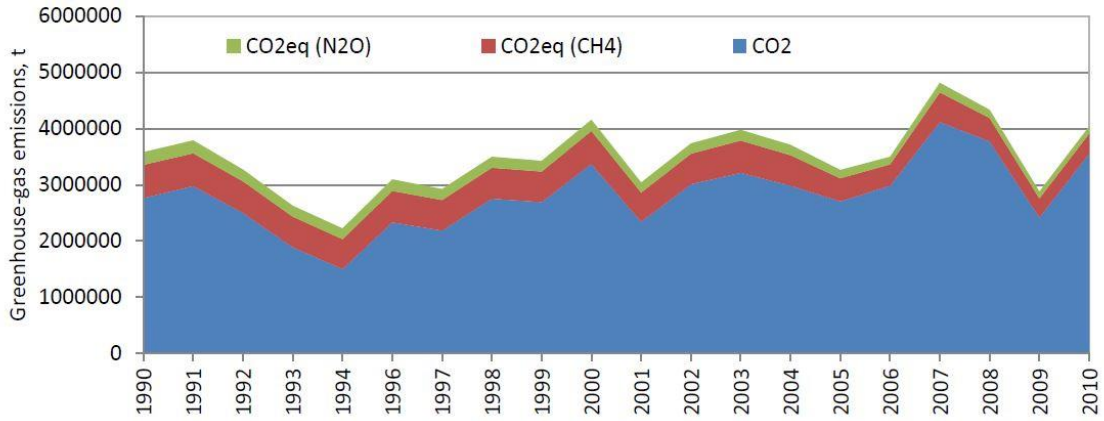


Figure 2.1.2-1. Greenhouse-Gas Emissions 1990-2010[4]

In 1998 the GHG emissions already reached those from 1990. (the baseline year). In the period 1998-2008, there was an evident growing trend, as a result of energy consumption in virtually all sectors other than the industry. The last year observed recorded, as a result of the global economic crisis, a new decline in industrial production and consumption of energy which caused the decrease of greenhouse gas emissions to a level lower by 22% than that for the baseline year.

Below is a more detailed overview of trends in emissions of key GHG gases.

CO_2 Emissions

As a result of fuel combustion, the largest share of total CO_2 emissions (85.5 to 96.7%) comes from Energy sector (Figure 2.1.2-2.). The fall in CO_2 emissions during some years of the observed period (1990 - 2011) is mainly related to the reduced volume of production of electricity in TPP Pljevlja and significantly reduced industrial production.

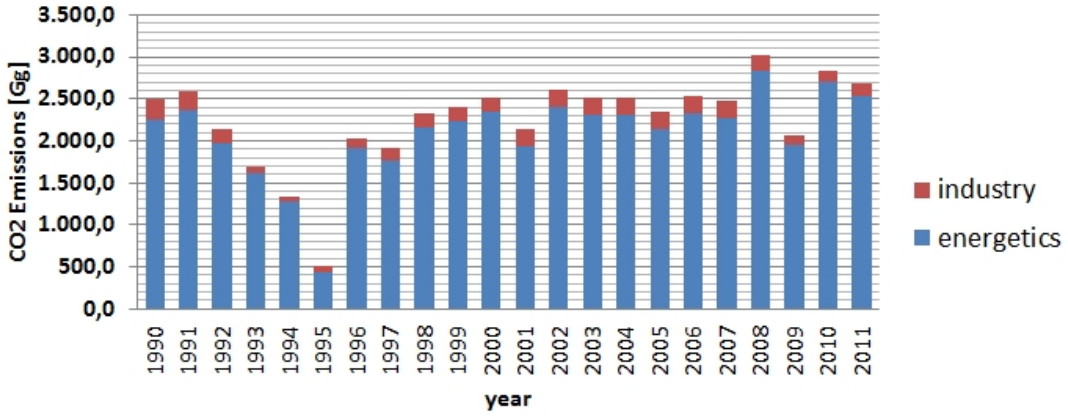


Figure 2.1.2-2. CO_2 emissions[5]

[4] Ibid

[5] Drugi nacionalni izvještaj Crne Gore o klimatskim promjenama ka Okvirnoj Konvenciji o Klimatskim Promjenama Ujedinjenih Nacija (UNFCCC) (NACRT), Ministarstvo održivog razvoja i turizma, 2014

CH4 Emissions

The biggest share of CH_4 emissions are in agriculture 53% -70%, followed by the sectors of waste 17% - 25% and energy 9% - 24% (**Error! Reference source not found.**, **Figure**). Reducing the volume of agricultural production (livestock) caused a significant reduction in the level of CH_4 emissions from this sector in the period (2005- 2011). Emissions from waste sector are more-less stable.

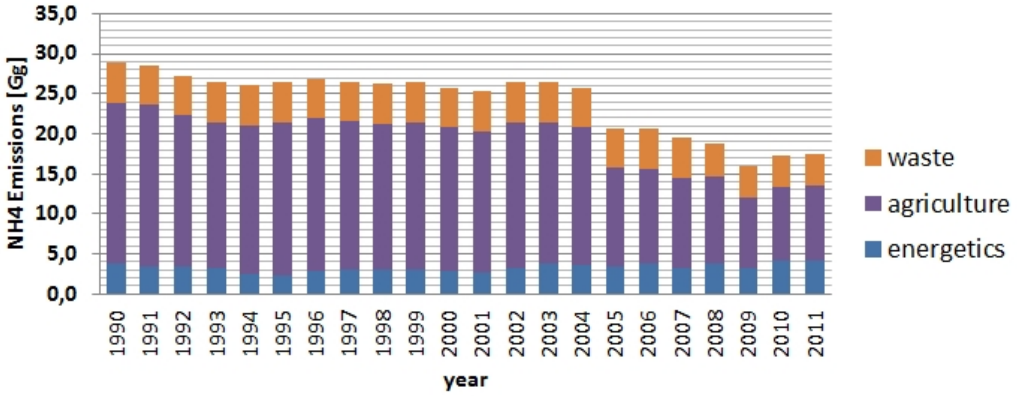


Figure 2.1.2.-3 CH_4 Emissions[6]

2.2. METEOROLOGICAL DATA

As it is possible to establish a direct link between climate changes and air temperature and precipitation regime, an analysis of meteorological data was based on air temperature analysis and precipitation amount in 2013, whereas in terms of impact on air quality, analysis of wind frequency was carried out on the following locations - Bar, Nikšić, Herceg Novi, Berane, Bijelo Polje.

During 2013, air temperature in the large part of Montenegro was higher than climate normals. Ever since air temperature was first measured, the year 2013 was the warmest year in the larger part of Montenegro (area of Bar, Ulcinj, Budva, Cetinje, Nikšić, Kolašin, Bijelo Polje, Rožaje, Žabljak, Pljevlja), and based on the percentile distribution, air temperatures ranged within the category of extremely warm.

The table (Table 2.2.-1.) shows values for mean air temperatures during 2013 and maximum values, to date, of mean annual temperatures, provided together with the years when they were measured.

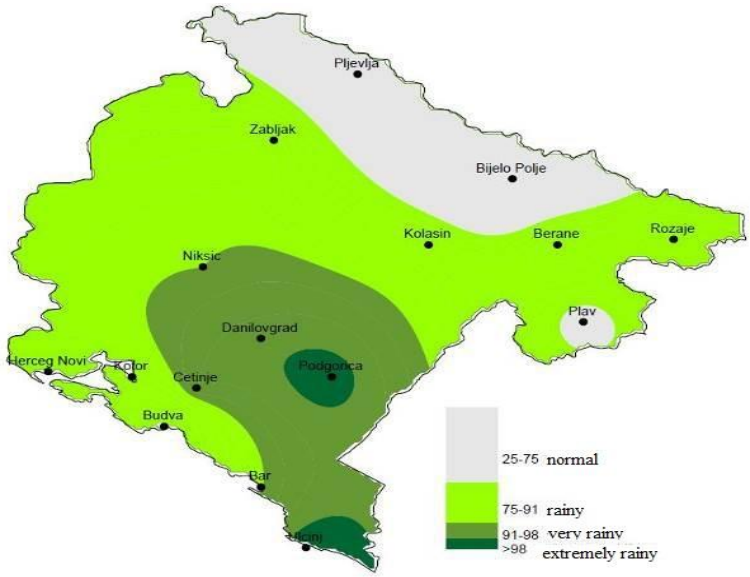
Table 2.2.-1 Mean air temperatures and maximum values, to date, of mean annual temperatures

Measuring station	Mean air temperature in 2013 [°C]	Maximum temperature to date [° C] (the year of occurrence)
Nikšić	12.5	12.4 (2004, 2011)
Bar	17.9	17.6 (2011)
Pljevlja	10.9	10.4 (1994, 2008)
Ulcinj	17.2	17.1 (1999)
Kolašin	9.7	9.1 (1994)
Žabljak	7.3	7.1 (2003)
Budva	18.2	18.1 (2011)

[6] Drugi nacionalni izvještaj Crne Gore o klimatskim promjenama ka Okvirnoj Konvenciji o Klimatskim Promjenama Ujedinjenih Nacija (UNFCCC) (NACRT), Ministarstvo održivog razvoja i turizma, 2015

Measuring station	Mean air temperature in 2013 [°C]	Maximum temperature to date [° C] (the year of occurrence)
Cetinje	11.9	11.9 (2007, 2011, 2012)
Bijelo Polje	12.3	11.9 (2008, 2009)
Rožaje	9.6	9.4 (2012)

Based on the percentile distribution, precipitation amount ranged within categories of normal, rainy, very rainy and extremely rainy (Graphic1.2-1), and it ranged from 829 l/m^2 in Pljevlja to 4,311 l/m^2 in the area of Cetinje. The year 2013 was the rainiest year in the area of Podgorica and Ulcinj. 2,427 l/m2 were measured in Podgorica, an amount which is 47% greater than climate normals and also the highest ever measured precipitation amount (the previous maximum amount was recorded in 2010 and was 2,357 l/m^2). Maximum precipitation amount of 1,949 lit/m2 was also recorded in Ulcinj (previous maximum amount of 1,813 lit/m2 was also measured in 2010) Almost all deviations of precipitation amounts in relation to climate normals were positive and ranged between 3% (Pljevlja) and 55% (Ulcinj). The only exception being Bijelo Polje with 1% less precipitation than climate normals.



Graphic1.2-1 Percentile distribution for precipitation

Wind is one of the most important factors which affect dispersion of pollutants in the air Owing to a specific topography of the Montenegro area, locally analysed microclimate elements are not representative of the wider area. As a result, great differences in characteristics of meteorological parameters may occur in a very small area, especially in relation to wind direction and speed. The great spatial and temporal fluctuation of this meteorological factor requires that wind parameters be measured in every particular location.

Wind characteristics in the Bijelo Polje area and wind characteristics in the Berane municipality area are taken as benchmark values for wind in the north region area.

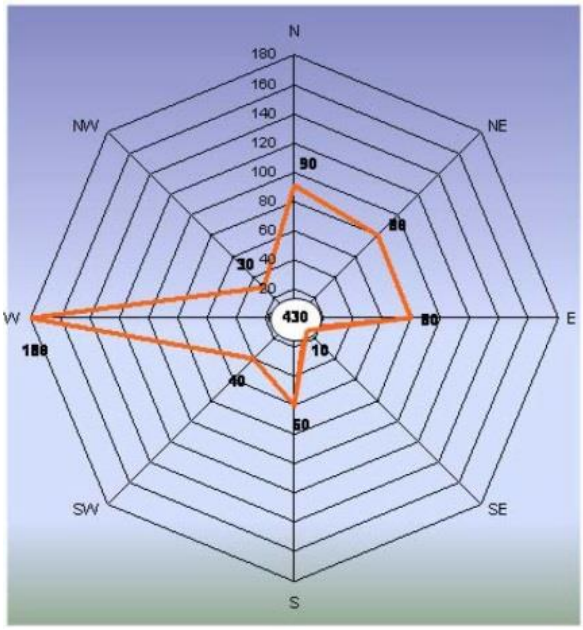
The valley of Bijelo Polje is surrounded by mountain ranges and consequently, Bijelo Polje municipality has a temperate continental climate with clearly pronounced seasons, which means that autumn is warmer than spring. Mean temperature in spring is around 8.7°C, 16.9°C in summer, 9.4°C in autumn and 0.1°C in winter period. Winter in the valley of Bijelo Polje is characterised by temperature inversions, i.e., lower temperatures in the Lim valley and its tributaries than in the highland rim area.

Mountains and mountain ranges surrounding the valley of Bijelo Polje, particularly those spreading in the east-west direction, shelter the valley from cold winds. The frequency of particular wind directions in the Bijelo Polje area is as follows:

- winds from the west– 18.0%
- winds from the north– 9.0%,
- winds from the north-east– 8.0%
- winds from the east– 8.0%
- winds from the south– 6.0%
- winds from the southwest-4.0%
- winds from the southeast-1.0%.

In terms of monthly distribution, north winds are the most frequent in January, May and July, and west winds usually during March, April and December.

The calm periods are still the most frequent (periods without winds) (43.0%) and this is a result of terrain features, i.e., of the previously mentioned mountain surroundings in the observed area.



Graphic 2.2-2 Annual wind rose for Bijelo Polje area (source: Report on strategic environmental assessment for physical and urban plan of Bijelo Polje, Bijelo Polje, Podgorica, March 2014)

Table 2.2.-2 shows a frequency of certain wind directions and their average and maximum speed in the area of Berane municipality. Calm periods are the most frequent and account for 64.1% cases.

Table 2.2.-2 The frequency of winds blowing from certain directions and their average and maximum speed in the area of Berane municipality (source: EIA for sanitary landfill of Municipality of Berane, Podgorica, June 2009)

	frequency	**Wmax**	**Wav**
N	4.0	11.0	2.5
NNE	3.8	13.0	2.3
NE	2.3	10.8	2.1
ENE	1.5	5.0	1.9
ENE	1.8	6.0	1.6
ESE	1.9	11.0	1.7
SE	0.8	9.8	2.0
SSE	1.8	14.0	2.9
S	1.3	12.0	3.3
SSW	2.2	18.0	3.0
SW	1.9	15.0	2.9
WSW	3.5	17.6	3.3
W	2.7	10.0	3.2
WNW	2.5	14.0	2.8
NW	1.0	8.0	2.2
NNW	3.6	11.0	2.7
calm	64.1		

The values of wind parameters in the area of Nikšić municipality were observed as reference values of frequency and strength of the wind in the area of the region center.

Climatic characteristics of the Nikšić Field are conditioned by the connection of the observed area with the Adriatic Sea (30 km as the crow flies) and the relief. Depending on the geographical location, altitude and relief, in the area of Nikšić municipality climatic differences are distinct - ranging from modified Mediterranean, temperate continental to Alpine climate, although for the most part Mediterranean-mountain climate is present.

The municipality area is characterized by frequent changes in air flow with rapid changes of air masses. Spring is the windiest season and winter the least windy. More frequent occurrences of sirocco are related to the spring period. The most frequent wind is cold, dry northern continental wind blowing in gusts. Western and eastern winds are less frequent.

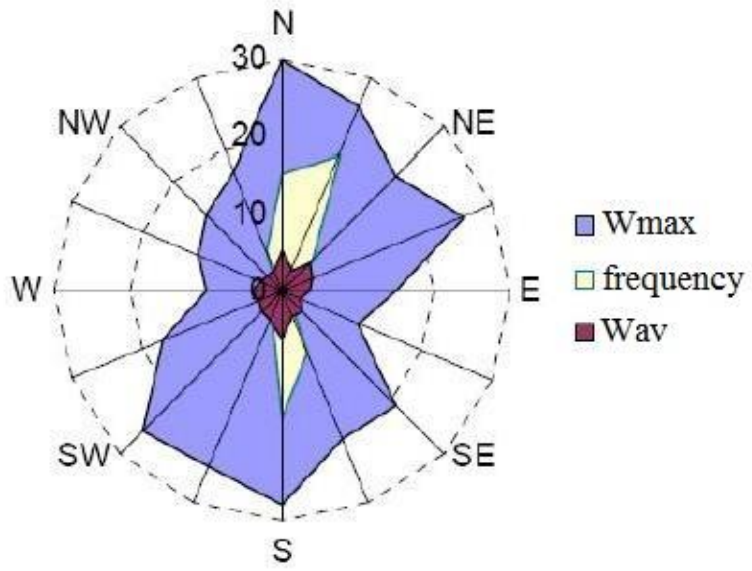


*Figure 2.2-3 Annual wind rose for the Nikšić area (*source: The assessment study of the impact on the environment of the local sanitary landfill in Nikšić, Podgorica, November 2012)

The values of wind parameters in the area of the municipality of Herceg Novi and the municipality of Bar were observed as reference values of frequency and strength of the wind in the area of the region littoral.

The main characteristics of the climate (and the wind) of the Herceg Novi area are determined by high mountainous highlands, which dominate over the maritime zone of the Bay of Kotor. The average annual temperature in this area is 15.8 ° C. Ten months a year have temperature higher than 10° C, four summer months above 20° C, while the air temperature rarely drops below 0° C.

The occurrence of wind depends on the distribution of air pressure which is lower during the summer and much higher in the winter. General annual feature of windiness of the area is the emergence of a large percentage of silence (41%). During the season it stands between 35% in winter and 47% in summer. The most common annual directions are E, SE, NW, which are represented with 10 - 12%, while the incidence of other directions is around 5% *(sources: The assessment study of the impact on the environment of the sanitary landfill "Duboki Do" - Herceg Novi; Physical Plan of the Municipality of Herceg Novi until 2020).*

The area of Bar municipality is affected by strong southerly winds and strong and very cold northerly winds. The frequency of winds in the area of Bar municipality from northeast and east-northeast is 38.9%, while from the north-northeast, west-southwest and west is 23.1%. The other 11 directions altogether, including periods of calm (silence), account for the remaining 38%. Thus, the winds in Bar blow mainly from the northern and the western quadrants. Wind force data according to the direction of blowing for Bar are shown numerically in Table 2.2-3., and graphically by the wind rose in Figure 2.2-4.

Table 2.2.-3. Frequency of specific wind directions and their average and maximum speeds in the area of Bar municipality (source: The assessment study of the impact on the environment of the regional sanitary landfill at the Možura site for the municipalities of Bar and Ulcinj, Belgrade, April 2010).

	frequency	Wmax	Wav
N	5.9	15.8	5.0
NNE	8.1	13.7	2.7
NE	20.0	18.0	3.2
ENE	18.9	15.8	2.4
ENE	3.6	10.2	1.9
ESE	3.5	12.7	2.5
SE	3.3	12.0	3.7
SSE	2.6	11.0	3.3
S	3.1	12.5	3.9
SSW	3.1	12.0	2.5
SW	3.5	13.3	2.8
WSW	7.2	12.5	2.9
W	7.8	13.3	3.6
WNW	2.9	11.0	3.3
NW	0.7	11.7	2.5
NNW	0.6	6.7	1.6
calm	5.2		

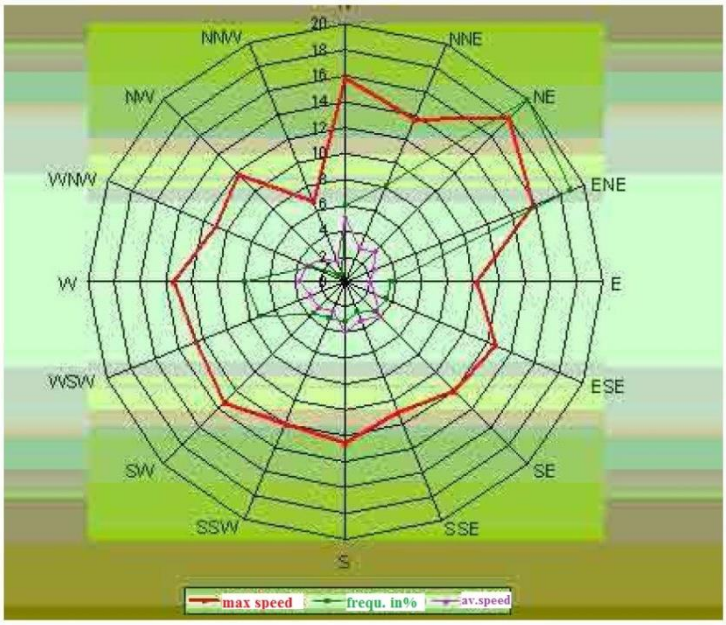


Figure 2.2-4. Annual wind rose for the Bar area (source: The environmental impact study of the regional sanitary landfill at the Možura site for the municipalities of Bar and Ulcinj; Belgrade, April 2010)

2.3. AIR QUALITY

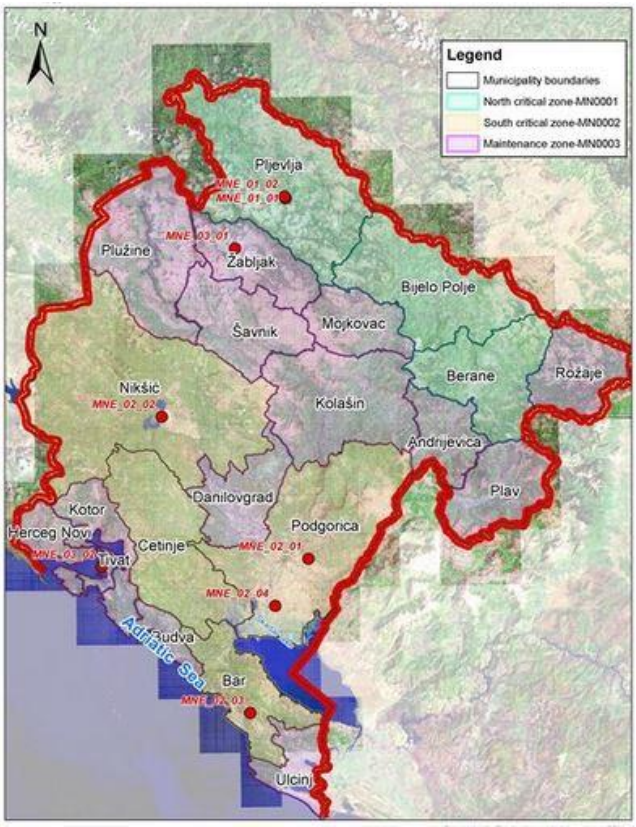
Current state

The National Network for Air Quality Monitoring of Montenegro was established following the adoption of the Regulation on the establishment of the measurement points network for air quality monitoring ("Official Gazette of Montenegro", no. 44/10, 13/11), harmonized with European Union legislation.

The entire territory of the country is divided into zones with uniform air quality and emission sources, respecting the inter-municipal administrative boundaries. Municipalities with the same air quality belong to the same zone, and the territories of one zone are treated in the same way when assessing air quality during operation.

The territory of Montenegro is divided into the following areas (Graphic 2.-1):

- **Air quality maintenance area** (represented by the purple color on the map), which includes the following municipalities: Andrijevica, Budva, Danilovgrad, Herceg Novi, Kolašin, Kotor, Mojkovac, Plav, Plužine, Rožaje, Šavnik, Tivat, Ulcinj, and Žabljak;
- **Critical area North** (green-coloured sections on the map), which includes the following municipalities: Berane, Bijelo Polje, and Pljevlja;
- **Critical area South** (yellow-coloured section on the map), which includes the following municipalities: Bar, Cetinje, Nikšić, and Podgorica.



Graphic 2.3 -1 Division of the territory of Montenegro with regard to air quality areas with markings of the existing air quality measuring stations.

In terms of global indicators, the air quality in Montenegro is at a satisfactory level, although some pollutants in certain locations require additional measures to prevent pollution. Annual mean concentrations of pollutants in most towns and villages in Montenegro are under the legally permitted pollution limits.

The source of most emissions of air pollutants is the industry (with the largest energy consumption), followed by general consumption and transportation. The industrial and power plants are the sources of significant air pollution because they use old technology and as a rule do not take appropriate mitigation measures. The pollution caused by traffic is rising, especially in urban centers. Therefore, elevated concentrations of atmospheric particulate matter appear (PM_{10}), usually in larger cities. Other parameters that sometimes exceed the permissible concentrations include sulfur oxides (SO_2) (contained in the exhaust gases of motor vehicles) and the maximum concentrations of nitrogen oxides (NO, NO_2, NO + NO_2) which sometimes exceed permissible short term pollution limits. Furthermore, the maximum daily concentrations of ground-level ozone exceed the permissible limits in several towns (Berane, Budva, Herceg Novi, Kotor, Pljevlja, Podgorica, Tivat, and Žabljak).

The existing data on energy intensity and energy efficiency (although not calculated systematically and continuously) suggest that there is a considerable space for the introduction of energy saving measures and energy efficiency (compared to EU countries, Montenegro consumes substantially less primary energy per capita, and in terms of electricity consumption per capita they are above the EU average). There is also room for improvement in the development of renewable energy resources because they account for only 27% to 46% of primary energy produced in the country, out of which 21% - 37% is hydro energy (almost exclusively large hydro-power plants) and 6% - 10% comes from firewood. Fossil fuels have a dominant position in the total consumption of energy, with a share of up to 70%. Solid and liquid fuels are used almost exclusively. All demand for solid fossil fuel (mostly lignite) is covered from national resources, whereas the demand for fossil fuels is covered by import from other countries.

As for the natural factors that affect air quality in Montenegro, we need to point out to thermal inversions in karst fields (Cetinje and Nikšić) and valleys (Pljevlja, Berane and Bijelo Polje) that prevent mixing with fresh air and removal of pollutants.

The prevention and reduction of climate-changing air pollution is governed by the monitoring of greenhouse gases emissions, using flexible mechanisms, and other measures established by relevant international treaties that are binding on Montenegro. The list of greenhouse gases, the method of monitoring their emissions, the report deadlines, and the methods to produce greenhouse gas inventories are defined by the Ministry in charge of environmental protection. Greenhouse Gas Emission Inventory is maintained by the Environmental Protection Agency and the inventory is an integral part of the air quality information system.

Measures to reduce trans-boundary air pollution are carried out in accordance with international treaties binding for Montenegro. The exchange of information, preparation of national emission inventories, and keeping records on production and consumption of substances and products that contribute to trans-boundary pollution are defined by the Ministry's regulations.

Identified sources of air pollution in certain regions

In the coastal region, there is an air pollution risk in the area around the town of Bar, resulting from industrial operations, i.e. loading, unloading, transshipment, and warehousing certain materials (bauxite, sinter magnesite, additives, etc. for the aluminum plant in Podgorica).

The air pollution in the central region results from the mining and industrial activities in Nikšić and Podgorica. Unless appropriate physical planning, urban development, and other environment protecting measures are taken, further air and water pollution resulting from the operations of the aluminum plant in Podgorica can be expected, as well as continued air pollution issues in the area around the town of Nikšić (Nikšić valley).

As for the northern region, unless the mentioned measures are taken, air pollution resulting from the environmentally and physically uncontrolled production activities in the region surrounding the Pljevlja thermal power plant can be expected.

Air quality monitoring

Air quality control on all measuring stations is carried out to determine the level of air pollution and evaluate its impact on human health, the environment and climate, in order to take appropriate measures to protect the environment, human health and material goods. The air quality monitoring program includes measuring the air pollutants concentration on automatic stationary units or stations within the national air quality monitoring network. The station modules and types of measurement are prescribed in the Regulation on the establishment of the measurement points network for air quality monitoring ("Official Gazette of Montenegro", No. 44/10 and 13/11), in accordance with the established air quality zones.

In 2013, the national network for permanent air quality monitoring[7] included seven stationary units distributed across the urban and rural areas of Montenegro. The list of stations within the national network is shown in the table (

[7] The latest available data from the Annual report on the monitoring of air quality on the territory of Montenegro for 2013, CETI, February 2014

Table 2.3-1) and the spatial distribution is shown in the graph (Graphic 2.1).

The network of semi-automatic stations for air quality monitoring, managed by the Institute of Hydrometeorology and Seismology (IHMS), which are not included in the national air quality monitoring network, included 14 stations in 2013: Podgorica (at IHMS and Biotechnical Faculty), Pljevlja, Kolašin, Bar, Bijelo Polje, Berane, Nikšić, Cetinje, Golubovci, Herceg Novi, Ulcinj, Budva, and Žabljak. The air quality monitoring methodology carried out by the IHMS does not conform to regulations in force due to the lack of equipment for automatic measurement of the concentration of pollutants, which allows tracking hourly concentrations and comparing the measured values with the limit values.

Table 2.3-1 List of automatic stationary stations within the national air quality monitoring network

No.	Station name	Area	Measuring station type	Pollutants to be measured
1	Nova Varoš	South	UT	NO, NO_2, NO_x, CO, Benzene, PM_{10} and Pb, BaP in them
2	Bar 2	South	UB	NO, NO_2, NO_x, CO, Benzene, SO_2, O_3, $PM_{2,5}$, PM_{10} and Pb, As, Cd, Ni, and BaP in them
3	Nikšić 2	South	UB	NO, NO_2, NO_x, CO, Benzene, SO_2, O_3, $PM_{2,5}$, PM_{10} and Pb, As, Cd, Ni, and BaP in them
4	Pljevlja	North	UB	NO, NO_2, NO_x,, SO_2, $PM_{2,5}$, PM_{10} and Pb, As, Cd, Ni, and BaP in them
5	Tivat	Maintenance area	UB	$PM_{2,5}$
6	Gradina	North	SB	NO, NO_2, NO_x,, SO_2, O_3
7	Golubovci	South	SB	NO, NO_2, NO_x, SO_2, O_3

The expressions used in analysis of measurement results have the following meanings:

- *Limit value* is the level determined on the basis of scientific knowledge, in order to avoid, prevent or reduce the harmful effects of pollution on human health and/or the environment as a whole.
- C*ritical limit is* the level determined on the basis of scientific knowledge, above which a direct adverse impact on certain receptors may occur, such as vegetation and natural ecosystems but not humans.
- *Margin of tolerance* is the percentage of a limit value by which it may be exceeded within the prescribed time limits.
- *Upper assessment threshold* is the prescribed level below which air quality can be assessed by combining measurements and modeling techniques and/or indicative measurement.
- *Lower assessment threshold* is a level below which a source of data for evaluating the quality of air can use only modeling techniques and objective assessment
- *Target value* is the level to be achieved in a given period in order to avoid, prevent or minimize the adverse effects on human health and/or the environment as a whole.
-

Air quality monitoring

Based on the review of the air quality measurement results from the stations within the national network in 2013, it is evident that similar air pollution issues occurred both in 2013 and in the preceding years.

Sulfur dioxide (SO_2)

In 2013, all average hourly SO_2 values as well as all daily mean values recorded at the measuring station in Bar (Bar 2), the measuring station in Nikšić and the measuring station in Gradina (background rural station) were significantly below the prescribed limit values and below the lower assessment threshold for public health protection.

At the measuring station in Pljevlja (urban background station), one hourly average SO_2 value exceeded the prescribed limit value in 2013, whereas all daily mean values were below the limit values. At this station, the daily mean SO_2 values exceeded the upper limit of assessment for 18 days and the lower limit for 50 days and thus they exceeded the upper (and lower) assessment threshold for public health

protection. The annual mean SO_2 value on this measuring station also exceeded the lower assessment threshold.

Nitrogen dioxide (NO_2)

During 2013, all mean hourly values and the mean annual value of NO_2 were below the prescribed limit value and below the lower limit of assessment of public health in the town of Bar (at the urban background station), at the Golubovci station, at the background rural measuring station in Gradina in Pljevlja, on an urban background station.

At the locations in Podgorica (Nova Varoš) and Nikšić, the mean hourly values and the annual mean value of NO_2 were below the prescribed limit value. The measuring station Nova Varoš recorded 18 hour values above the lower assessment threshold, whereas the station in Nikšić recorded 11. The average annual value at both stations was below the lower assessment threshold.

PM_{10}

At the location of Nova Varoš in Podgorica, the daily mean PM_{10} value was above the margins of tolerance for 19 days, above the prescribed limit value for 64 days, above the upper assessment threshold for 148 days, and above the lower assessment threshold for as many as 252 days in 2013. The annual mean value was below the prescribed limit value and below the upper, but above the lower assessment threshold.

In Bar, the daily mean PM_{10} values were above the margins of tolerance for 13 days, above the prescribed limit value for 50 days, above the upper assessment threshold for 155 days, and above the lower assessment threshold for 241 days in 2013. The annual mean value was below the prescribed limit value and below the upper, but above the lower assessment threshold.

At the urban background station in Nikšić, the daily mean PM_{10} values were above the margins of tolerance for 42 days, above the prescribed limit value for 104 days, above the upper assessment threshold for 177 days, and above the lower assessment threshold for as many as 236 days in 2013. The annual mean value was above the prescribed limit value and below the upper and above the lower assessment threshold for public health protection.

At the urban background station in Pljevlja, the daily mean PM_{10} values were above the margins of tolerance for 85 days, above the prescribed limit value for 177 days, above the upper assessment threshold for 281 days, and above the lower assessment threshold for as many as 321 days. The annual mean value was above the prescribed limit value and above the upper assessment threshold.

$PM_{2.5}$

At the measuring stations in Bar and Tivat, the annual mean value of $PM_{2.5}$ was below the margins of tolerance, below the prescribed limit value, and below the upper, but above the lower assessment threshold.

At the urban background station in Nikšić and at the station in Pljevlja, the annual mean $PM_{2.5}$ values in 2013 were below the margins of tolerance but above the prescribed limit value, and thus above the upper assessment threshold for public health protection.

Carbon monoxide (CO)

At all three stations where carbon monoxide was measured (Bar, Nikšić and Podgorica -Nova Varoš), the maximum eight-hour average values in 2013 were below the limit value and below the lower assessment threshold.

Ozone O_3

At the measuring stations in Bar and Nikšić, 30 maximum daily eight-hour mean values of ozone were above the prescribed target value. Measurements of ground-level ozone concentrations during the preceding years indicate that the prescribed concentration of ground-level ozone was mostly exceeded during the summer months (July and August), especially in the coastal territory.

Polycyclic aromatic hydrocarbons (PAHs)

One of the indicators of the negative impact that transport and the proximity to the industry have on air quality in urban areas are high concentrations of polycyclic aromatic hydrocarbons, benzo(a)pyrene markers and benzo(a)pyrene itself. The average annual value of benzo(a)pyrene in Podgorica (at the location of Nova Varoš), in Nikšić and in Pljevlja was above the prescribed target value. At the measuring station in Bar, the annual mean value was below the prescribed target value but above the upper assessment threshold for public health protection.

Heavy metals in PM_{10}

The annual mean values of lead at the location of Nova Varoš and at the measuring stations in Bar, Nikšić and Pljevlja were below the prescribed limit value and below the lower assessment threshold. The annual mean values of As, Cd and Ni at all four measuring locations (Podgorica, Bar, Nikšić, and Pljevlja) were below the prescribed target values and below the lower assessment threshold.

Benzene

In Podgorica, at the location of Nova Varoš, and at the measuring station in Bar, the annual mean values of benzene were below the limit value and below the lower assessment threshold.

Air quality in specific zones

The largest impact on air quality in the **South and North zones** is made by particulate matter PM_{10} and $PM_{2.5}$, and by the content of benzo(a)pyrene in PM_{10} particles and therefore the air quality in these zones needs to be improved in accordance with the Regulation on the establishment of the air quality monitoring network. These zones include the following municipalities: Berane, Bijelo Polje and Pljevlja (North Zone) and Bar, Cetinje, Nikšić and Podgorica (South zone).

In **the air quality maintenance area** which includes: Andrijevica, Budva, Danilovgrad, Herceg Novi, Kolašin, Kotor, Mojkovac, Plužine, Rožaje, Šavnik, Tivat, Ulcinj, and Žabljak, the air quality is monitored at the station in Žabljak with the equipment for so-called. semi-automatic monitoring, whereas the station in Tivat measured only concentrations of $PM_{2.5}$ particles due to malfunction of measuring instruments. Based on the measured concentrations of the monitored parameters, the air quality in this area is satisfactory.

Conclusion

The quality of air in Montenegro, evaluated using sulfur(IV)oxide (SO_2) as a global indicator is satisfactory. Moreover, the concentrations of nitrogen dioxide (NO_2) at all measuring stations are below the prescribed limit values. Increased concentrations of ground-level ozone have been reported both in coastal and continental region. The good air quality rating refers to the concentration of carbon monoxide (CO) at all measurement locations. Concentrations of heavy metals in PM_{10} particles were also within the prescribed norms.

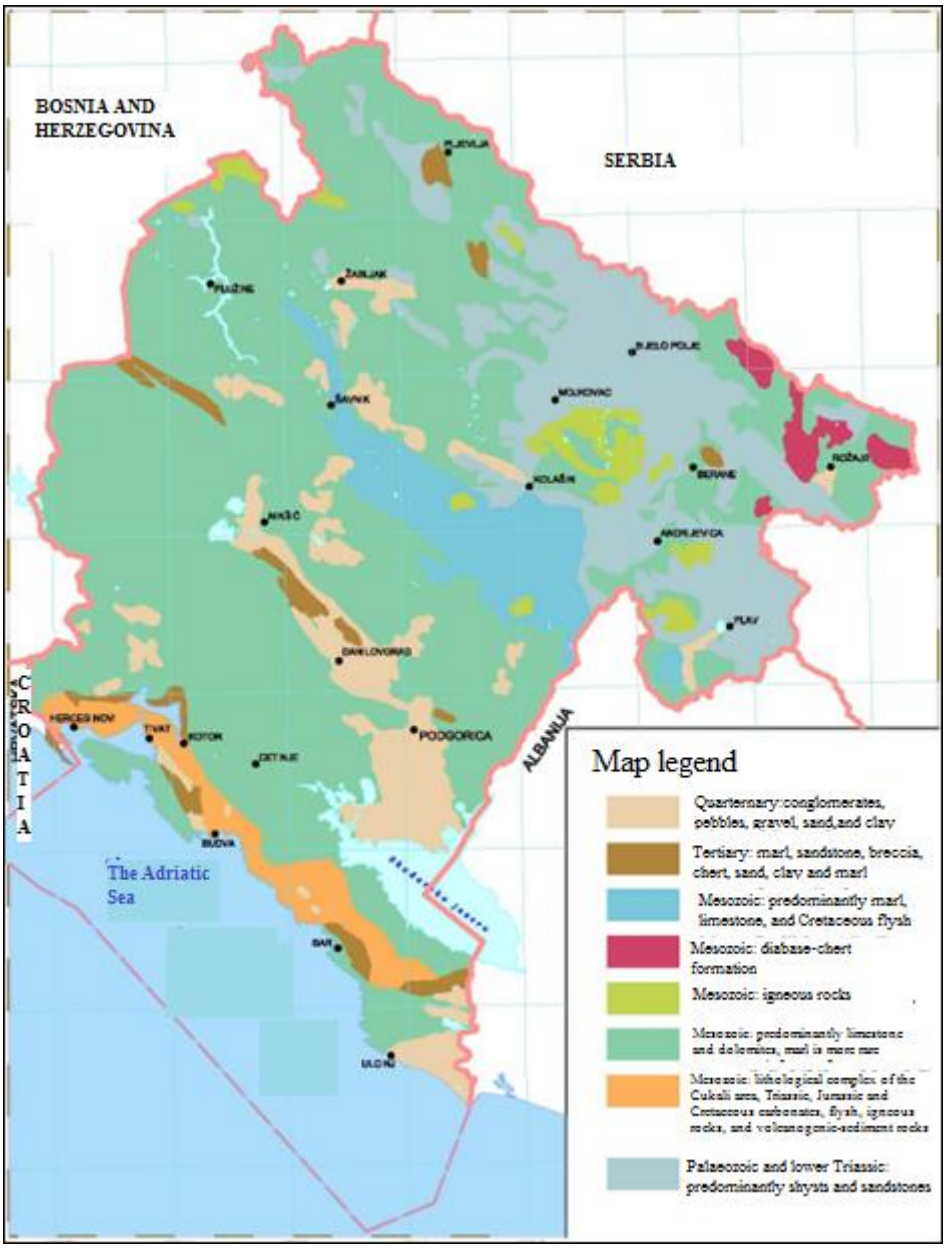
Poorer air quality is mostly caused by exceeding the maximum concentration of particulate matter PM_{10} and $PM_{2.5}$. This problem is the most strongly pronounced in Pljevlja and Nikšić where limits are often exceeded and high concentrations are recorded on a daily basis; furthermore, permissible annual mean concentrations are also exceeded. Cases of exceeding the limit values for mean daily concentrations were also recorded in Podgorica, Bar, Pljevlja, and Nikšić. The town of Pljevlja has, in terms of health protection, the biggest presence of these particles in concentrations above the prescribed ones. Cases of exceeding the limit values most frequently occur during the heating season, but there is a downward trend in annual mean concentrations of this pollutant compared to the previous year at all measurement locations.

Increased concentrations of polycyclic aromatic hydrocarbons, benzo(a)pyrene markers and benzo(a)pyrene, whose average annual concentrations in Nikšić, Pljevlja and Podgorica exceed the prescribed target value, indicate a great impact of traffic and industry (fuel combustion) on the air quality. Microclimate conditions relating to stable atmosphere and temperature inversions also contribute to local deterioration of air quality, particularly in valleys, where there is not enough air circulation.

2.4. GEOLOGICAL AND HYDROGEOLOGICAL CHARACTERISTICS

2.4.1. Geological characteristics

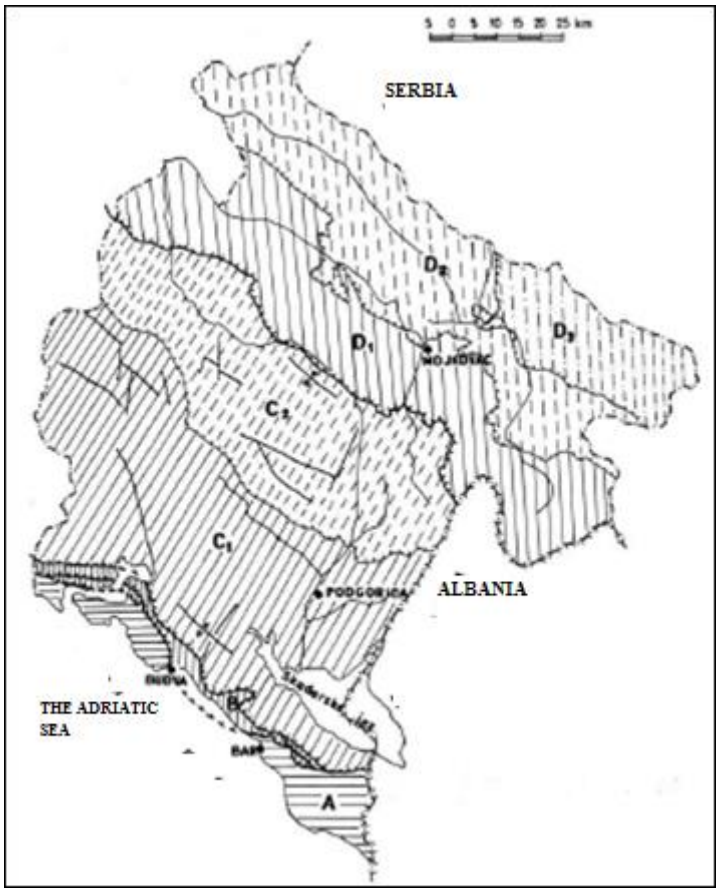
According to data presented in the Physical Development Plan of Montenegro until 2020, the country's ground is made of sediment beds that have been developed over the past 400 million years. In stratigraphic terms, the rocks belong to the era of the Paleozoic, Mesozoic and Cenozoic. The Paleozoic rocks are represented with more or less schistose, clay and marl sandy layers and different types of schists with rare interlayers and limestone lenses and conglomerates. These rocks mostly build the NE part of the country. Mesozoic rocks are represented with more facies, among which the following are the most prominent: carbonate, igneous, volcanogenic-sediment, diabase-chert and flysch rocks. The carbonate facies is made of limestones and, to a lesser extent, dolomites. Rocks of this facies in the central zone of Montenegro form a well known geotectonic unit called "high karst zone" and they appear in other parts of Montenegro. Igneous facies is made of numerous equivalents of eruptive rocks and their tuffs. Volcanogenic-sedimentary facies is represented by cherts, tuffs, tuffites, bentonite, limestone with mugglestones, and chert interlayers. The diabase-chert facies consists of sediment, volcanic and intrusive igneous rocks. Flysch facies is made of clay, marl, sandstone, limestone and transitive variants of these lithologic elements with occurrences of breccias and conglomerates. Cenozoic rocks are represented by carbonate and flysh facies of Palaeogene, Neogene marine and freshwater sediments and quaternary loose sands, pebbles, bigger blocks with or without clays, glacial, fluviglacial, lumniglacial, delluvial, and alluvial origin.



Graphic 2.4-1. Lithologic and stratigraphic map of Montenegro (*Source: Physical Development Plan of Montenegro until 2020, The Ministry of Economic Development, 2008.*)

Tectonic distribution

The territory of Montenegro belongs to the SE Dinarides and there are four main geotectonic units: Parautochthonous zone, Budva-Cukali zone, high karst, and Durmitor tectonic unit. Graphic 2.4.2. shows the main tectonic units in Montenegro.



Graphic 2.4.-2 The tectonic map of Montenegro (*Source: DIKTAS, Montenegro country report, 2012)*

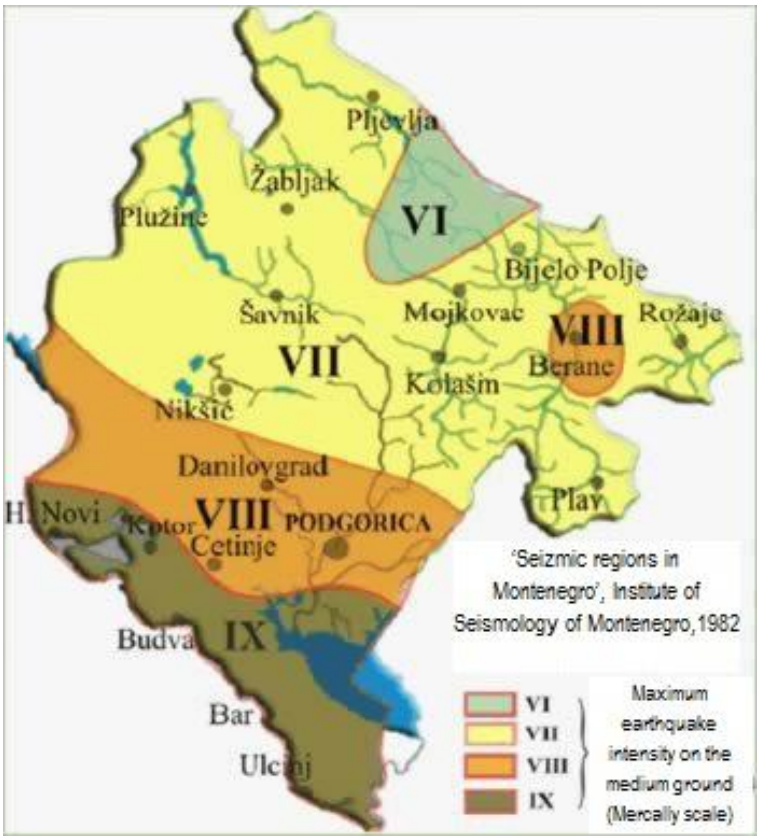
Key:

A - Parautochthonous; B - Budva Cukali zone; C - a high karst; C_1 - Old Montenegrin tectonic units; C_2 - Tectonic units; D - Durmitor tectonic units; D_1 - Sinjajevina, Durmitor; Komovi tectonic units; D_2 - Cehotina tectonic units; D_3 - Lim tectonic units.

Seismicity[8]

Seismic activity in Montenegro is characterized by numerous autochthonous earthquake foci, but also by a larger number of seismogenic zones in the Western Balkans, particularly those in the south of Croatia, east Herzegovina, northern Albania and south and southeast Serbia. Seismic zones around the towns of Ulcinj, Bar, Budva, Brajići and the Bay of Kotor need to be emphasized as particularly active seismic areas of Montenegro, as well as the immediate surroundings of Berane, the whole region around Lake Skadar, Maganik mountain, etc. Graphic 2.4.-3. shows the map of seismic regions of Montenegro.

[8] Source: Physical Plan of Montenegro until 2020, Ministry of Economic Development, 2008



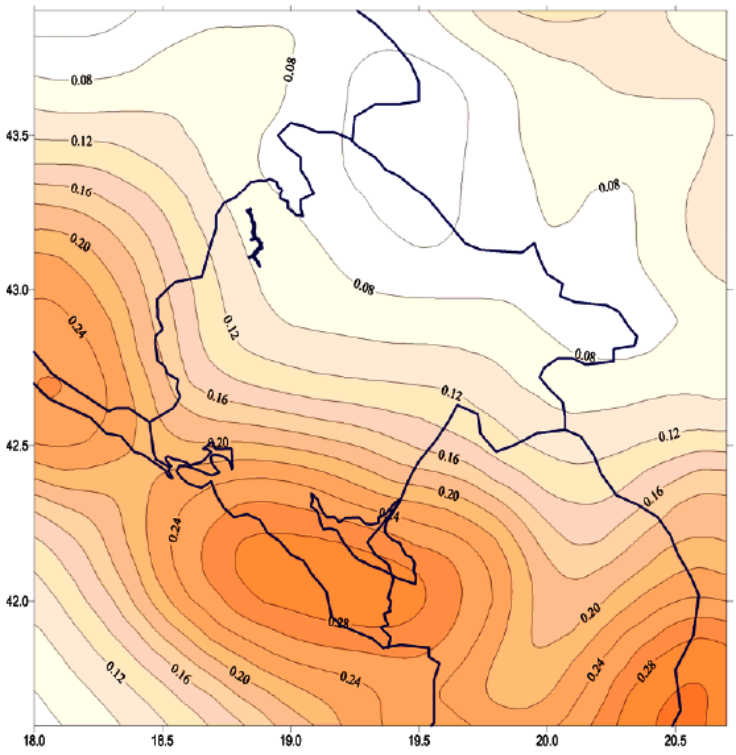
Graphic 2.4.-3. Seismic regions map of Montenegro (1982).

This map displays the basic level parameter of seismic intensity in Montenegro, with several active and potentially active seismic zones:

- southern, coastal region, the region of Ulcinj-Budva-the Kotor Bay, with potential maximum intensity of 9.0 magnitude on the Mercalli scale in medium ground conditions;
- the area of Podgorica and Danilovgrad with potential maximum intensity of 8.0 magnitude on the Mercalli scale;
- central Montenegro with the northern region, including the towns of Nikšić, Kolašin, Žabljak and Pljevlja, with potential maximum intensity of 7.0 magnitude on the Mercalli scale; and
- the isolated seismogenic zone of Berane, which can generate earthquakes with a maximum intensity of 8.0 magnitude on the Mercalli scale.

As for the aspect of seismic hazard, the coastal region is particularly significant because, in terms of geodynamics, it represents the direct collision zone between the southern edge of the outer Dinarides and the north-east edge of the Adriatic tectonic microplate. Therefore, the coastal region of Montenegro which includes the seismogenic zones around the towns of Ulcinj, Bar, Budva, and Berane and the zone in the immediate vicinity of Berane, as well as the entire region surrounding Lake Skadar, Maganik mountain etc. should by all means be emphasized as seismically active.

Graphic 2.4.-4. displays a simplified seismic hazard chart of Montenegro and the surrounding regions (expected maximum horizontal ground acceleration in parts of gravity) within the return time period of 100 years, with a 70% probability of not recovering from the events.



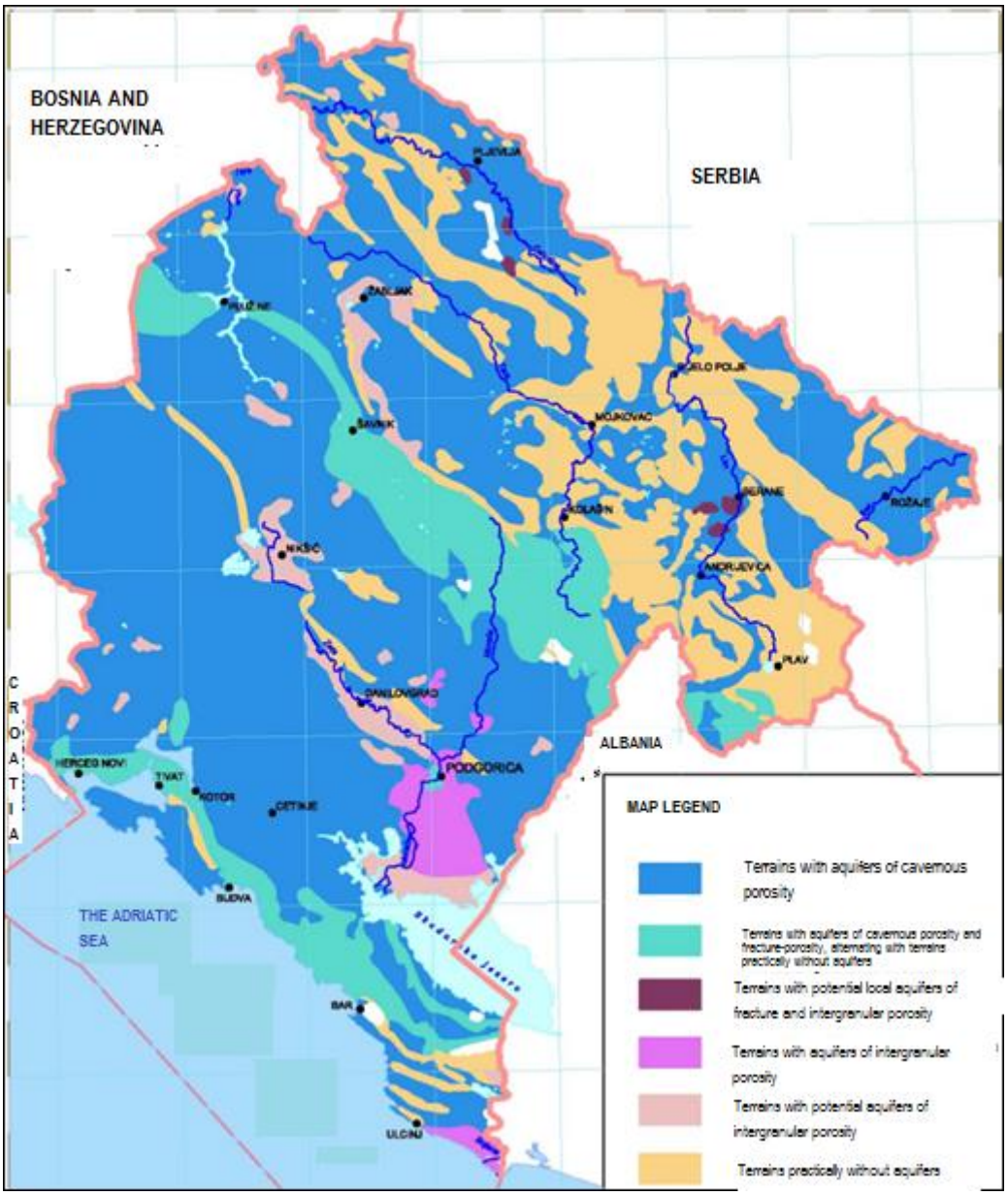
Graphic 2.4.-4. The chart of seismic hazard in Montenegro, for a return period of 100 years, with the maximum ground acceleration (in parts of gravity) with a 70% probability of not recovering from the events (B. Glavatovic, 2004).

2.4.2. Hydrogeological characteristics

According to the Physical Development Plan of Montenegro by 2020, most of Montenegro's terrain is built of carbonate rocks, fracture-cavernous rocks, and rocks with primary or intergranular porosity (around 70%). The terrains composed of these rocks are highly water-permeable. There are no surface water courses on such terrains. Atmospheric precipitates sink very quickly and feed water to discontinuous karst and continuous aquifers which are emptied in the zones of base level erosion, on sea shores, in Lake Skadar with the edges of Zeta and Bjelopavlići plains, Nikšić valley and along riverbeds.

Smaller part of Montenegro's terrain consists of lithological complexes in which porous sedimentary rocks alternate with igneous rocks which have no significant effective porosity. Terrains composed of these rocks hold smaller deposits of ground water in the form of discontinuous and continuous aquifers. These waters are emptied along the base levels of erosion, and even on higher hills above those levels, through less abundant springs. The terrain structure in Montenegro includes clay schist rocks, flysh, igneous, volcanic, diabase-chert facies and freshwater clay-marl neogene rocks and sediments without significant effective porosity. Those rocks build watertight terrains - impermeable for surface and ground waters.

The dominant hydrogeological features of Montenegro's territory are manifested in karst erosion processes and phenomena (holokarst), followed by fluvial and glacier erosion and sea abrasion processes. Another significant hydrogeological feature of Montenegro's terrain is, of course, the sea shore and the rivers belonging to the Black Sea and Adriatic Sea catchments.



Graphic 2.4.2-1. Hydrogeological map of Montenegro (*Source: Physical Development Plan of Montenegro until 2020, the Ministry of Economic Development, 2008*.)

From hydrogeological point of view, rocks are divided into three groups:

- Permeable rocks - hydrogeological collectors, with two subgroups: water permeable rocks - hydrogeological collectors of intergranular structure and fracture-cavernous porous rocks (alluvial and glacio-fluvial sediments and solid rocks of carbonate composition accounting for about 65% of the territory of Montenegro).
- Impermeable rocks - hydro-geological insulators, consisting of two subgroups: practically impermeable rocks and generally impermeable rocks (Paleozoic clastic sedimentary rocks, igneous rocks, etc.).
- Hydrogeological complexes that form the groups of collector and insulator rocks, i.e.: complexes of permeable and impermeable rocks (flysch formation, formation of carbonate and clastic rocks, etc.) with varying hydrogeological characteristics of intergranular porosity in permeable parts and complexes of permeable and impermeable rocks with variable hydrogeological characteristics that are distinguished by fractures and cavernous porosity in permeable parts.

In general, the ground waters in Montenegro flow in two directions:

- to the Adriatic Sea basin in the south, and
- to the Black Sea basin in the north.

In general, the spring waters in the Adriatic Sea catchment flow mainly in direction NW, NW-SE, and NE-SW. Exceptions are the northern slopes of Rumija and Gluhi Do where groundwaters spring around the shores of Lake Skadar, i.e. along the edges of Crmnica plain, where the direction of groundwater flow is S-N.

The reverse is the case with karst terrain of the Black Sea basin, where S-N is the major direction of groundwater flow. However, other water sources often flow from north to south and from east to west, which is caused by deep canyons of Piva, Tara, and Ćehotina rivers.

2.5. WATER

2.5.1. Ground waters[9]

In order to simplify the presentation of the main characteristics of important aquifer water deposits by specific hydrogeological units, the following regions were selected on territory of Montenegro:

- Coastal karst (Parautochthonous, Cukali zone);
- Karst fields, plateaus and high mountains (High Karst and parts of the Durmitor tectonic unit);
- Karst of inner Dinarides (tectonic units: Lim, Rozaje, and Ćehotina).

Basic water-bearing areas, where groundwater reservoirs - of interest for the public water supply of urban and larger rural communities, large industrial plants, as well as for irrigation of large areas - form and exist, include only:

- Quaternary gravel, gravel-sand, and sand deposits - glaciofluvial and alluvial sediments of intergranular porosity, and
- carbonate rocks of the Late Palaeozoic, Mesozoic and Tertiary - limestone, dolomite limestone and dolomites with fracture-cavernous porosity.

Permeable diluvial and glacial sands, gravel and occasional larger blocks are not widely spread and they are, along with accumulations of groundwater-aquifers, significant only for individual water supply and therefore are not included in the list of basic water-bearing areas.

Permeable rock masses alternating with impermeable, water-bearing areas are neither widely spread nor thick and have very limited accumulations of ground water; therefore they are of local importance for public water supply. To some extent, the exceptions are free discontinuous karst aquifers in the Budva-Bar area at the Montenegrin coast.

Practically impermeable rock masses function as watertight bottom or watertight side and hanging barriers which prevent or direct movement of groundwater from aquifers. The groundwater

[9] Source: Physical Plan of Montenegro until 2020, The Ministry for Economic Development, 2008 and Sectoral study (SS-AE) 4.1 Natural features, Republic Institute for Urban Planning and Design, University of Montenegro, Podgorica, 2005)

accumulations formed in some fault zones and in the rock mass decomposition crust get discharged through numerous springs with yield below 1.0 l/s, which are or can be used for water supply.

Some water springs in the coastal zone of the karst are salinated (Škurda, Springs of Orahovac, Risan Cave, Topliš, Plavda etc.).

Groundwater quality status[10]

Water that can be used for drinking and for food industry, based on the limit values of 50 parameters, is categorized into four classes, i.e.:

- Class A - water which can be used as drinking (potable) water in its natural state, with disinfection, if necessary;
- Class A1 - water that can be used for drinking after a simple physical processing and disinfection procedure;
- Class A2 - water that can be used for drinking after appropriate conditioning (coagulation, filtration and disinfection);
- Class A3 - water that can be used for drinking after intense physical, chemical and biological treatment with prolonged disinfection and chlorination, i.e. coagulation, flocculation, decanting, filtration, absorption on activated carbon and disinfection with ozone or chlorine.

Groundwaters in Montenegro provide for about 92% of the total quantity of water needed to supply the towns and villages. The overall quality of groundwater in Montenegro in natural conditions for most parts of the year (excluding coastal aquifers that are under the influence of the sea) corresponds to the first class.

In the coastal region, the main natural negative factor affecting the quality of groundwater is the impact of seawater on low karst aquifers along the coast. Groundwaters that appear in this area are often either salty or exposed to the influence of sea water during operation, to the point where they can no longer be used for drinking.

In the mainland, natural quality of water at almost all sources of groundwater has been deteriorated by the dominant man-made influences as a result of inadequate sanitary protection and inadequate sanitation in the catchment area.

Water and aquifers in the valley of the Zeta river have the best quality and fall in Class A, and the water from some wells is today still used for drinking without treatment. The most polluted wells are those in Vranje and Drešaj, whereas the wells in Mitrovica (near Cijevna) and Farmaci are in the best condition.

The nitrate content in the water from the well in Vranj is particularly worrying because of its constantly high value. This is the result of the impact of artificial fertilizers - saltpeter because the content of potassium is also high, ranging up to 30 mg/l.

Microbiological indicators have shown some deviations from their class, which particularly relates to the content of fecal bacteria in the Class A2, in the wells in Gostilje, Vranj, and Drešaj. The wells in Farmaci and Cijevna were the cleanest in this respect as well.

[10] Source: Information on the environmental situation in Montenegro for 2013, Agency for Environmental Protection, Podgorica, 2014

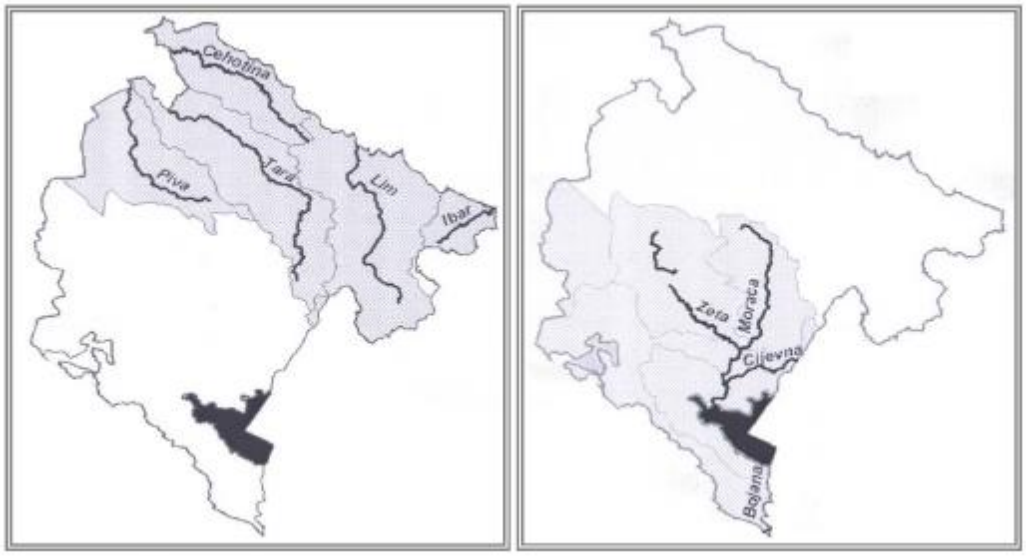
Quality of potable water[11]

In compliance with the regulations in force in Montenegro, health care institutions are in charge of controlling hygiene, i.e. safety and quality of drinking water as well as sanitary and hygienic conditions of water supply facilities. The number of samples and sampling dynamics are determined based on the population equivalent. Based on a review of sanitary and hygienic conditions, it was found out that not all legally prescribed sanitary protection zones have been established, i.e. most water intake structures only have the immediate protection zone. The reservoirs existing on several urban water supply facilities have no appropriate sanitary protection and the distribution network on most urban water supply facilities is rather old. Disinfection of water is not carried out continuously in all of the urban water supply facilities.

Although it can be concluded that the health safety of drinking water in most of the municipalities in Montenegro is satisfactory, special attention must be paid to sanitary protection zones, and in the municipalities where a high percentage of irregularities was established it is necessary to take appropriate measures (Ulcinj, Andrijevica, Plav).

2.5.2. Surface water body[12]

The main feature of Montenegro's hydrography is the existence of two approximately equal catchment areas: Black Sea and the Adriatic. Around 47.5% of Montenegro's territory belong to the Adriatic Sea and around 52.5% to the Black Sea catchment.



Graphic 2.5.2-1. The catchment areas of Montenegro (*Source: DIKTAS, Montenegro country report, 2012)*

Another specific feature of the territory is that the highest mountain peaks and chains belong to the the Black Sea catchment, and the watershed between the Black Sea and Adriatic Sea catchment lies south of them. In general, both catchment areas are rich in water, even according to the world standards. However, significant part of Montenegro's territory belongs to the continental karst area, where there are

[11] Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020, Ministry of Sustainable Development and Tourism, (2014)

[12] Sectoral study (SS-AE) 4.1 Natural features, Republic Institute for Urban Planning and Design, University of Montenegro, Podgorica, 2005

no constant watercourses, with numerous swallow-holes into which the waters fall and flow underground toward the watercourses (rivers) or the sea.

Significant rivers (the main surface watercourses) of the Black Sea catchment are: the Piva, the Tara, the Cehotina, and the Lim as watercourses from the Drina river basin and the Ibar as a watercourse from the Zapadna Morava's basin. Significant rivers (the main surface watercourses) of the Adriatic Sea catchment are: the Morača, the Crnojevića River and the Cijevna, which all gravitate to Lake Skadar, from where they overflow into the Bojana river and flow further into the Adriatic Sea.

The continental karst watercourses flow through the swallow-holes to the underground and surface in the Adriatic or Black Sea catchment or spring out under the sea surface. Some of the waters flow underground to the neighbouring territories (Trebišnjica, Konavlje). The largest number of surface watercourses in Montenegro is of torrential nature. They are grouped in torrential systems according to typical geographical indications: coastal, Skadar, Kotor Bay, Nikšić, Cetinje, Podgorica, Piva, Lim, and other torrent flows.

The important torrential system in the coastal area include torrential subsystems of the Bay of Kotor, Budva, Sutomore and Ulcinj. The Kotor Bay torrent flows include, among others, the Zverinjak creek; Kučac is one of the Budva torrent flows, and Željeznica and Rikavac are Bar torrents flowing toward the sea. Typical Ulcinj torrents include: Meñurječka, Vladimirska, and Rastiška torrents flowing towards Lake Šasko and the Bojana river.

The Skadar torrent flows include some typical subsystems: Crmnica, Orahovac, and Skadar; more significant among them are the torrent flows in the Crmnica valley: Bistrica and Sutorman.

Artificial lakes are also very important for the hydrography of Montenegro and they can be found on the following rivers: the Piva, the Ćehotina, the Zeta (in the Nikšić valley) and the Grahovska river (Grahovo). A part of Montenegro's territory was flooded with the construction of the artificial lake of the "Trebišnjica" hydro-power plant.

Natural lakes in Montenegro are relatively numerous and the largest ones are located in the lowland areas of the southern part of the territory. Lake Skadar, formed in a large depression, is also the largest lake in the Balkan Peninsula. Three-fifths of Lake Skadar belong to Montenegro. At the highest water level of about 9.85 meters above sea level, the lake has an area of about 525 km^2. Lake Šasko is the second largest lake in Montenegro and it is located between Lake Skadar, the Bojana River and the Adriatic Sea. Lakes Crno, Plavsko and Biogradsko are also nature reserves, as typical examples of glacial lakes. All these lakes, with the exception of Lake Plavsko, lie in national parks. There are also many smaller lakes of glacial or karst origin.

Surface waters quality status

Ecological status of the rivers[13]

The Water Act defines the categorization and classification of surface and ground waters. The Regulation on the classification and categorization of surface and ground waters ("Official Gazette of Montenegro", No. 2/07) provided for classification and categorization of land surface and ground waters land as well as coastal sea water in Montenegro. Permanent quality control of surface waters in

[13] Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020, (Ministry of Sustainable Development and Tourism, 2014)

Montenegro is carried out to assess the quality of groundwater and surface water bodies, water, coastal sea waters, water courses, to monitor the pollution trends and to preserve the quality of water resources. Water quality is tested at water sources to evaluate the safety of water for water supply and recreational purposes with the aim of protecting both the water source and the public health. State administration bodies in charge of hydrogeological affairs (Hydrogeological Institute of Montenegro) monitors the qualitative and quantitative parameters of water, in compliance with the annual systematic quality and quantity testing plan for surface and ground waters.

With regard to the quality of water in the rivers, the most polluted rivers are:

- Ćehotina, downstream from Pljevlja and Vezišnica. Pollution sources are substances present in urban wastewater (e.g. BOD_5, NO_2, NH_3, PO_4 faecal coliforms and saprobiotic matter), which is why these rivers are classified as "poor" to "very poor" quality.
- Morača, downstream from Podgorica. A favorable hydrological regime is in force so that the water in this river is of better quality compared to the previous years. However, increased amount of ammonia and total coliforms can be observed downstream of Podgorica.
- The Ibar river, downstream of Rožaje. Downstream from Rožaje, near Bać. Based on its water quality, the river does not even meet the criteria for the third quality class in terms of the parameters which it comprises, for example ammonia, nitrites, phosphates, total and faecal coliforms.

In addition to regular monitoring, in compliance with the Regulation on the classification and categorization of surface and ground waters, there are also other water body analyses carried out by municipalities on specific watercourses. For example, the Municipality of Pljevlja has had the water of the Vezišnica river analysed before it flows into the Ćehotina river. The analyses have shown that the river is under strong impact of alkaline waste water from the Pljevlja heat-power plant, which are discharged into the Vezišnica upstream from the sampling point. The greatest deterioration in water quality has been registered in Paleško creek: from class A1 upstream of the "Maljevac" landfill the situation is deteriorating and passes to class A3, or even to uncategorized classes downstream from the landfill. Leachate from coal depots, wastewater from Pljevlja, the inflowing Vezisnica river and from the Mjedenički creek deteriorate water quality of the Ćehotina river.

Other polluted water courses include:

- the Lim river Water quality has been assessed as good in terms of many parameters. However, the micro-bacteriological condition of this river can be characterized as "poor" or "very" poor, due to the increased concentrations of faecal and total coliforms, which were found downstream from Berane and Bijelo Polje.
- the water of the Zeta river is of poor quality only when it comes to total coliforms, measured on the stations in Duklov Most (upstream of the discharge of wastewater in Nikšić) and Danilovgrad. Higher values were recorded at the station in Duklov most, although other parameters point to "high" to "medium" water quality. It should be emphasized that the position of the monitoring stations along the Zeta river is not such that it can enable full assessment of the impact of the wastewater from the town of Nikšić on the Zeta river.

As for the saprobiotic composition, all these rivers fall into class 2, apart from the Ćehotina, which falls into class 3 downstream from Pljevlja.

It can be concluded that adequate treatment of urban wastewater could significantly improve the condition of Montenegro's rivers.

Ecological status of the lakes[14]

Lake Skadar has several sites with pronounced eutrophication. In general, the north shore of Lake Skadar has lower water quality compared to the southern part of the lake. Regardless of the inflow of the Morača river in Lake Skadar and what it brings along, in the northern part of Lake Skadar, there are certain industrial activities (especially Aluminum Plant Podgorica), as well as run-off from the plains of Podgorica, where certain agricultural activities take place. The water of Lake Skadar is classified as A2CK2 class.

Lakes Plavsko and Crno are included in the water quality monitoring plan. These lakes have "high" to "good" water quality.

Skadar and Plavsko are particularly threatened by discharges of polluted urban waste water, causing the slow accumulation of nutrients in the ecosystem. Lake Skadar is protected by a wide wetlands strip on the north side, but increased eutrophication can still be expected to occur over a longer period of time.

As in previous years, the most polluted waterways were the Vezisnica and the Cehotina in Pljevlja area, the Ibar near Bać and the Morača downstream of the discharge of Podgorica's sewage system. Moderately polluted are the waters of the rivers Crnojevića, Grnčara, and the lower course of Cijevna; Lim and Tara had a good water quality status, Zeta and Bojana had a very good quality status, whereas Piva and Kutska had excellent quality status. The measurement results indicate the high sensitivity of these water systems, especially during low water level regimes. The quality of the water in the observed watercourses in 2013 was better than in 2012, which can be explained with more favorable weather conditions and less pressure of the human factor.

2.5.3. Coastal waters (the sea)[15]

The general direction of the coast is northwest-southeast with a few major and minor deviations. Bay of Kotor is unique by many parameters (shape, coast indentation, physical and chemical characteristics of the sea, the characteristics of flora and fauna, hydrological characteristics, natural environment, etc.). Other major bays include: Trašte, Trsteno, Jaz, Budva, Buljarica, Spičanski, Bar, and Valdanoski; these are mostly larger coves along the open coast characterized by rocky, sandy or gravel beaches with various types of hinterland. In the sea there is a relatively small number of islands, two larger islands being Spradioti and Sveti Nikola. The main characteristics of the coast:

- the length of the coastline on the mainland - 249.1 km;
- the length of the coastline on the islands - 11.1 km;
- there are 7 islands, 37 reefs and 4 ridges; Total – 48;
- the total area of islands and reefs - 0.9 km^2.

When speaking of the coastal sea, we can distinguish two zones: Bay of Kotor and the open sea. The Bay of Kotor penetrates the mainland about 28 km deep. It is a branched gulf, bordered by steep mountains. In terms of geographical and hydrographical characteristics there are three units: Bay of Herceg Novi, Bay of Tivat with the strait of Kumbor, and Bay of Kotor and Risan with the strait of Verige.

[14] Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020, (Ministry of Sustainable Development and Tourism, 2014)

[15] Source: Physical Plan of Montenegro until 2020, Ministry of Economic Development, 2008

The average depth of the sea is 27.3 m and the maximum depth is 60 m. A depth of about 20 m follows the coastline at a distance of 200 to 300 m. The Bay closes an area of about 90 km^2. Along the bay's coast, particularly in the Kotor-Morinsko-Risan region, there are estuaries and sources of fresh water at the sea bottom (Škurda, Široka rijeka, Ljuta rijeka, Gurdić, Sopot, Gradišnica).

Open shoreline of the Montenegrin coast is relatively poorly indented with several bays and coves and very few islands and reefs. The largest part of the coast is open and mostly exposed to influences from the open sea, i.e. from the Mediterranean Sea. In addition, this part of the coast is exposed to the influence of the great fresh water tributaries (the Bojana river).

The open sea of the South Adriatic is characterized by the greatest depths (depth of 1230 m is the greatest depth in the Adriatic Sea, registered southwest of Budva).

Coastal (sea) water quality status[16]

In the coastal region, based on the analysis of the environmental situation, deterioration in the quality of bathing water has been registered in multiple locations in the Bay of Kotor, as well as at some sites of the high seas: Ada Bojana, Velika Plaža, Mala Plaža and Port Milena, Sutomore, Bečići. Eutrophication in the Bay of Kotor is evident in inshore bays (phytoplankton bloom in Kotor and Risan Bay), while the middle bay (Tivat and Herceg Novi) is within the threat zone. Along the open sea coast, there are indications that the eutrophication is present, particularly on Plavi Horizonti and in Buljarica, but it is much less pronounced than the process in the Bay. In line with the statements above, priorities have been set as well as the waste water treatment level. Construction of waste water treatment plants has been designed and it has been going on in all cities of the coastal region.

2.5.4. Harmful effects of water (flood water)[17]

Floods in Montenegro mostly occur because of the hydrology of rivers (torrential type), meanders in the plains, karst fields, the presence of the floodplains and the conflict with the area bordered by agricultural land and infrastructure. Protection against floods and changing the river beds require most careful planning, in proportion with the preservation of water ecosystems with huge self-purification capacity. We need to point out to additional risk of flooding caused by improperly planned construction in flood plains and karst fields.

Practically all the rivers in Montenegro are of torrential type in their upper courses and some of them stay torrential through their entire length. This means that there are large differences in the flow of larger and smaller waters and regular occurrences of torrential waves with a significant concentration of deposits.

How the the problem of protection against torrents will be approached depends on the size of the watercourse. In case of larger torrential flows, the protection against flood is achieved with conventional watercourse management and flood defense measures. In case of smaller torrential flows, the measures to be taken are based on a complex anti-erosion regulation of the basin.

[16] Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020, (Ministry of Sustainable Development and Tourism, 2014)

[17] Source: Physical Plan of Montenegro until 2020, The Ministry for Economic Development, 2008 and Sectoral study (SS-AE) 4.1 Natural features, Republic Institute for Urban Planning and Design, University of Montenegro, Podgorica, 2005)

This means that there are large differences in the flow of larger and smaller watercourses (over 1000:1) and regular occurrences of torrential waves with a significant concentration of deposits. Such feature of the mainstream would not be possible without the numerous torrential tributaries of extremely short course and large longitudinal falls with all the conditions for the formation of the devastating torrential waves. Each of the numerous torrent flows is a threat to roads and settlements.

The railway line Belgrade-Bar (in Montenegro) is threatened by 8 major torrential flows, whereas a number of small torrential streams gravitate to the railway line Podgorica-Nikšić and the highway from Bijelo Polje to Podgorica is cut by 12 torrents. The Adria Highway (Jadranska magistrala) is a problem of a particular kind. Most torrential flows in that region fall into a very small basin area, and they are very numerous.

In Montenegro, floods are the biggest threat to large land areas along the shores of Lake Skadar, along the lower course of the Morača river and along the Bojana river. In addition, significant flooding can occur in the Lim basin, from Gusinje to Zaton, near Kolašin and Mojkovac, as well as in the Ćehotina river valley near Pljevlja. Floods occurring in larger and smaller karst fields must not be ignored either, because of their significance, i.e. the amount of damage they cause. In this respect, the floods are certainly the most frequent in Cetinje and Nikšić valley.

2.6. SOIL

2.6.1. Pedological data

The diversity of soil types in Montenegro is the result of interaction between the natural soil factors of relief, parent material, climate, vegetation and living organisms, including man, as well as pedogenetic process. Their conjunction led to the formation of mainly autogenous and, to a much lesser extent, hydrogenous soil.[18]

The most common soil types of Montenegro are:

- **Limestone-dolomite black soil (Calcomelanosol)** occupying an area of 660,000 hectares. In this type of soil, lithosols and regosols appear as the initial phases of soil formation.
- **Distric brown soil (Distric Cambisols)** is formed on base-poor quartz-silicate substrates; when they wash away due to heavier rainfall, the soil is further acidified. This process is supported by forest ground cover generated by coniferae and deciduous trees, which breaks down very slowly, leading thus to an increased content of humic acid in the soil. This type of soil covers an area of 394,820 hectares.
- **Brown eutric soil (Eutric Cambisol)** has a similar structure profile as brown acidic soil. Unlike the distric brown soil, the eutric cambisol is formed on the substrates containing $CaCO_3$, but it usually has acidic or slightly acid reaction and occupies an area of 118,300 hectares.
- **Rossa (terra rossa)** is round in the coastal region and in the Skadar Lake basin at the height of 500-600 m. The red soil covers a surface of 84,000 ha.
- **Fluviatile and alluvial soils (Fluvisol)** occupy an area of 34,250 hectares in the river valleys, on the shores of Skadar, Plav and Sasko lakes and in the coastal region.

[18] Action plan to combat land degradation and to mitigate the effects of drought in Montenegro, Podgorica, December 2014

- **Humus-accumulative soils (Rendzinas)** are formed on carbonate loose material from moraines, glacio-fluvial deposits, scree or talus on an area of 31,200 ha.
- **Brown soil on limestone and dolomite (Calcocambisols)** appears in the lower areas in succession with calcomenasol on an area of 30,000 ha.
- **Humus silicate soil (Ranker)** developed mainly at altitudes above 1500 m above sea level on silicate substrate under the surface of 6,830 ha.
- **Pseudogley soil (Pseudogley)** occur on the substrate of diluvial clay in Bjelopavlići valley and Lješkopolje, above an impermeable illuvial horizon resulting from stagnant water and heavy rainfall.
- **Marschy-gley and peat soil** are formed in the lowest parts of the fluvisol terrain. They take up a small area of only 3,500 ha, at Štoj near Ulcinj and in riverbeds.

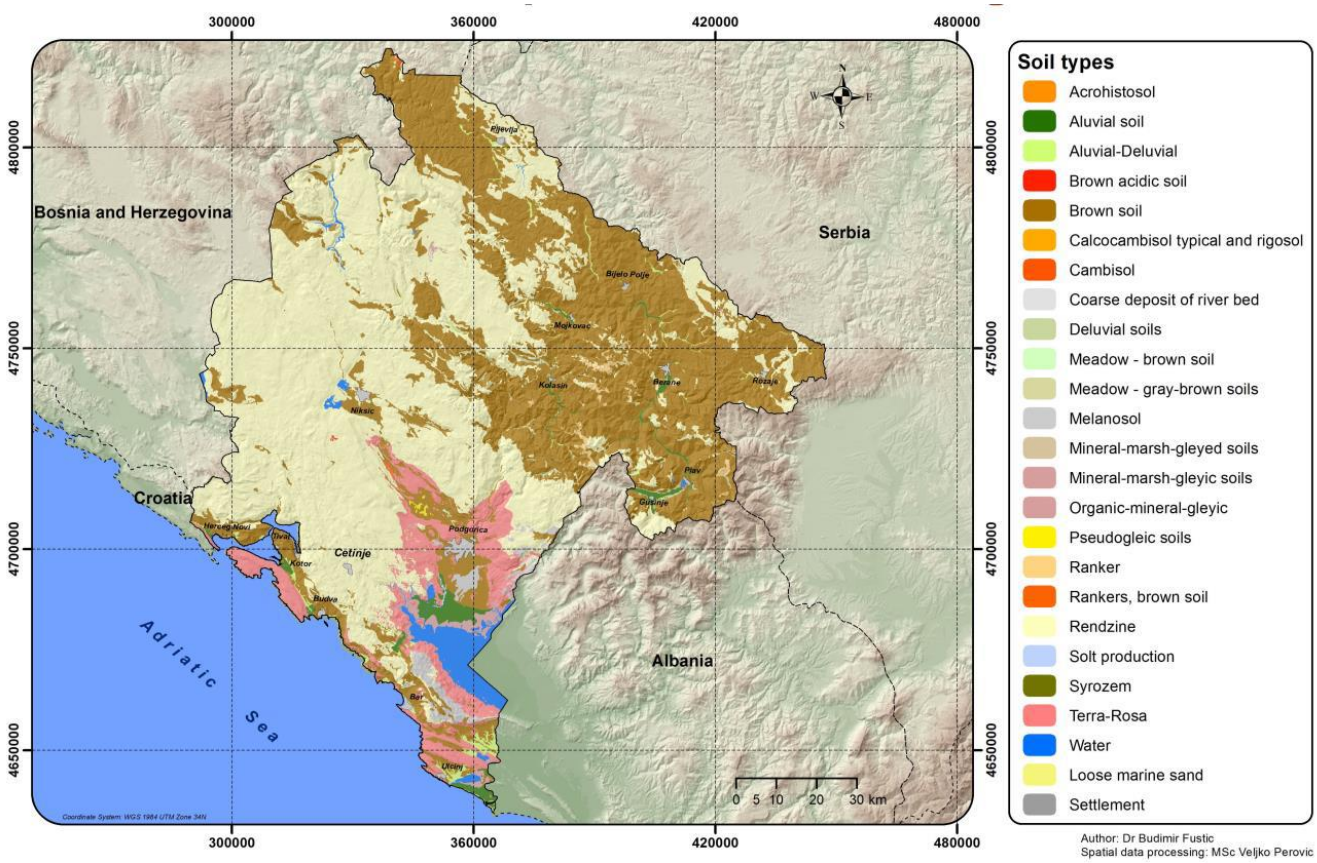
There is also a slight area of technogenic (landfills, mine tailings and other mineral resources) and re-cultivated land.

According to the data presented above, the most common types of soil in Montenegro are calcomelanosol (47%) and distric cambisol (28%), followed by (8%), red soil (6%), fluvisols (2.4%), rendzinas (2.2%), etc. (Figure 2.6.1.).

Most of soil types found in Montenegro have a shallow layer of soil and a low vegetable-food potential. The total land resources in Montenegro, without the barren surfaces (rocks, swamps, lakes, rivers, roads and urban areas) are classified into five categories of soil fertility (Fuštić and Đuretić, 2000) (Table 2.6.1.).

Table 2.6.-1. Categories of effective soil fertility with area estimation

Nr.	***Fertility categories***	***Land capability***	***Area (ha)***	***%***
1	High fertility	I and II	20,000	1.5
2	Medium fertility	III and IV	60,000	4.3
3	Reduced fertility	V and VI	350,000	25.3
4	Low fertility	VII and VIII	640,000	46.2
5	Unfertile	no capability	312,000	22.7
Total			**1,382,000**	**100**



Graphic 2.6.-1. Pedological map of Montenegro (Source: Fuštić and Đuretić, 2000)

2.6.2. Soil quality

In order to determine the quality of the soil, i.e. to determine the content of hazardous and harmful substances, sampling and analysis of soil was conducted in 10 urban settlements in Montenegro in 2013 (out of which 4 samples were taken at playgrounds in different municipalities). The results of analysis of soil samples collected at the playgrounds were more than satisfactory. Testing for hazardous and harmful materials in soil was carried out in the municipalities of: Berane, Bijelo Polje, Žabljak, Kolašin, Nikšić, Pljevlja, Tivat, Ulcinj, Mojkovac and in the wider area of the capital Podgorica.[19]

In most towns of Montenegro, municipal waste is disposed of at town landfills, but there is also a large number of dumpsites. The dangers of soil pollution specifically refer to leachate water from landfills. An example of such landfills are: landfill Željezara Nikšić (steelworks), a pool of red mud in KAP (Aluminum Plant), landfill of ash and slag at the "Pljevlja" thermo-power plant.

According to the Report on the Environmental Status in Montenegro in 2013, land in the vicinity of unselectively and improperly disposed industrial or municipal waste has possibly been polluted. Physical and chemical parameters of soil were measured and the samples had been taken in the vicinity of municipal waste landfills in Žabljak and Bijelo Polje, near the industrial waste landfill of the foundry in Nikšić, Brskovo mine in Mojkovac, as well as near Jalovište and Gradac in Pljevlja. The results showed that the land near the town landfill in Žabljak contained increased concentrations of inorganic pollutant - cadmium[4]. The sample of non-arable land taken about 200 m from the steelworks' landfill displayed increased content of nickel and chromium, which cannot be attributed to the impact of the landfill.

[19] Agency for Environmental Protection; Information on the environmental situation in Montenegro for 2013

Results of the analysis of the soil sampled near the Brskovo mine show increased contents of lead, mercury, cadmium, arsenic, copper and zinc in comparison to standard values. It is wort mentioning that the whole area is characterized by a high content of the above metals of geochemical origin. The location Gradac recorded higher content of lead, cadmium, arsenic, fluorine, copper, and zinc in comparison to standard values, whereas the content of all tested parameters in the soil samples taken in the vicinity of slag landfill in thermal-power plant Pljevlja was below the prescribed MAC.

Cases of land degradation were recorded in places where material for the construction of certain facilities was excavated. Such cases were particularly recorded in the Nikšić valley where material was taken out during the construction of embankments and dams for artificial lakes Krupac, Slano and Vrtac. After the excavations stopped, no soil remediation was conducted on any of the locations where earthy material had been exploited. Similar situations occurred in a number of quarries, after the extraction of gravel and sand from the bed of certain watercourses, as well as due to the use of other mineral resources.

2.6.3. Erosion

Soil erosion is mainly present in areas with impermeable geological grounds, where the soil is mostly non-resistant and susceptible to erosion. Frequent occurrence of erosion is recorded in places with rather devastated vegetation cover, on steep slopes and in places with insufficient protection of the soil from possible erosion.

The consequences of erosion are losses and impoverishment of soil as a result of removing the nutrients; furthermore, large deposits are generated (about 4 million m^3/year) which are disposed of in river valleys, backfilled or transfered to fertile land, shoals of sand and gravel expand, causing droughts, floods, etc. Torrential floods and drifted earth mass threaten the roads, towns, villages, and various facilities.[20]
The largest areas affected by erosion in Montenegro are found in the catchment area of the largest rivers: 19% in the Ćehotina basin, 44% in the Lim basin, 29% in the Tara basin, 27% in the Piva basin, 33% in the Morača basin and 45% in the coastal region of Montenegro.

2.6.4. Salinization of soil

In Montenegro, the problem soil salinization occurs along the sea coast and in the area around Ulcinj, Buljarica and Tivat. Salinization is caused by penetration of salty sea water through permeable alluvial soils, which are mostly of sandy and clay-like texture. Salinization of soil in the delta of the Bojana river occurs due to the presence of saline ground water and mixing of fresh and salt water, which is brought along by tide along the river Bojana up to Reč. Saline intrusion into the interior of the country creates salt marshes in several places, which are important in terms of biodiversity.

Saline intrusion must be taken into account during the design of sewer systems and water purification units.

[20] Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020 (2014)

2.6.5. Agrobiodiversity

Montenegro is traditionally divided into five major agro-ecological regions based on common features (largely on the basis of climate, agricultural production structure, cultivated and plowed areas, income, and the concentration of livestock), which are:

- coastal region;
- plain of Zeta and Bjelopavlići;
- karst region;
- northern mountains;
- Lim and Ibar basins[21].

2.7. BIOLOGICAL AND LANDSCAPE DIVERSITY, PROTECTED AREAS

Owing to its geographical location, as well as various geomorphological and climatic conditions, Montenegro is one of the European countries with very high biodiversity. It is situated in two major bio-geographic regions: Mediterranean and Alpine, with different habitat types and ecosystems on a very small area.

2.7.1. Habitats

The diversity of ecosystems

Since there is no official, widely accepted classification of ecosystems, the National Strategy for Biodiversity[22] defined the following typical ecosystems, habitats and geological formations:

Ecosystems	Mountains	• High-mountain area in the continental part of Montenegro • Dominant mountain peaks: Durmitor (2523 m), Komovi (2461 m), Prokletije (2,536 m), Sinjavina (2,277 m), Bjelasica (2.037 m) • Coastal mountains: Orjen (1,893 m), Lovćen (1,749 m), Rumija (1,586 m) • Major habitat types: alpine pastures, rocky walls and cliffs, bare land with sparse vegetation and gullies.
	Forests	• They cover the largest area (54%), out of which natural forests take up 45%.
	Steppe	• Rare, found mostly on alluvial soil (Ćemovsko valley, Karabuško, Tuško and Dinoško valley and in the lower parts of the Cijevna river canyons
	Freshwater	• wetlands mainly in the plains and on the sea coast • Lake Skadar (the largest lake, very large biodiversity, particularly important because of the presence of a large number of relict and endemic species) • Lake Šasko • Cold high-mountain glacial lakes in the north of Montenegro, especially within the national parks of Durmitor, Biogradska gora and Prokletije
	Marine	• Over 300 species of algae, 40 species of sponges, 150 species of crustaceans,

[21] Fourth National Report of Montenegro on the implementation of the Convention on Biological Diversity, Podgorica, 2010

[22] National Biodiversity Strategy for the period from 2010 to 2015

		340 species of molluscs, 400 species of fish, 3 species of sea turtles, and 4 species of dolphins • The Bay of Kotor and the mouth of the Bojana river are of particular importance for biodiversity.
Habitats	Coast	• Sea coastline is 313 km long • Rocky shores (cliffs), natural sand beaches and 8 smaller islands • The Big Ulcinj Beach - the sand dunes host a unique halophytic/saline vegetation. • The southern slopes of the coastal mountains developed the typical Mediterranean maquis and garrigue vegetation. • Saline vegetation and cultivated land (olives and orchards) are present at lower terrains and on the shore. • Natural reserve Tivat Saline and Ulcinj saltworks are of great importance for the habitation and overwintering of marsh birds
	Caves	• Lipska cave, Đalovića cave • The caves are among the deepest in the Balkan Peninsula (the cave at Vjetrena brda and Durmitor, Duboki Do on the Lovćen mountain)
	Canyons	• This area is under the influence of the Mediterranean climate (Morača and Cijevna canyons) • This area is influenced by the cold continental climate (the Tara river canyon, remains of Piva and Komarnica canyons, gorges like Ibarska, Tifranska and Đalovića)
	Karst (specific geological formation)	• At altitudes above 1,000 m asl • characteristic vegetation of bushes
Priority habitats: the negative effects are mostly reflected on the water and forest ecosystems.		

Diversity of species

Due to its geographical location, distribution and heterogeneity of habitats, topography, geological history and climate variations, Montenegro is characterized by a great diversity of species. Monitoring of the biodiversity status has been carried out since 2000 as part of the national environmental monitoring program. However, given the fact that the monitoring of the situation is carried out on a reduced scale, the information collected so far provide insufficient grounds for a serious analysis of trends in the condition of indicator species population, or regarding the changes in selected habitat types.

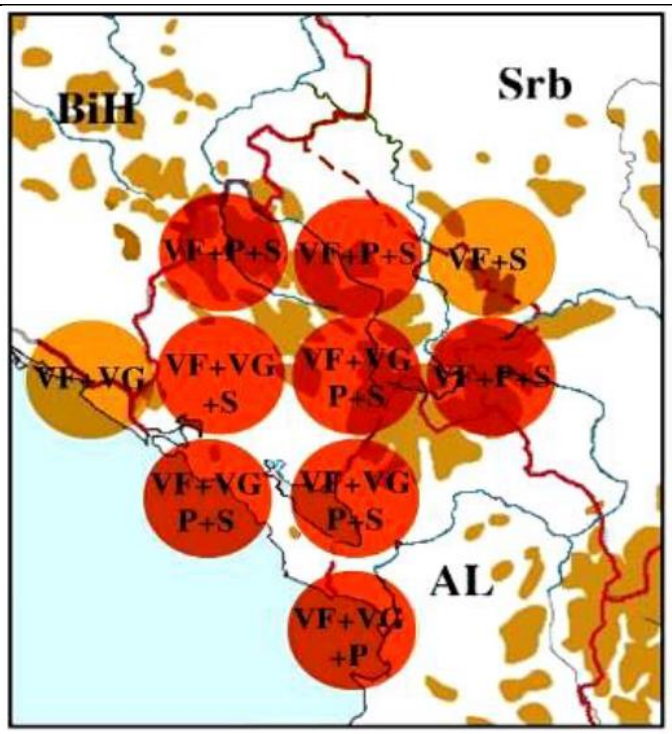
Algae	Freshwater algae	• 1,200 species and varieties have been described so far and the most dominant group among them are the diatoms (Bacillariophyta) and green algae. • The northern areas are dominated by oligotrophic freshwater ecosystems with relatively few species. • The south is dominated by mesotrophic and eutrophic ecosystems with a larger number species. • The most important location is Lake Skadar (an endemic species Cyclotela Skadariensis) • Other significant sites: Lakes: Crno jezero (Black Lake), Bukumirsko jezero, Ridsko jezero, Plavsko jezero, Zminje, Šasko jezero, as well as Veliko and Malo Stabanjsko jezero and the artificial lake Krupacko.
	Marine algae	• Over 300 species of macro algae (although there are probably a lot more),

	(seaweed)	most of which are red algae (*Rhodophyta)* • Most species are widespread in the Adriatic and the Mediterranean sea.
Mosses and lichens	Mosses	• Currently, there are 589 species recorded (research is limited and the actual number is probably higher) • The largest number of species is related to the beech, hornbeam, oak, and maple forests. The number of species and the number of forest ecosystems goes down as the altitude rises. • They are also associated with watercourses and mires (Lake Barno, Prokletije)
	Lichens	• 693 species recorded
Vascular plants		• There area approximately 3,250 described species, primarily within the families of Asteraceae, Poaceae, Fabaceae, and Caryophyllaceae • The high mountain flora is of great importance. • Vascular plants biodiversity centers: Durmitor with Bioč and canyons of Tara, Piva and Sušica; Bjelasica, Komovi and Prokletije with Visitor, Žijovo and Hum Orahovski, Cijevna River canyon, Mrtvica canyon; Lake Skadar and the northern slopes of the Rumija mountain. • Vascular plants endemism centers: Prokletije massif, Moračke mountains, Bjelasica, and Komovi.
Fungi		• About 2,000 species of fungi
Invertebrates	Terrestrial and freshwater invertebrates	• A very poorly explored group, comprehensive descriptions are mostly approximate • Many species are relict, especially from the Tertiary (*Congeria kusceri* - the only known underground shell). • Significant caves: Lipska cave (endemic genera Amphipod *Typhlogammarus*, endemic species of snails and copepods), Babotuša cave, near Trnovo (endemic species of copepods, harvestmen (*Opiliones*), and beetles, Obodska cave (endemic species of beetles, amphipods and snails) and Magara cave, near Podgorica, (endemic species of beetles and harvestmen)
	Invertebrates	• Very large number of species, a small degree of endemism. • Poorly explored group
Fish	Freshwater fish	• In the Adriatic Sea basin, there are approximately 60 species, whereas the Black Sea is the home to about 30 freshwater fish species (differences are due to geological history). • The salmon species are typical for the fast mountain rivers (with several cyprinid species). • Cyprinid species dominate in moderately rapid rivers (with a smaller presence if salmon species) and in stagnant waters. • Among the most important areas inhabited by freshwater fishes is Lake Skadar, where over 40 species of fish are registered, including species that migrate from the sea to a freshwater ecosystem.
	Marine fish	• There are approximately 400 species within 117 families. • poorly explored • Cliffs and ridges in coastal areas near the sea shore are the richest habitats of in fish species. • Sandy bottoms, like the one at the mouth of the river Bojana, are relatively poor in fish species, although shallow water meadows covered with seagrass *Posidonia* are important spawning grounds.

Reptiles and amphibians		• 18 species of amphibians, 38 species of reptiles, and 69 subspecies live here. • Amphibians and reptiles biodiversity centers: coastal region of Montenegro and its hinterland, Lake Skadar, Lovćen (wetlands) and Prokletije (lakes Bukumirsko and Ridsko). • Other significant sites: Pošćenska Lake, Komarnica canyon, from Skakavica to the village of Duži, Zminičko lake, part of the Tara River Canyon (from Ćelije to Borovi), Kotor-Risan Bay, Platamuni, island of Katici, Cijevna river canyon, Ćemovsko valley, Buljarica, canyon of Mrtvica, Ada Bojana, Mala Rijeka Canyon, Rumija, Tivat Saline
Birds		• It is assumed that 333 species are regularly present in Montenegro, out of which 204 are nesting birds. • This large number of species includes many birds of prey, forest and wetland species. • Montenegro is also a significant refuge for a number of rare and endangered bird species, including the Dalmatian pelican *Pelecanus crispus* and the pygmy cormorant *Phalacrocorax pygmeus.* • a major migration corridor • Centers of biodiversity of birds: The areas around Lake Skadar and Ulcinj, mountain ranges Prokletije and Durmitor. • Other significant bird sites include: Buljarica, Velika Plaža, Ada Bojana, Tivat and Ulcinj saltworks, Šasko Lake in the Mediterranean region, the pastures and flooded swamp along the Bojana river, and further inland, Durmitor, Bjelasica, Komovi and the canyons of Piva, Tara, Morača and Cijevna, Maglić, and Prokletije.
Mammals		• There is a rich fauna of mammals, but there are no systematic data on the numbers and size of the population. • The largest number of species is found in forested mountains in the north. • Mammals biodiversity centers: Durmitor, Sinjajevine, western side of Prokletije, Komovi, and Bjelasica; lower concentration of mammals is found in the eastern Prokletije, central parts of Montenegro, the northern parts of the Bay and Orjen and coastal Dinarides (Lovćen, Rumija with Skadar Lake).

The centers of biodiversity:

vascular plants (VF), amphibians and reptiles (VG), birds (P) and mammals (S)



In the country there are numerous areas of international importance with rare, endemic and endangered species, including 13 IBAs i.e. important bird areas (plus 7 potential IBAs) and 22 IPAs i.e. important plant areas. The following IBAs have been identified: Lake Skadar, Ulcinj saltworks, Lake Šasko, Durmitor, and Biogradska Gora. In the integral list of identified and potential(*) IBAs, there are: delta of the Bojana, Rumija, Buljarica, Lake Skadar, Lake Plavsko with flood plains, Tivat Saline, Ćemovsko valley, Prokletije, Nikšić accummulation lakes, Hajla, Biogradska gora, Durmitor, the Cijevna river, valley of the Zeta river*, Kučke mountains*, Visitor*, Komovi*, Golija*, Pivska plateau*, Ljubišnja*. Among the IPAs that are important for plants the following have been identified: Jerinja Glava, Lukavica, Trebjesa, Starac, Bogićevica, Visitor, Haila, Lake Skadar, Orjen, Lovćen, Rumija, the Big Ulcinj Beach, Babji Zub, canyons of the Piva, the Tara, the Komarnica, the Mrtvica, the Cijevna, the Lim, Komovi, Durmitor, and Biogradska Gora (mountain). (*Source: Fifth National Report of Montenegro to the UN Convention on Biological Diversity, March 2014*).

Agricultural biodiversity is another important characteristic of Montenegro.

Physical Development Plan of Montenegro provided the concept of protection of natural heritage according to which the areas under special protection having the status of national or regional parks form basic points of the ecosystem network in Montenegro.

Montenegro's part of the southeast Dinarides is mainly located in the northern region as a part of the large wildlife corridor of the south-east Dinara Mountain ("Dinaric Arc"), which extends from the Alps to Prokletije and the Sarp-Pindor massif. In the area of Prokletije, this wildlife corridor is also associated with a large regional wildlife corridor called "Green Belt". Due to the specific regime of use of this area in the past, it has become a refuge for the wildlife and a corridor of great importance for biodiversity. The well-known corridor of coastal mountains Orjen - Lovćen - Rumija is connected with this corridor. Most of the junction areas of the ecosystem are included in two primary ecological corridors. The third corridor has been established in the direction of Orijen - Pusti Lisac - Maganik - Sinjajevina - Kovren.

Secondary corridors, dividing functional entities, improve natural resistance of the system to the negative effects of human activities.

2.7.2. Protected areas

According to the Nature Protection Act ("Official Gazette" no. 51/08), protected natural assets are sites that have a strong biological, geological, ecosystem or landscape diversity.

In accordance with Article 37, protected natural assets include:

1) protected sites - strict and special nature reserve, national park, regional park and nature park, natural monument, protected habitat and landscape tract with exceptional features;
2) protected species of plants, animals and fungi - strictly protected wild species and protected wild species;
3) protected geological and paleontological objects.

In accordance with Article 35, protected natural assets can be of:

- international importance;
- national importance;
- local importance;

In accordance with Article 49, protected natural assets are classified into the following categories:

- I category - protected natural asset of exceptional importance;
- II category - protected natural asset of great importance;
- III category - important protected natural asset.

Bill on Amendments to the Nature Protection Act defined the possibilities to use the space in protected areas, in line with the the protection regimes of the I, II and III degree.

According to available data (*Source: MORT, January 2015.*), there are five national parks on the territory of Montenegro, including: "Biogradska Gora", “Durmitor", "Lovćen", "Lake Skadar", and "Prokletije". In addition to national parks, there are over 47 isolated and protected areas in Montenegro, falling into these categories:

- Nature reserves, a total of 650 ha, out of which 150 ha are out of national parks;
- Natural monuments - gorges, caves, pits, plant communities, individual dendrological facilities, beaches, city parks, memorial parks, botanical reserves, botanical gardens, at a total area of 13,638 ha - out of which 7741 ha are outside national parks;
- The areas (tracts) with special natural features - 354.7 hectares, out of which 43.3 hectares are natural monuments;
- Areas protected by municipal decisions - 15,000 ha.

Out of the 13,812 square kilometers, which is the area of Montenegro, 1,250 km² or 9.04 % of the national territory has been officially declared as protected by national laws. A significant part of the country (17.2%) is internationally protected as an area of outstanding natural or cultural significance. The total area of protected natural areas of Montenegro (Table 2.7.2-1) is 360,395 ha, accounting for 26.30% of the national territory.

Table 2.7.2.-1. Protected areas in Montenegro

Name and national category	IUCN Category	Area (ha)	Percentage of the national territory	Year when protection was established
National parks:			6.01%	
Lake Skadar	II	40000		1983, modified in 1991
NP "Lovćen"	II	6400		1952, 1978, modified in 1991
Durmitor	II	31200		1952, 1978, modified in 1991
NP 'Biogradska Gora'	II	5400		1952, 1978, modified in 1991
NP Prokletije	II	21000		2007
Regional nature parks:				
Piva	V	32471		2011
Komovi	V			2012
Natural monuments:	III / V	7733	0.60%	
Djalovića klisura	III / V	1600		Dec. nr. 01-959 12.12.1968
Lipska pećina (cave)	III / V			Dec. nr. 01-959 12.12.1968
Magara Cave	III / V			Dec. nr. 01-959 12.12.1968
Globočica Cave	III / V			Dec. nr. 01-959 12.12.1968
Spila cave near Trnovo / Vurpazar	III / V			Dec. nr. 01-959 12.12.1968
Babatuša cave	III / V			Dec. nr. 01-959 12.12. 1968
Novakovića caves near Tomaševo	III / V			Dec. nr. 01-959 12.12.1968
Duboki Do pit at Njeguši	III / V			Dec. nr. 01-959 12.12.1968
Piva River Canyon	III / V	1700		1969
Canyon of the river Komarnica	III / V	2300		1969
Tara River Canyon	III			Dec. Nr. 01-172 01/05/1967
Plant community of pine tree "krivulja" (Pinetum mughi montenegrinum) on Ljubišnja	III / V	1000		
Plant community of pine tree "krivulja" (Pinetum mughi montenegrinum) on Durmitor	III / V	5200		
Plant community of pine tree (Pinetum mughi montenegrinum) on Bjelasica	III / V	400		
Plant community of white bark pine trees (Pinus heldraichii) on Orjen	III / V	300		
Plant community of white bark pine trees (Pinus heldraichii) on Lovćen	III / V	300		
Plant community of white bark pine trees (Pinus heldraichii) on Rumija	III / V	100		

Beaches on the shores of Lake Skadar	III / V			Dec. nr. 01-959 12.12.1968
The Big Ulcinj Beach	III / V	600		Dec. nr. 01-959 12.12.1968
The Small Ulcinj Beach	III / V	1.5		Dec. nr. 01-959 12.12.1968
Valdanos Beach	III / V	3		Dec. nr. 01-959 12.12.1968
The beach Veliki Pijesak (Great Sand)	III / V	0.5		Dec. nr. 01-959 12.12.1968
Topolica beach, Bar	III / V	2		Dec. nr. 01-959 12.12.1968
Sutomore Beach	III / V	4		Dec. nr. 01-959 12.12.1968, 2011
The beach Lučice, Petrovac	III / V	0.9		Dec. nr. 01-959 12.12.1968
Čanj Beach	III / V	3.5		Dec. nr. 01-959 12.12.1968
Pećin Beach	III / V	1.5		Dec. nr. 01-959 12.12.1968
Buljarica Beach	III / V	4		Dec. nr. 01-959 12.12.1968
Petrovac Beach	III / V	1.5		Dec. nr. 01-959 12.12.1968, 2011
Drobni pijesak Beach	III / V	1		Dec. nr. 01-959 12.12.1968
St. Stefan Beach	III / V	4		Dec. nr. 01-959 12.12.1968
Miločer Beach	III / V	1		Dec. nr. 01-959 12.12.1968
Bečići Beach	III / V	5		Dec. nr. 01-959 12.12.1968, 2011
Slovenian beach, Budva	III / V	4		Dec. nr. 01-959 12.12.1968, 2011
Mogren Beach	III / V	2		Dec. nr. 01-959 12.12.1968
Jaz Beach	III / V	4		Dec. nr. 01-959 12.12.1968, 2011
Pržno Beach	III / V	2		Dec. nr. 01-959 12.12.1968
Savinska Dubrava, Herceg Novi	III / V	35.46		Dec.Nr. 01-307 22/05/1968 Dec.Nr. 01-760 27.06.2000 2014
Botanical reserve of laurel and oleander above the Sopot spring near Risan	III / V	40		
Botanical garden of mountain flora in Kolašin	III / V	0.64		Dec.Nr. 01-78 21.08.1994
General Kovačević's botanical garden in Grahovo	III / V	0.93		Dec.Nr. 01-574 / 2 12.06.2000
Parks "13th July" and "Njegoš' Park" in Cetinje	III / V	7.83		Dec.Nr. 01-30028.04.1965, Dec.Nr. 01-298 07.05.1965
Park near the Boka hotel in Herceg Novi	III / V	1.2		Dec.Nr. 01-299 28.04.1965
City park in Tivat	III / V	3		Dec.Nr. 01-959 12.12.1968
Castle Park on Topolica	III / V	2		Dec.Nr. 01-959 12.12.1968
Lake Plavsko				2007
Special natural areas:				
Spas Hill above Budva	III	131		Dec.Nr. 01-959 12.12.1968, 2009
Ratac Peninsula with Žukotrlica	III	30		Dec.Nr. 01-959 12.12.1968
The island of Stari (Old) Ulcinj	III	2.5		Dec.Nr. 01-959 12.12.1968
Trebjesa Hill, Nikšić	III	159	1.08%	
Other areas proclaimed by municipal decisions:	III	15000	0.03%	

Kotor-Risan Bay, Municipality of Kotor	III	15000		
Nature reserves:		15000		
NP Lake Skadar Manastirska tapija, Pančeva oka, Crni Žar, Grmožur, Omerova Gorica		1420		Dec.Nr. 01-959 12.12.1968
NP Prokletije Hridsko Lake, Volušnica and Visitor				2007
NP Durmitor: Crna Poda		180		1952, 1978, modified in 1991
Tivat Saline	III	150		Dec.Nr. 01-12 /2 12.11.2008

International protected areas (Source: UN List of Protected Areas, 2014) are:

- Tara River Basin (World Biosphere Reserve, declared in 1976);
- Durmitor National Park (World Heritage Site, declared in 1980);
- Skadar Lake (Ramsar site, waterfowl habitat, declared in 1995);
- Tivat Saline (Ramsar site, waterfowl habitat, declared in 1995).

2.7.3. Ecological network areas (Emerald)

According to the Nature Protection Act ("Official Gazette" no. 51/08) Article 30, the ecological network consists of habitat types, ecologically important sites and a protective strip, if necessary. Parts of an ecological network can be connected to natural or artificial ecological corridors.

Activities on the establishment of the Natura 2000 network started in 2009 through collaboration between the WWF, the Institute for Nature Protection of Montenegro (which became part of the Agency for Environmental Protection in 2012) and Daphne Institute for Applied Ecology. As a result of the project, a draft reference list of habitats and species Natura 2000 in Montenegro was compiled, using previous knowledge gained from the identification project Emerald Network and based on the analysis of existing data. Proposal of EMERALD areas (in accordance with the Berne Convention on the Conservation of European natural habitats and wild flora and fauna) in Montenegro consisted of 32 sites of special conservation interest (ASCI). Establishment of the EMERALD network in Montenegro began in 2005 under a project funded by the Council of Europe and it was implemented by the former Ministry of Environment and Physical Planning in cooperation with Montenegro's experts. The project was finished in 2008, and standard forms for most EMERALD sites were completed (central database was in the then Institute for the Protection of Nature). Meanwhile, the Council of Europe's revised database for EMERALD (it underwent quality control) which was then improved/updated.

A draft Catalogue of habitats Natura 2000 in Montenegro was made and was later used for the first training on how to make an inventory on the site and mapping previously identified habitats within Natura 2000. Despite the actions taken, the results did not provide full identification and mapping of the sites for Natura 2000.

2.7.4. Landscape features

Landscape diversity of Montenegro was created by the combination of dynamic natural conditions and traditional way of using space. Landscape grounds are largely determined by the highland relief, water surfaces, and conditions pertaining to the climate zones. These elements have direct or indirect impact

on the composition and density of vegetation cover. These natural conditions, combined with historical and cultural aspect and anthropogenic factors such as agriculture, infrastructure or human settlements, result in anthropogenic and cultural landscapes whose quality varies from a low level to highly valuable and specific sections.

Landscape of Montenegro can generally be divided into the coastal areas and the mountainous hinterland. The coastal area is primarily characterized by the contrast ratio of the sea surface and the dynamic relief of the coastline with a high degree of horizontal and vertical indentation. Landscape features of the coastal areas are defined by the relief and by the Mediterranean plant cover, human settlements and infrastructure. Illegal and uncontrolled construction is often the cause of landscape degradation. The landscape is marked by a strongly indented hinterland relief with the occasional appearance of plateaus and fields. Typical landscape features also include watercourses with deep gorges and the area around Lake Skadar in the southeast. Cultural landscape elements are also numerous, such as terraced farmland and pastures in the vicinity of small or medium-seized villages. Landscape value is mostly high with the occasional appearance of the landscape degradation caused by uncontrolled construction, industrial and infrastructure elements.

Although the Republic of Montenegro has not developed a unique landscape basis so far, which would be the basic document of identification and evaluation of the landscape, the landscape can be divided into several units and types, depending on the preferred view. According to the PDP of Montenegro (2008), there are the three divisions:

The **biogeographical-ecological analysis** has identified ten landscape types:

(1) European-Mediterranean	(6) mountain silicate
(2) lower sub-Mediterranean	(7) mesophilic
(3) Mediterranean-flysh	(8) mountainous
(4) plain-marshy type	(9) high-mountainous
(5) higher sub-Mediterranean	(10) anthropogenic (man-made)

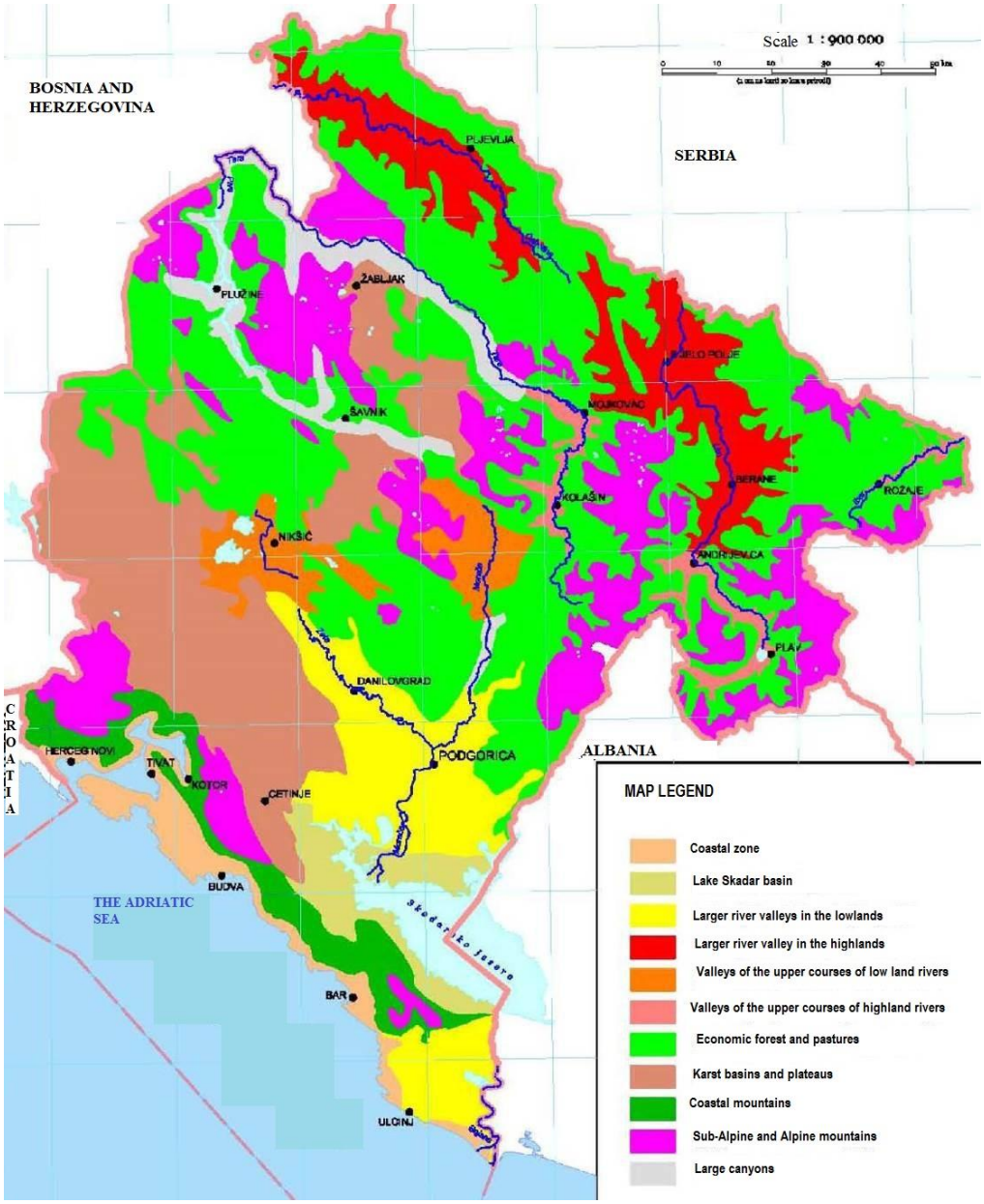
The division that takes into account **the natural characteristics of the area and anthropogenic elements** identifies 21 basic landscape units. This division also includes some smaller landscape units, which mainly encompass susceptible ecosystems with outstanding specific features and identity.

(1) Bay of Kotor	(12) Canyon of the Cijevna river
(2) Central and southern coastal area	(13) The Tara river valley
(3) Tivat Saline	(14) Durmitor and Sinjajevina
(4) Dunes in the Ulcinj area	(15) The Piva river basin
(5) The Bojana river valley, Zogajsko blato, and Lake Šasko	(16) Pljevlja Plateau
(6) Mountain ranges of Orjen, Lovćen and Rumija	(17) Polimlje - the Lim river basin
(7) The Karst plateau in western Montenegro	(18) The Rožaje area
(8) The area around Lake Skadar	(19) Prokletija mountain range
(9) THe plain of Zeta and Bjelopavlići	(20) Bjelasica
(10) Nikšić valley	(21) Komovi
(11) Canyon valleys in the Morača basin	

The division of the landscape in a number of specific **environmental zones** is perhaps the optimal illustration of landscape features of Montenegro. The division is based on natural conditions that,

combined with anthropogenic elements, generate different environmental zones. According to the above, the territory of Montenegro is divided into 11 zones:

(1) The coastal zone	(7) Forests and pastures used for economic purposes
(2) The Lake Skadar basin	(8) Karst turf and plateaus
(3) Larger river valleys in the lowland	(9) Coastal mountains
(4) Larger river valleys in the highland	(10) Subalpine and alpine mountains
(5) Valleys of the upper courses of lowland rivers	(11) Large canyons
(6) Valleys of the upper courses of highland rivers	



Graphic 2.7.4-2. Excerpt from the cartogram map *Ambiental zones in Montenegro - the current situation* (PDP MNE, 2008)

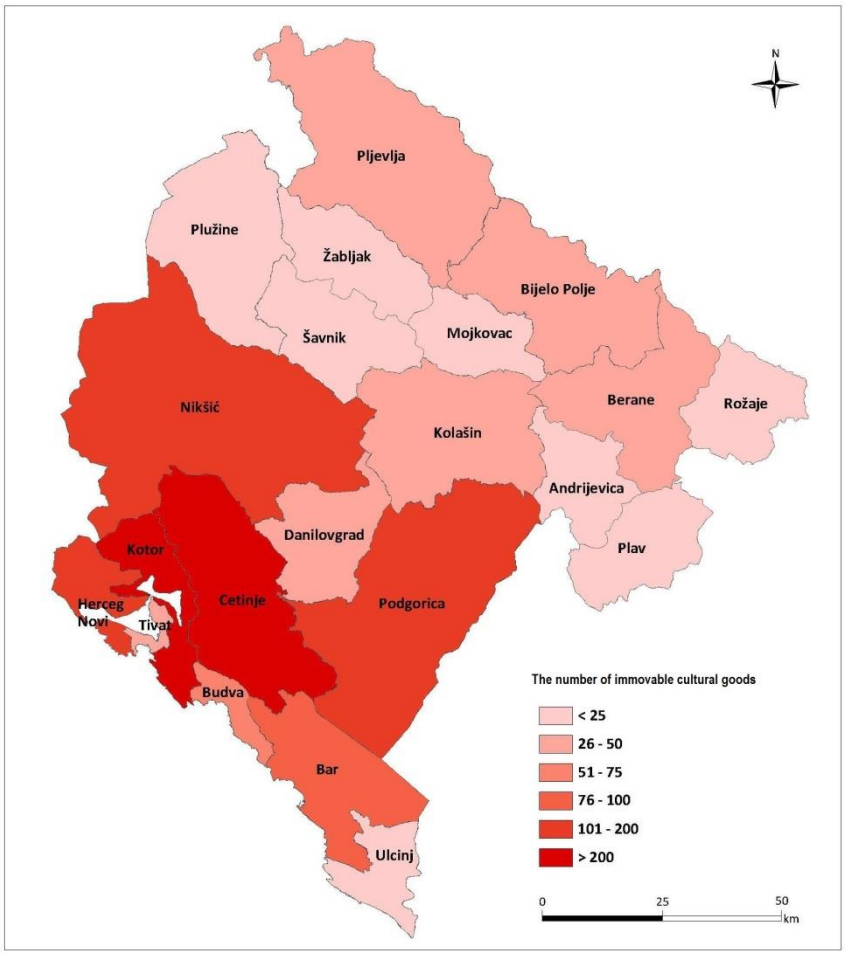
2.8. CULTURAL HERITAGE

Geographical and historical conditions resulted in the richness and diversity of the cultural heritage of Montenegro. Mostly hilly and mountainous area is located at the junction of the Mediterranean basin and the Balkan hinterland. This position caused numerous civilizational influences over almost the entire history of modern mankind. In addition to prehistoric sites, elements of cultural heritage were created directly or indirectly under the influence of: Illyrian tribes, ancient Greece, the Roman Empire, the Byzantine Empire, the Bulgarian empire, the Serbian Empire, the Ottoman Empire, the Venetian Republic, the Austro-Hungarian Empire, the Republic of Italy and later by Yugoslavia. In this area Orthodox, Catholic and Islamic religious influences overlapped as well.

According to the data of the Directorate for the Protection of Cultural Property under the Ministry of Culture of Montenegro (April 2015), there were 1,946 cultural goods in total (Table 2.8.-1.). In accordance with the data, their number is classified and graphically presented in the cartographic display 2.8.-1.

Table 2.8.-1. Distribution of elements of cultural heritage of the Republic of Montenegro by municipalities

Municipality	**Significance/Category**			**Type of cultural properties**			**Total**	
	local	national	international	movable	immovable	intangible	number	class
Andrijevica	0	3	0	0	3	0	**3**	< 25
Bar	14	44	0	23	58	1	**82**	76-100
Berane	1	44	0	11	45	0	**45**	26-50
Bijelo polje	1	22	0	9	23	0	**32**	26-50
Budva	9	42	0	18	51	0	**69**	51-75
Danilovgrad	4	33	0	7	37	0	**46**	26-50
Žabljak	1	11	0	0	12	0	**12**	< 25
Kolašin	0	28	0	6	28	0	**28**	26-50
Kotor	138	63	258	141	459	4	**604**	> 200
Mojkovac	0	11	0	0	11	0	**11**	< 25
Nikšić	10	136	0	26	146	0	**172**	101-200
Plav	0	7	0	0	7	0	**7**	< 25
Pljevlja	3	47	0	7	50	0	**50**	26-50
Plužine	2	17	0	0	19	0	**19**	< 25
Podgorica	22	99	0	14	121	0	**135**	101-200
Rožaje	1	0	0	0	1	0	**1**	< 25
Tivat	5	19	1	9	25	0	**34**	26-50
Ulcinj	6	9	0	0	15	0	**15**	< 25
Herceg Novi	50	76	2	69	126	0	**195**	101-200
Cetinje	17	100	0	252	117	1	**369**	> 200
Šavnik	6	11	0	0	17	0	**17**	< 25
Total	**290**	**822**	**261**	**592**	**1371**	**6**	**1946**	



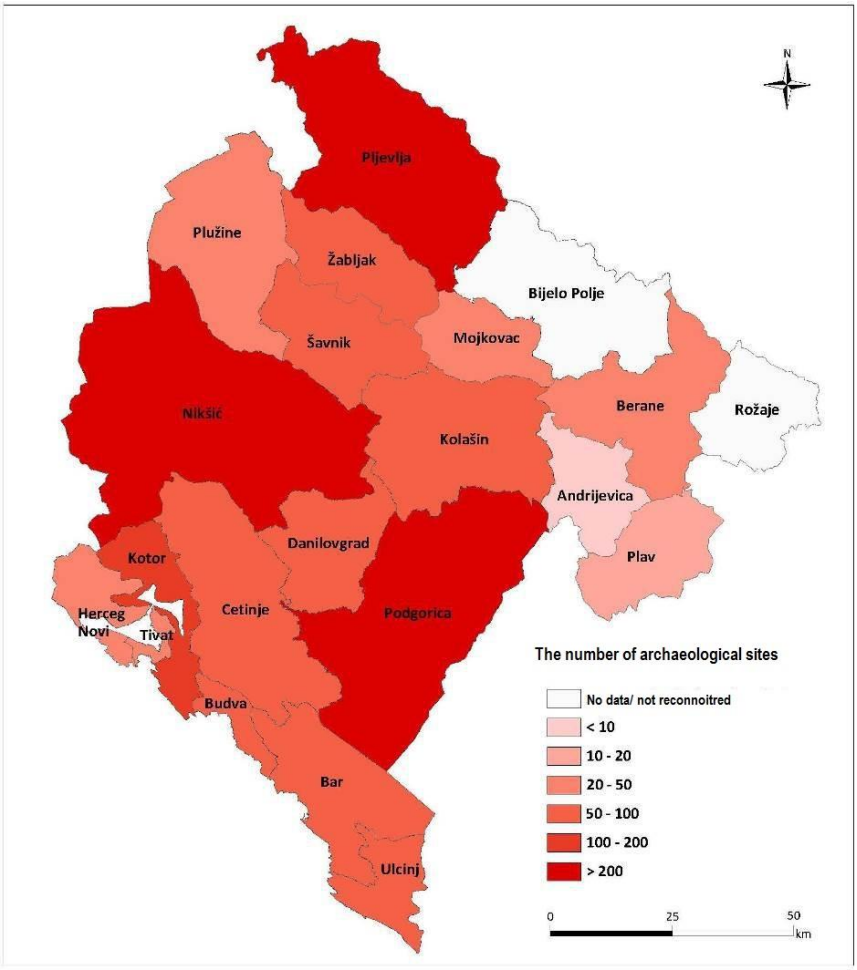
Graphic 2.8.-1. Geographical distribution of the numbers of cultural heritage by classes

There is a total of 1,667 registered archaeological sites, of which 68 are protected as cultural goods (source: the Directorate for the Protection of Cultural Property under the Ministry of Culture of Montenegro. The exception are the data for the municipalities Rožaje and Bijelo Polje, which are currently unavailable. In accordance with the data, their number is classified and graphically presented in the cartographic display 2.8.-2.

Table 2.8.-2. Number of archaeological sites by municipalities

NUMBER OF ARCHAEOLOGICAL SITES AND ARCHAEOLOGICAL SITES PROTECTED AS CULTURAL GOODS BY MUNICIPALITIES											
CLASS	MUNICIPALITY	ARC SITE	CULT GOOD	CLASS	MUNICIPALITY	ARC, SITE	CULT GOOD	CLASS	MUNICIPALITY	ARC SITE	CULT GOOD
	Rožaje	/	/	21-50	Berane	35	1	51-100	Cetinje	71	4
	Bijelo polje	/	/	21-50	Plužine	39	1	51-100	Budva	81	6
< 10	Andrijevica	6	/	51-100	Ulcinj	52	3	51-100	Danilov grad	96	6
10-20	Plav	14	/	51-100	Šavnik	53	/	101-200	Kotor	194	10
21-50	Tivat	22	/	51-100	Žabljak	55	/	> 200	Nikšić	219	6

NUMBER OF ARCHAEOLOGICAL SITES AND ARCHAEOLOGICAL SITES PROTECTED AS CULTURAL GOODS BY MUNICIPALITIES											
21-50	Herceg Novi	22	24	51-100	Bar	63	4	> 200	Podgorica	261	/
21-50	Mojkovac	32	/	51-100	Kolašin	69	1	> 200	Pljevlja	325	2
TOTAL: ARCHAEOLOGICAL SITES: **1677**						TOTAL: ARCHAEOLOGICAL SITES - CULTURAL GOOD: **68**					
NOTE: The data are retrieved from the PI Center for Conservation and Archaeology of Montenegro. There are no data for the municipality of Rožaje. The data for the municipality of Bijelo Polje will be reconnoitred in 2015.											



Graphic 2.8.-2. Layout of the number of archaeological sites by classes

According to available data from 2008, among the elements of tangible cultural heritage, monuments of culture for religious purposes account for the largest share - 58%. They are followed by secular elements with the share of 16%, archaeological with 7.5% and fortifications with the share of 7%. The share of other elements of tangible heritage is below 5% of the total number, while the concept of cultural landscapes has not yet been recognized nor legally defined in spite of its extraordinary potential.

By April 2015, six intangible cultural goods were protected. In the area of the coastal region there are: Boka Navy, Boka Night, Dobrota lace and Perast *fašinada* (event when local residents take their boats and throw rocks into the sea, compensating for the rocks taken away by the sea). The cult of St. Vladimir, in the area of Rumija and the skills of boat building, on Skadar Lake, were protected.

Durmitor National Park with the Tara River Canyon, as natural heritage, and the area of Kotor, as cultural and natural heritage, are both included on the UNESCO List of World Cultural and Natural Heritage.

2.9. POPULATION

2.9.1. General population trends

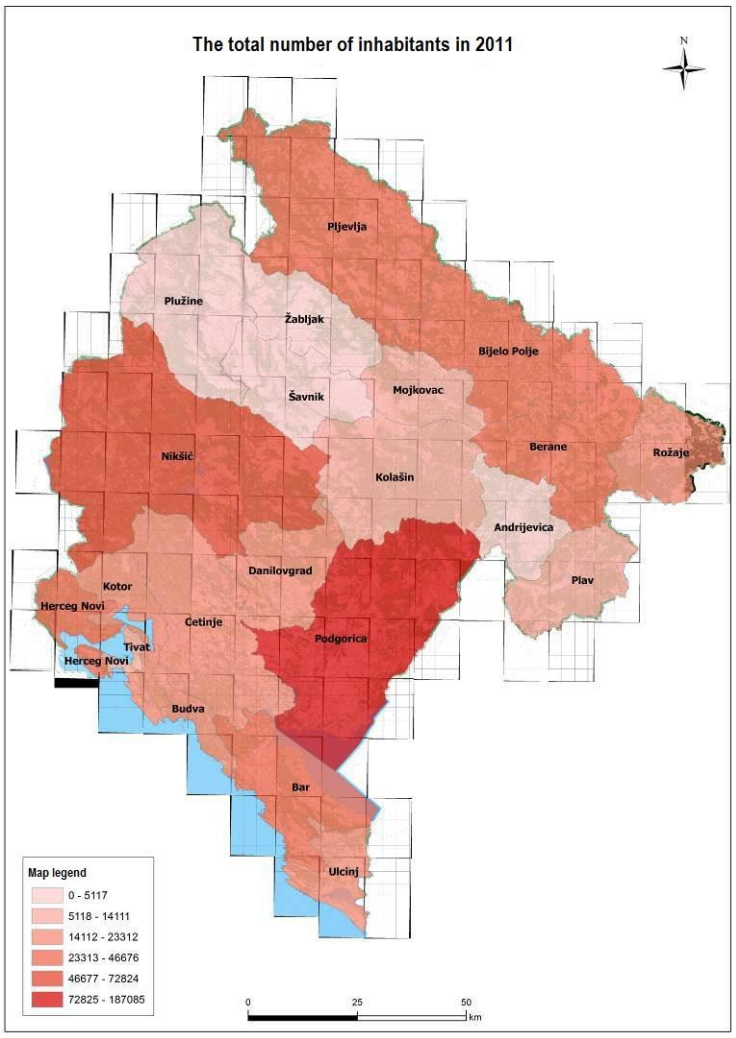
According to the Census in 2011, the total population of Montenegro was 625,266, about 30% of whom live in Podgorica. According to the available data, the total population increased by 63% from 1948 to 1991. The increase in the number varied by regions; the lowest increase was recorded in the northern part of Montenegro, while it was doubled in the central and coastal region.

In the period 1991 - 2011, the population at the national level had a positive trend. On the other hand, population density varies greatly, especially when analyzed by regions. The average population density is 44.8 inhabitants/km^2. The highest concentration of the population is in the Central and Coastal region (e.g. the municipality of Tivat 307.64 inhabitants /km^2) and the lowest in the Northern region (e.g. Šavnik 3.89 inhabitants/km^2.). On the territory of Montenegro there are intensive internal migrations. The area of the Coastal region and Podgorica has a steady intake of population, primarily from the area of the Northern Region.

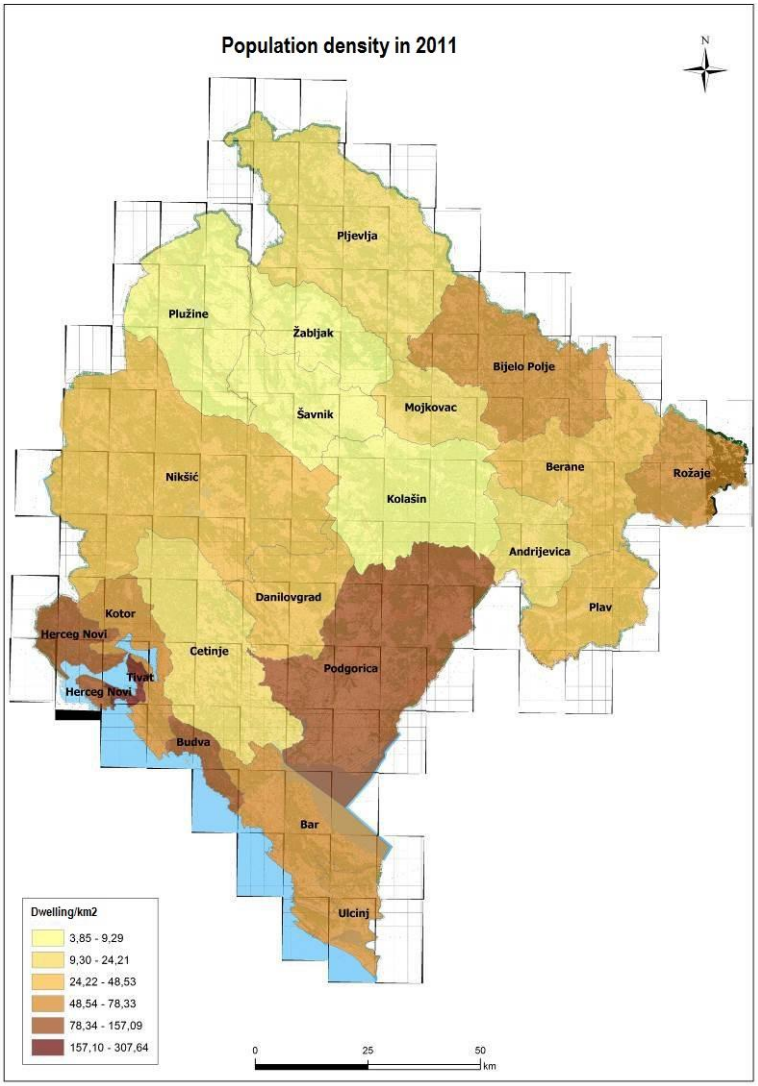
Table 2.9.-1. The population by municipalities of Montenegro in 2003 and 2011 (Physical Plan of Montenegro)

Municipality/Town	Population in 2003	Population in 2011	Index of census changes 2011/2003
Ulcinj	20290	20265	0.999
Bar	40037	42368	1.058
Budva	15909	19170	1.205
Tivat	13630	14111	1.035
Kotor	22947	22799	0.994
Plav	13805	13549	0.981
Cetinje	18482	16757	0.907
Danilovgrad	16523	17678	1.070
Andrijevica	5785	5117	0.885
Kolašin	9949	8420	0.846
Rožaje	22693	23312	1.027
Mojkovac	10066	8669	0.861
Berane	35068	35452	1.011
Šavnik	2947	2077	0.705
Nikšić	75282	72824	0.967
Bijelo polje	50284	46676	0.928
Žabljak	4204	3599	0.856
Plužine	4272	3286	0.769
Pljevlja	35806	31060	0.867
Herceg Novi	33034	30992	0.938
Podgorica	169132	187085	1.106
TOTAL	**620145**	**625266**[23]	**1.008**

[23] Information obtained by adding up the number of inhabitants in individual municipalities in 2011



Graphic 2.9.-1. Total population by municipalities in 2011 (*Source: the Census of Population, Households, and Dwellings in 2011, Statistical Office of Montenegro (Monstat)*



Graphic 2.9.-2. Population density by municipalities in 2011 (*Source: the Census of Population, Households, and Dwellings in 2011, Statistical Office of Montenegro (Monstat)*

2.9.2. Natural and migratory population trends

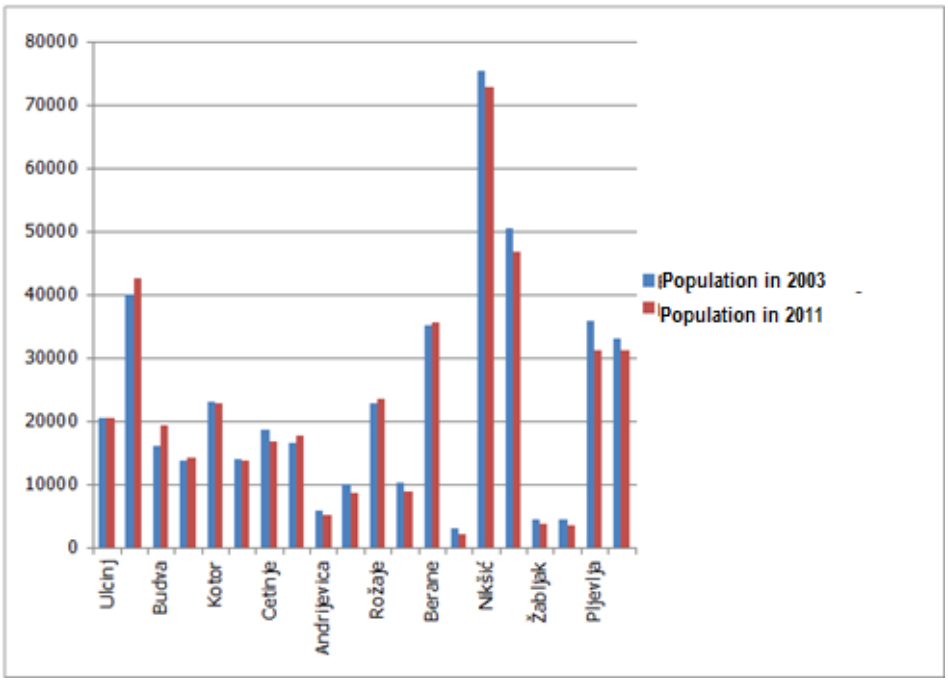
Natural trend is a fundamental determinant of population trends. It is the most dynamic component of the overall trend, but also an indicator of future demographic growth.

In the period from 1991 - 2003 there was a trend of a decreasing birth rate. The lowest annual number of live births was recorded in 2011, and the reason could be found in the change in the population number, their age structure and their level of fertility. The tables and figures below show the demographic structure and changes in the period 2003 - 2011.

Table 2.9.-2. Population in the municipalities of Montenegro in 2003 and 2011

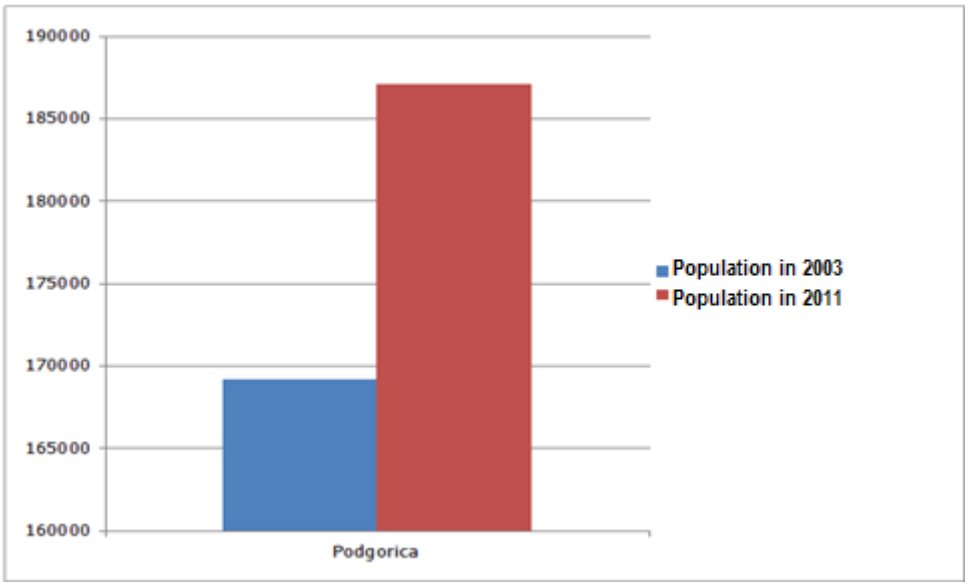
Municipality/Town	Population in 2003	Population in 2011	Index of census changes 2011/2003
Ulcinj	20 290	20 265	0.999
Bar	40 037	42 368	1.058
Budva	15 909	19 170	1.205
Tivat	13 630	14 111	1.035
Kotor	22 947	22 799	0.994
Plav	13 805	13 549	0.981
Cetinje	18 482	16 757	0.907
Danilovgrad	16 523	17 678	1.070
Andrijevica	5 785	5 117	0.885
Kolašin	9 949	8 420	0.846
Rožaje	22 693	23 312	1.027
Mojkovac	10 066	8 669	0.861
Berane	35 068	35 452	1.011
Šavnik	2 947	2 077	0.705
Nikšić	75 282	72 824	0.967
Bijelo polje	50 284	46 676	0.928
Žabljak	4 204	3 599	0.856
Plužine	4 272	3 286	0.769
Pljevlja	35 806	31 060	0.867
Herceg Novi	33 034	30 992	0.938
Podgorica	169 132	187 085	1.106
TOTAL	**620 145**	**625 266**[24]	**1.008**

Source: the Census of Population, Households, and Dwellings in 2003 and 2011, Statistical Office of Montenegro (Monstat)



*Graphic 2.9.-3. Population in the municipalities of Montenegro in 2003 and 2011 (*Source: the Census of Population, Households, and Dwellings in 2003 and 2011, Statistical Office of Montenegro (Monstat)

[24] Information obtained by adding up the number of inhabitants in individual municipalities in 2011



Graphic 2.9.-4. Population by municipalities of Montenegro in 2003 and 2011[25] (Source: the Census of Population, Households, and Dwellings in 2003 and 2011, Statistical Office of Montenegro (Monstat)

In Montenegro in the last 20 years or so, visible changes in the level of fertility have taken place, mainly showing a decreasing trend. This trend is a continuation of the process of a long-term decline in fertility. For example, in comparison with the year 2000, the number of live births in 2011 was lower by 27%. At the same time there is a noticeable increase in the number of deaths. The highest number of deaths in an observed period was recorded in 2007. The cause of the increase in the number of deaths is largely due to the intense demographic aging, and at the same time an insufficient reduction of mortality by age. This means that the aging of the population increases the mortality rate.

In terms of immigration, the largest proportion of immigrants in the total population is located in coastal municipalities (Budva 36%, Herceg Novi 34%, 31%, Tivat, Bar 28%). In Podgorica, immigrants account for 1/5 of the population[26]. Internal migrations are mainly caused by economic circumstances. Thus, migration is most prominent between the Northern region, which has a large proportion of towns recording economic stagnation. Accordingly, the capital and the Coastal region are experiencing an influx of young population. All this affects the demographic structure of the population in the mentioned areas (e.g. more and more unfavorable age structure of the population).

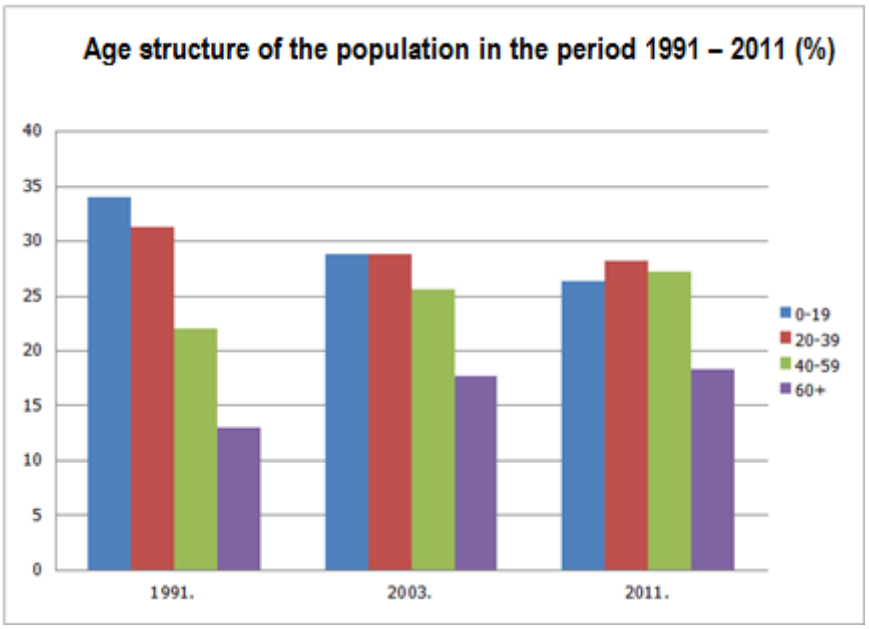
2.9.3. Age structure of the population

In the period from 1991 - 2011, the population of Montenegro was characterized by slight aging of the overall population. This means there was an increase in the proportion of the elderly in the overall population, i.e. a decrease in the proportion of young people.

Specific long-term decreasing tendencies in the proportion of young people and an increase of the proportion of mature and elderly population in the overall population have been noticed in the structure of the population of Montenegro in the last 20 years. The changes in the age structure are mainly a result of pronounced birthrate transition in this area, together with a significant impact of migration (emigration).

[25] City of Podgorica was singled out for the large differences in the number of inhabitants

[26] Population projections of Montenegro by 2060 with a structural analysis of the population of Montenegro



Graphic 2.9.-5. Age structure of the population in the period of 1991, 2003 and 2011 (Source: Population projections of Montenegro by 2060 with a structural analysis of the population of Montenegro Statistical Office of Montenegro (Monstat), 2014)

Table 2.9.-3. Indicators of the age structure of the population of Montenegro (Source: Population projections of Montenegro by 2060 with a structural analysis of the population of Montenegro, Statistical Office of Montenegro (Monstat), 2014)

	1991	**2003**	**2011**
Average age	32.4	36.0	37.7
Median age	30.1	34.0	36.6
Aging index	32.6	58.2	66.8
% of people older than 65 in total population	8.3	12.0	12.8

2.9.4. Employment by sectoral activities

In the period 1991 - 2011, there was a significant change when the employment by sectoral activities is concerned. Although the data are not fully comparable due to methodology in the Censuses in 1991, 2003 and 2011, a significant reduction in the number of employees in agriculture, forestry and fisheries is clearly visible. Possible reasons are depopulation of rural areas, i.e. internal migrations. The population increasingly focused on other activities.

In addition to migration, possible reasons for reducing the number of employees in the said sector were the closing down of agricultural cooperatives after 1991[27].

The industry sector shows even greater differences in the number of employees in the observed period from 1991 to 2011. Employment in the sectors of agriculture and industry has a similar trend. In 1991, the industry sector employed 50,375 people. The number decreased to 24,293 inhabitants in 2011.

[27] Population projections of Montenegro by 2060 with a structural analysis of the population of Montenegro

Restructuring, closed market and poor economic situation in the 1990s caused the closing down or bankruptcy of a large number of industrial enterprises. In the observed period, a shift from manufacturing to service industries is visible. Thus, the trade sector recorded a growth; in 1991 there were 19,577 employees in this sector, whereas in 2011 there were 34,992 employees (Table 2.9.-3).

The sectors of industry, agriculture, forestry and fisheries and of wholesale and retail trade experienced the greatest changes recording the largest decline in employment in the past twenty years.

Table 2.9.-3. Number of the employed in Montenegro by sectors of activities

Sector	**1991**	**2003**	**2011**
Agriculture, forestry and fisheries	28096	15335	4454
Mining and quarrying	50375	3546	1807
Processing industry		23558	14809
Power engineering		5139	3261
Utility infrastructure			4416
Construction	10407	6101	8517
Wholesale and retail trade, repair of motor vehicles	19577	24514	34992
Traffic and storage	16314	14280	13611
Information and communication			5000
Accommodation and food service	11652	9957	11624
Financial activities and insurance	4715	2278	4209
Real estates activities	/	3903	618
Professional, academic and technical activities	/	/	5493
Administrative and auxiliary services	/	/	3947
Public administration and defense, social security	13500	22709	22078
Education	13078	11947	13815
Health and social welfare	10091	10689	10733
Artistic and recreational activities	/	/	5083
Other services (crafts and utility services)	8480[28]	9861[29]	4617
Activities of households as employers and production of goods and services for personal use	/	53	288
Activities of foreign organizations and bodies	/	148	432
No data	2048	7307	1367

Source: Population projections of Montenegro by 2060 with a structural analysis of the population of Montenegro, Statistical Office of Montenegro (Monstat), 2014.

[28] Crafts and Utilities

[29] Other community social and independent activities

2.10. ECONOMIC ACTIVITIES

2.10.1. Agriculture

Of the total territory of Montenegro, 515,740 ha or 37.4% is agricultural land. According to the physical plan of Montenegro by 2020, the cadastre of agricultural and forest land has not been established and standards for their recording have not been agreed upon, so certain parts of the land are categorized as forest (not covered forest) and as agricultural land (meadows).

The structure of agricultural land usage is unfavorable since pastures (323,953 ha) and natural meadows (126,990 ha) account for the majority of the agricultural land (87%). Arable land, gardens, orchards and vineyards account for 62,154 hectares, or 0.095 ha/inhabitant (Table 2.10-1).

Table 2.10-1. Land structure and area

Land structure	**Area (ha)**
Agricultural land	515,740
Arable land and gardens	45,748
Orchards	12,007
Vineyards	4,399
Meadows	126,990
Pastures	323,953
Ponds, fish ponds, ponds with reeds	2,643

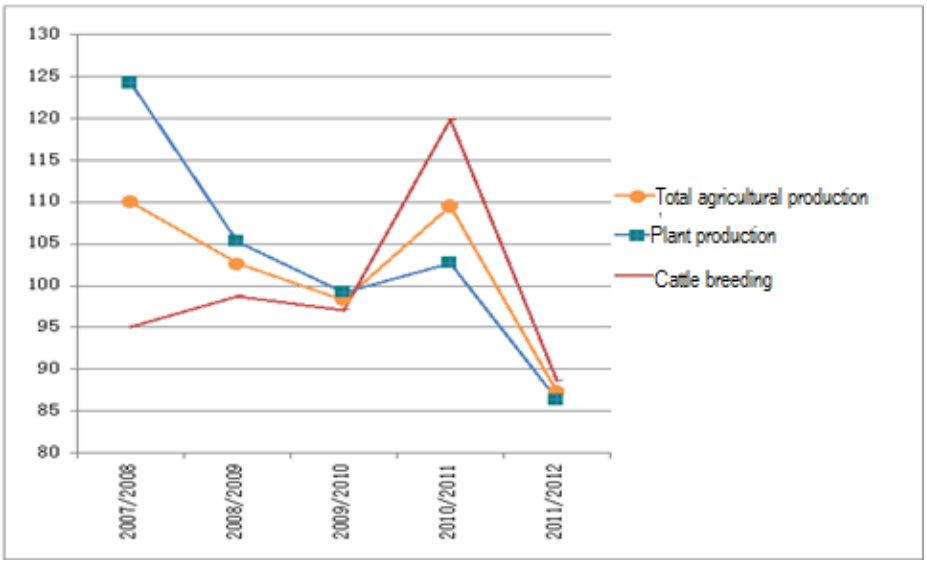
(Source: Monstat Statistical Yearbook 2012)

The agricultural production index in Montenegro in the observed period from 2008 to 2012 recorded a decrease in crop and livestock production. In accordance to areas of pastures and meadows, livestock production, as shown in the following table and figure (Table 2.10-2 and graphic 2.10-1.) is increasing and in the last observed year it was the same as crop production.[30]

Table 2.10-2. Agricultural production index

	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012
Total agricultural production	110.03	102.6	98.3	109.5	87.3
Plant production	124.3	105.3	99.2	102.7	86.3
Cattle breeding	95.1	98.7	97.1	119.9	88.6

[30] State Statistical Office of Montenegro (http://www.monstat.org/cg/)



Graphic 2.10.-1. Agricultural production index

Montenegro has 741 km² of quality agricultural land, which is 5.4% of the total area of Montenegro. The largest part of quality agricultural land (75.6%) is located in the municipalities of: Podgorica 17%, Pljevlja 14.5%, Bijelo Polje 14.2%, Berane 9.5%, Bar 7.4%, Nikšić 7.3%, Ulcinj 5.7%, and in other municipalities 0.8 - 3.9%. For high quality land, as well as for land intended for agricultural use, concepts of irrigation will be developed. It is estimated that it is necessary to irrigate about 80% of the area, and to drain excess water from approximately 50% of the area.

2.10.2. Forestry and hunting

According to the latest data of the National Forest Inventory of Montenegro, forests and forest land cover approximately 69.7% of the territory. Forests cover 59.5% and forest land about 9.8% of the country. The latest inventory data show that the forest coverage, timber reserves and growth are much higher than anticipated (coverage amounts to 59.9% compared to the estimated 45%, timber reserves amount to 118 million cubic meters compared to the estimated 72 million, and annual growth is 2.8 million cubic meters compared to the estimated 1.4 million. Although this situation creates preconditions for the increase of the total annual amount of timber that can be cut, it can be expected that it will not produce the expected financial effect due to very high intensity of cutting throughout the twentieth century, which has greatly deteriorated assortment structure of trees (on average much smaller diameters of trees and therefore inferior wood assortments - 34.6% of the trees are in the diameter class between 11 and 30 cm, and 37.3% in the diameter class between 31 and 50 cm). Due to the characteristic relief of Montenegro, coniferous wood makes up a significant share (32.5%), and the most widespread tree species are Balkan (moesiaca) beech (*Fagus moesiaca*), Norway spruce (*Picea abies*), common fir (*Abies alba*), sessile oak (*Quercus petraea*), Scots pine (*Pinus sylvestris*), black pine (*Pinus nigra*), ashes (*Fraxinus* sp.), common hornbeam (*Carpinus betulus*) and other types of oak trees (*Quercus cerris, Quercus pubescens*) and pines (*Pinus heldreichii, Pinus peuce*).

According to the ownership structure, 49.6% are state forests, while the remaining 50.4% are privately owned. However, it is important to notice a large discrepancy in the amount of timber reserves accumulated in state-owned woods (73.2%) compared to private woods (26.8%), indicating a bad situation in the private forestry sector, i.e. a much worse situation in private forests in relation to those state-owned (Table 2.10.-3.). The high forests of economic purpose account for around 61% of the

forest territory, young forests for 12%, thickets and macchia for 13%, while the remaining 14% is non covered forest land[31]. A significant increase in the total forest area has recently been registered, which is mostly a result of abandonment of rural areas (the succession of forests onto former agricultural land) and reforestation. Approximately 5.8% of forest land is incorporated into national parks, and a big portion will become a part of planned regional parks. About 12% of forests and about 8% of forest land is not suitable for exploitation because of its inaccessibility, and therefore follow natural development[32].

Table 2.10.-3. Area, timber reserves and growth in state-owned and private forests available for use (*source: the National Forest Inventory*)

Ownership	Forest area for usage (ha)	A%	Timber reserves (m^3)	O%	Timber reserves per hectare (m^3/ha)	Annual growth (m^3)	Growth per hectare (m^3/ha)
State	334,781	49.6	75,162,069	73.2	224.5	1,762,223.3	5.3
Private	340,608	50.4	29,812,676	26.8	87.5	763,027.7	2.2
Total	675,389	100.0	104,974,746	100	155.4	2,525,251.0	3.7

The forestry industry in Montenegro is under the jurisdiction of the Ministry of Agriculture and Rural Development, 9.e. the Directorate for Forestry, Hunting and Wood Industry. The Directorate consists of three organizational units: the Directorate for Forestry, the Directorate for Hunting and the Directorate for Monitoring in Forestry. State forests are managed by the Forest Administration, and in the area of national parks by Public Company Montenegro National Parks. For forestry of Montenegro it is characteristic that a large part of state forests (approximately 400,000 m^3/year) is given in concession to private forestry companies through public tenders on an annual basis[33]. Delimitation between the state and private property on large surfaces has still not been completed[34].

Due to the diameter structure of the current timber reserves, a significant increase of firewood supply is to be expected in the next decade. Technical round timber offer will not decrease or stagnate if investments in the development of plans and programs for forest management, reforestation and cultivation of young and degraded forests, transport technology and construction of forest roads are implemented[35].

According to the results of SWOT analysis[36], the *benefits* of the forestry sector of Montenegro are the following: a large part of the territory is covered by forests, the level of biodiversity is very high, forests are natural and vital, they present an important resource for the sustainable development of the whole country, especially rural areas, the potential of wood usage is much higher than previously believed, there is export market for timber and timber products, forests represent a great potential for the development of eco-tourism, greater use of renewable energy and other useful functions.

[31] Ministry of Agriculture, Forestry and Water Management (2008): Forests for the Future of Montenegro - National Policy for Forests and forest lands, Podgorica 2008, p. 15

[32] Ministry of Agriculture and Rural Development (2014): Strategy with the plan of forests and forestry development 2014 to 2023 - National Forest Strategy, proposal, p. 4

[33] Ministry of Agriculture, Forestry and Water Management (2008): Forests for the Future of Montenegro - National Policy for Forests and forest lands, Podgorica 2008, p. 15

[34] Ministry of Agriculture and Rural Development (2014): Strategy with the plan of forests and forestry development 2014 to 2023 - National Forest Strategy, proposal, p. 4

[35] Ibid, p. 4

[36] Ibid, p. 12

The *possibilities* of the forestry sector development in Montenegro consist of a large amount of available timber, a higher degree of finalization in the wood industry, increased usage of biomass as a renewable energy source, greater usage of non-timber forest products (game, etc ...), the development of eco-tourism, job creation in rural areas and so on.

Currently the most prominent *weaknesses* of the forestry sector of Montenegro are a low proportion of finished products compared to the total amount of wood available on the market, obsolete equipment and machinery, insufficient investment in forestry production (foreign investment is nonexistent), bad positioning in the international market and a small domestic market, poor state of private forests, generally insufficient implementation of silvicultural measures of thinning and cleaning, the impossibility of realization of the prescribed annual allowable cut, the inadequacy and insufficiency of the existing forest roads network, illegal logging, an inefficient concession system, insufficient activity of advisory services and lack of education of private forest owners, lack of cooperation between the forestry sector and wood industry and undervalued multi-beneficial functions of forests in national parks.

Primary source of *threats* for the forestry sector of Montenegro lies in climate changes causing an increase in the number of fires, illegal logging and unregulated legislation, unfair competition on the small market, the inability to terminate concession contracts in the event of non-compliances with the provisions, lack of qualified personnel, lack of political and public support for the forestry sector, unsuccessful development of wood industry and lack of coordination of planning documents at the national level.

Hunting activity in Montenegro, according to the provisions of Article 23, Paragraph 1. of the Law on Wildlife and Hunting (Official Gazette of Montenegro No. 52/08), among other issues, regulates the umbrella planning document "The program of the hunting development in Montenegro" which covers a period of ten years. At the end of 2014, the Government of Montenegro passed a draft of the new hunting development program in Montenegro, for which a strategic environmental assessment was conducted ("Taxus" d.o.o. Pljevlja, Podgorica 2014).

In accordance with the provisions of the Law on Wildlife and Hunting, hunting activity is under the jurisdiction of the Ministry of Agriculture and Rural Development. The same law stipulates that the Government of Montenegro at the proposal of the ministry establishes hunting grounds and hunting grounds with a special purpose[37]. Hunting grounds usage is assigned to legal persons for a period of 10 years and relations in the management of the hunting grounds are regulated under a contract concluded between the competent ministry and the user of the hunting grounds.

In accordance with Article 8 of the Law on Wildlife and Hunting, the association at the national level is the Hunting Association of Montenegro, which encompasses hunting organizations, hunting grounds users, companies and other entities engaged in hunting. The Decision on the establishment of hunting grounds and hunting grounds with a special purpose (OG of Montenegro, No. 62/10), established on the territory of Montenegro 31 hunting grounds and 4 hunting grounds with a special purpose. The total hunting area of Montenegro is 1,285,991 ha used by 27 hunting organizations and 3 public enterprises, while special purpose hunting grounds are used by the state administration body responsible for forest management[38].

[37] The Government of Montenegro (2014): The program of hunting development of Montenegro for the period 2014-2024, Podgorica 2014, p. 27

[38] Ibid., p. 28

Graphic 2.10.-2. Schematic overview of the hunting grounds of Montenegro (*source: Forest Directorate of the Ministry of Agriculture and Rural Development)*

Table 2.10.-4. Hunting ground area of Montenegro by its purpose[39]:

R / b	Hunting area	Area (ha)				
		Forest and forest land	Meadows and pastures	Fields and arable land	Other	Total
1.	Mediterranean	108,969	20,941	6,806	11,749	148,462
2.	Submediterranean	167,581	52,468	8,901	8,558	237,507
3.	Centrally	239,409	76,581	3,491	7,108	326,590
4.	East	182,720	75,495	870	3,181	262,270
5.	North	140,265	83,161	89	2,755	226,270
6.	Hunting ground with a special purpose	61,001	19,507	-	4,384	84,892
Total:		**899,945**	**328,153**	**20,157**	**37,735**	**1,285,991**

This shows that the vast majority of the hunting grounds of Montenegro consists of forest area (70%), while a smaller part (25.5%) consists of meadows and pastures, and only a small part (1.57%) consists of fields and arable land.

[39] Ibid, p. 31

Table 2.10.-5. Estimated number of game in Montenegro in the past three decades[40]:

GAME SPECIES	ASSESSMENT OF THE NUMBER OF GAME		
	1 April 1986	1 April 2004	1 April 2014
GAME BREEDING SPECIES			
Red deer	260	10	0
Fallow deer	75	54	48
Roe deer	860	2,019	5,302
Chamois	760	712	1,004
Wild boar	1,100	4,071	4,839
Brown bear	130	295	401
European hare	8,500	26.471	43,429
Partridge	6,500	11,220	14,914
Pheasant	1,600	5,040	2,920
OTHER GAME SPECIES			
Wolf	160	1,231	727
Badger	3,400	-	3,658
Wild cat	560	-	1,382
Red fox	4,000	9,239	8,280
Jackal	110	-	1,657
Marten	16,000	3,864	10,865

The table below shows that the number of most game species is improving compared to previous periods, except in the case of fallow deer and pheasants, which are allochthonous species and the wolf whose population has fallen significantly in comparison to 2004. There is a more significant increase in the population of European hare, roe deer and marten compared to the situation in 2004, while other species of game show an evident upward trend of the population.

What is characteristic for the hunting activity in Montenegro is the existence of the so-called "Hunting bans", or selected area where, according to the provisions of the Hunting Law (OG of Montenegro, no. 52/08), hunting is prohibited.

2.10.3. Tourism

Tourism affects the quality of the environment, being a consumer of natural and other resources: land, water, fuel, electricity, food, but also as a producer of significant amounts of waste and emissions. Negative impacts of tourism on the environment are seen through pressures on natural resources, wildlife and habitat, as well as through the creation of waste and pollution.

The positive effects of tourism in relation to the environment are reflected in the fact that it is a business that seeks adequate use of natural resources, improvement of the landscape and maintenance of the environmental, economic and socio - cultural values of the local community.

In Montenegro, foreign tourists prevail in the structure of the tourists (about 89% of total arrivals and about 89% of total overnight stays in 2013).

[40] Ibid, p. 75

In the period from 2000 to 2013 Montenegro had an almost permanent increase in the total number of tourist arrivals with significantly lower growth of domestic tourist arrivals (the annual rate of growth for the period 2007-2013 was 2%). Their share in the total number of arrivals was 11.3% in 2013. The annual growth rate of total tourist arrivals is around 9%, and foreign tourists about 23%. The number of arrivals in 2013 increased by about 2% compared to the year 2012 (which refers to foreign tourists, because domestic tourists came in an almost identical number).

In 2013, the recorded number of arrivals per capita 2.4 per km^2 - 108 arrivals.

Arrivals are mainly focused on coastal towns almost exclusively in the summer months which also shows, comparatively, a tremendous pressure on the environment of these places in the mentioned period. The period from 2007 to 2013 was dominated by foreign tourists. There was an increase of about 30.6% in the number of foreign tourists. Domestic tourist overnight stays recorded a slight increase of 14.73% in the analyzed period. Compared to the year 2012, total overnight stays in 2013 increased by 0.03%. In 2013, 681 nights per km^2 were registered and 15.2 nights per inhabitant. In 2013, the share of coastal towns, as the dominant location for overnight tourists, is as high as 97.1%. The capital city has a share of 1.13%, other tourist resorts 0.77%, mountain resorts 1.22%, and other places 0.03% overnight stays.

In 2013, 398 foreign ship cruises were realized in Montenegro with 310,693 passengers. Compared to the year 2012, the number of trips increased by 14.3%, while the number of passengers on these trips increased by 22.1%. The share of tourists on cruises in the total number of tourists (arrivals) increased by 4% in the analyzed period in 2007 to 20.8% in 2013.

In general, the tourist offer is not sufficiently branched out, when measured based on potentials and tourist motives which exist. Tourism in the northern region clearly falls behind, although there are marvelous nature conditions for the development of conventional forms of summer and winter mountain tourism, as well as numerous forms of alternative types of tourism. To summarize, alternative i.e newer types of tourism are not sufficiently developed, especially cultural, religious, nautical, ecological, etc. (*source: PP of Montenegro*).

2.10.4. **Mining and Industry**[41]

Since the late 1980s, the structure of employment in mining and industry has changed significantly. In 1989, the manufacturing industry employed around 42,000 workers and less than 17,000 in 2002. In the production and processing of metals there were about 17,000 employees in 1989, and less than 11,000 in 2002.

In terms of the structure of industrial products, by the end of the 1980s, the production sector was dominant: steel and aluminum (25.44%); machinery and electrical equipment (15.8%); various metal products (13,32); electricity (9.19%); textile yarn and fabrics (7.35) and mining and quarrying (6.06%).

In the last fifteen years, mining and industrial structure has changed significantly, and in 2002 there was a predominance of production of steel and aluminum (43.5%), electricity (21.6%), food products and beverages (8.2), salt (7.4%), mining and quarrying (7.2%) and tobacco products (6.4%).

[41] Source: Physical Plan of Montenegro until 2020 (Official Gazette 24/08)

The main characteristics of the structural changes in the mining and industrial production are the following:

- According to the situation in 2002, the extraction of minerals still dominates, as well as metal production, aluminum, energy and industry, which is the basis for the livelihoods of the population (food, beverages and tobacco);
- One part of the industrial activities, some of which had a significant role in the creation of income (for example, production of machinery and electrical equipment, production of final products in wood processing, textiles, etc.), practically disappeared;
- One part of the remaining industry (for example, metal processing, production of leather and leather products, chemical industry, etc.) has been privatized or is facing privatization.

With a significant drop in the 1990s, industrial production survived mostly in the energy production and in the manufacturing industry, based on domestic raw materials for the domestic market. As one of the main features of negative movements in the period from 1989 to 2003, exports have been halved, and in terms of structure the earlier level of diversification was lost.

Mining and industry have negative effects on the environment of Montenegro creating a polluted and degraded "environmental hot spots", which are to blame for the pollution of air, soil and water. Such points are the Aluminum Plant Podgorica (KAP), thermal power plant Pljevlja, Ironworks Nikšić, etc.[42]. Environmental conditions in the municipality of Pljevlja are the result of energy sector activities, while KAP and Ironworks represent environmental problems created as a result of the energy consumer as industrial producers. Burden on the town of Pljevlja is the consequence of coal mines, thermal power plant, particularly small boiler rooms in the city. Due to waste waters from the mentioned technologically obsolete plants, local rivers Vezišnica and Ćehotina are the most polluted water areas in Montenegro. Also, coal mine waste is considered, together with ashes and cinder from TPP Pljevlja, waste which is harmful to human health.

2.10.5. **Energy industry**[43]

The most important energy facilities in Montenegro are: TPP Pljevlja and Coal Mine, HE power plant Piva and Perućica with accumulations, and transport and distribution infrastructure.

With two large hydro power plants, Perućica and Piva (for which there is a specific agreement with EPS), and several small hydro power plants, there still remains only Pljevlja. According to the data at the end of 2011, the total output of all existing plants in the power system is around 3,000 GWh in an average hydrological year, with total installed capacity of 854.2 MW (thermal power plants - 218.5 MW, hydro power plants - 635.7 MW, out of which 8.7 MW small hydro power plants).

As of 31 December 2011, the transmission electric power system of Montenegro consists of five 400 kV power transmission lines with a total length of 284.3 km on the territory of Montenegro; eight lines of 220 kV, the total length of 348.1 km on the territory of Montenegro and 40 lines 110 kV, the total length of 724.3 km, out of which five (5) have a total length of 120.7 kilometers, working under the voltage of 35 kV. The transmission system includes 23 substations: 400/220/110 kV (Pljevlja 2), 400/110 kV

[42] Source: Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020, Ministry of Sustainable Development and Tourism, (2014)

[43] Source: Spatial Plan of Montenegro until 2020 (Official Gazette 24/08), the Energy Development Strategy of Montenegro until 2025., Ministry for Economic Development (2007), the Energy Development Strategy of Montenegro by 2030 (the Green Paper and the draft White Paper), Ministry of Economy (2012).

Podgorica (2), 400/110/35 kV (Ribarevine), 220/110/35 kV (Podgorica 1 and Mojkovac), 220/110 kV (Perućica - owned by EPCG), 110/35 kV (Nikšić, Herceg Novi, Tivat, Budva, Bar, Ulcinj, Cetinje, Danilovgrad, Berane, Pljevlja 1, Vilusi, Andrijevica and Virpazar) and 110/10 kV (Podgorica 3, Podgorica 4 Podgorica 5). 44 transformers are installed in these substations with total installed capacity of 3,349.5 MVA.

The distribution system is part of the power system used for transmission of electricity from the transmission network, power plants connected to the distribution grid, to end customers and is made up by the system lines and substations of voltage levels of 35 kV, 10 kV and 0.4 kV. As of 31 December 2010, the structure and main features of the distribution system of Montenegro are:

- Lines:
  - 35 kV overhead lines with a length of 1.041 km
  - 35 kV cable lines in the length of 77 km
  - 10 kV overhead lines with a length of 3.599 km
  - 10 kV cable lines in the length of 1.233 km
  - 0.4 kV overhead lines in the length of 11.341 km
  - 0.4 kV cable lines in the length of 1.549 km
- Substations:
  - number of substations 35/10 kV 85
  - installed capacity of substations 35/10 kV 797 MVA
  - number of substations 35/0.4 kV and substations 35/6 kV 28
  - installed capacity of substations 35/0.4 kV and substations 35/6 kV 85 MVA
  - number of substations 10/0.4 kV 2,254
  - installed capacity of substations 10/0.4 kV 1,405 MVA
  - number STS 10/0.4 kV 2,236
  - installed capacity STS 10/0.4 kV 225 MVA.

2.11. HEALTH

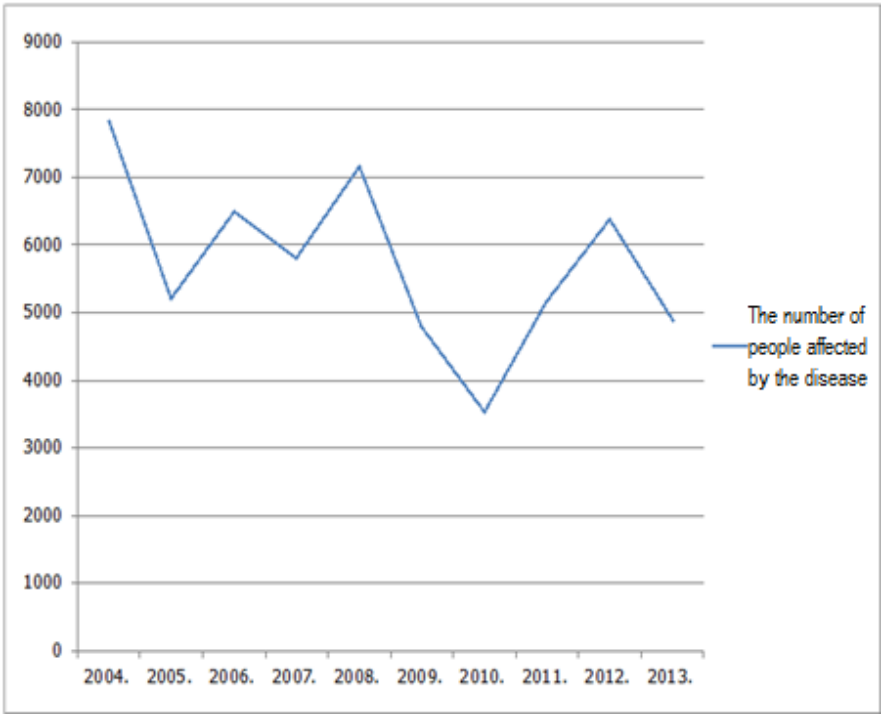
The health care system of Montenegro is based mostly on the public sector. Institutions are organized through a network of primary, secondary and tertiary health centers.

Basic indicators of the health status of the population of Montenegro, which will be analyzed further in the text, are registered numbers of patients with respiratory diseases (2004 - 2013), and health safety of the water (2013).

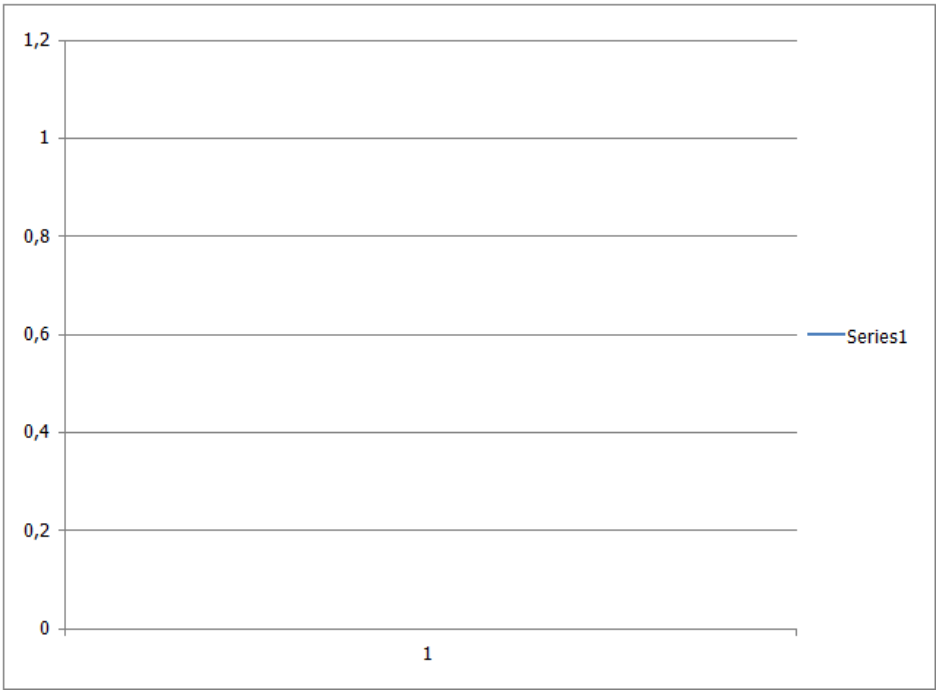
A significant reduction in the number of people affected by respiratory diseases and the incidence[44] in 2013 can be seen compared to previous years, but 2010 remains the year with the smallest recorded number of patients[45].

[44] the number of new cases of respiratory diseases in a defined period,

[45] number of patients with respiratory diseases may not be associated with landfills in Montenegro



Graphic 2.11.-1. Number of people affected by respiratory diseases in the period 2004-2013 Year (Source: Public Health Institute, Podgorica, 2014)



Graphic 2.11.-2. The incidence of respiratory diseases in the period 2004-2013 Year (Source: Public Health Institute, Podgorica, 2014)

Health safety of water is one of the most important indicators of the health status of the population. According to the Physical Development Plan of Montenegro, about 65-70% of the population is supplied with water through the water supply systems of municipal centers and bigger local centers, while just over 30% of the population in rural areas is supplied by its own water supply, wells or cisterns to collect rain water. Town water supply systems mainly supply suburban and rural settlements from their area.

Urban water supply systems cover, apart from 40 towns, another 174 suburban and rural settlements - a total of 214 settlements.

Limitations in the supply of sufficient quantities of safe drinking water are caused by the lack of springs, springs which are distant, accessibility and / or insufficient quantities of water; the lack of education of the population and improper handling of drinking water, technological problems (lack of training of persons employed in the processes of production of safe drinking water, lack of equipment), etc.

The term safe drinking water means the microbiological and physicochemical quality of drinking water and comprises the protection of springs, safe supply and handling of the drinking water.

The health safety of drinking water is primarily derived from the microbiological soundness of the drinking water. The microbiological quality of the drinking water must be constantly and continuously controlled, particularly in urban water supply systems. Disinfection of drinking water is of utmost importance to ensure microbiological soundness.

Testing of drinking water and sanitary hygienic conditions of water supply facilities were obtained for 2013. Here are some of the results:

- In 2013 on the territory of Montenegro, 13,697 samples of drinking water were examined from the city water supply and other public water supply facilities, as follows: 6,807 microbiological and 6,890 physical and physical-chemical.
- About 10% of the chlorinated water samples did not meet the prescribed standards of hygiene and mainly due to the increased number of bacteria and the presence of coliform bacteria.
- Based on the results of physicochemical tests in 2013, 11.46% of the tested samples of the chlorinated water was not fit. The most common cause of this was a lack of concentration or complete absence of residual chlorine and increased turbidity.

Noise

Center for Eco-Toxicological Research Ltd. conducted a "program of environmental noise monitoring" for 2013. The program includes twelve measuring positions in eleven municipalities of Montenegro (Podgorica, Nikšić, Žabljak, Petrovac, Budva, Kotor, Ulcinj, Kolašin, Mojkovac, Bijelo Polje, Berane). Two measurements were made for all the measuring positions, one during the warm period of the year and the other in the cold season.

Analysis showed that almost all the measuring positions recorded higher values of noise indicators in the I, warm cycle, than in II, colder cycle. The noise monitoring results in 2012 and 2013 confirmed that the traffic noise is the biggest source of noise in the environment of Montenegro. Hence the need to control the noise level and to plan measures to protect the population from its harmful effects.

Accidents - emergency situations[46]

Emergencies are caused by uncontrolled effects of few natural phenomena. On the geographic area that Montenegrin territory belongs to, such events are most often related to devastating earthquakes, large movements of rock masses (landslides, falling rocks), floods, long lasting extreme meteorological phenomena, avalanches, regional fires and other major natural disasters. Great technical and technological accidents which may result in catastrophes and emergencies, are associated with accidents at installations for oil and petroleum products, transport accidents while storing chemical and toxic materials, explosives and radioactive materials, big pollution of the drinking water for the supply of villages, large traffic accidents, accidents in mines, industrial accidents caused by explosions, radiological, biological and epidemiological and other technical or technological disasters. The emergency can arise as a result of major epidemics (epizootic and epiphytotic - mass infections of people, animals and plants). Unlike categories of disaster, accident (incident) is a sudden and immediate threat to life and health of people in a particular area, which the affected community is able to remove on its own - with its own forces and resources.

Summary of the primary risks according to the regions and cities of Montenegro

SOUTHERN REGION, which includes the municipalities of: Ulcinj, Bar, Budva, Kotor, Tivat and Herceg Novi, is characterized by specific geographical characteristics, the presence of marine waters, indented transport infrastructure (still lower rank) significant increase of population density during the summer tourism season, the complexity of the circumstances in which the tourism season is implemented, very intensive construction of buildings (tourist, as well as public and residential), the presence of high traffic and other public, commercial and infrastructure facilities. All these elements together make a very significant, complex and responsible issues of risk management of the implementation of the many forms of local and regional hazards.

In terms of protection of specified resources, it should be taken into account that in this region, individually and jointly, very significant public, infrastructural and other capacities are concentrated, with a high degree of vulnerability, especially the following: the tunnel "Sozina", energy installations and specific contents of the regional water supply, Tivat airport, the port of Bar, Zelenika and Kotor, installations of oil and petroleum products, liquefied petroleum gas installations, installations of technical gas, infrastructure of military facilities, shipyard Bijela and Tivat, storage of hazardous materials, more quarries, buildings and facilities for tourist purposes in the form of a big number of hotel and tourism facilities, public institutions for health, objects of cultural and historical heritage, old towns Bar, Ulcinj, Haj-Nehaj, Budva, Kotor, Herceg Novi, important religious buildings, sports facilities. As realistically expected risks for the above mentioned social and economic potential, these risks should be particularly emphasized in this region: high seismic risk, then the risk of traffic accidents, especially of major accidents in the tunnel "Sozina", risk of landslides and avalanches, traffic of hazardous materials, specific risks at sea, fires in the open spaces, the risk of accidents at installations for oil products, as well as the risks of aircraft accidents at airports and in the air. Bearing in mind the significant concentration of residents and tourists in the coastal region during the tourist season, outbreaks of certain infectious diseases, bioterrorism and other biological risks and their consequences, have a special dimension in this area.

THE CENTRAL REGION includes the territory of the municipalities: Podgorica, Nikšić, Cetinje, Danilovgrad. It is characterized by relatively high degree of seismic risk (with the expected level of

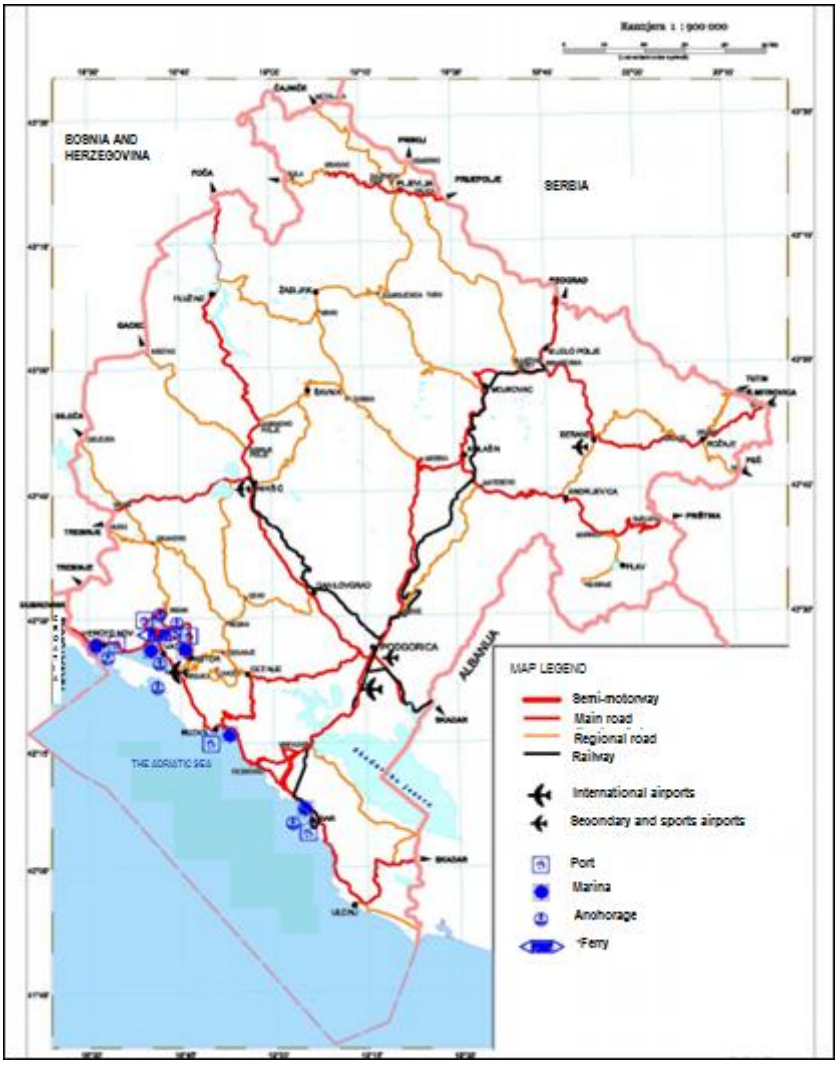
[46] Source: National Strategy for Emergency Situations, Ministry of the Interior, Department for Emergency Situations and Civil Security.

maximum intensity earthquakes of eight degrees on the MCS scale, except Nikšić with the intensity of seven degrees on the scale), the high risk in traffic, a significant level of risk in the transport of hazardous materials, fire in the open spaces, the risk on the installations for petroleum products, the risk of aircraft accidents, damage to hydraulic structures, bioterrorism and other biological risks.

NORTH REGION encompasses the municipalities of: Bijelo Polje, Mojkovac, Kolašin, Berane, Rožaje, Plav, Pljevlja, Šavnik, Žabljak, Andrijevica, Plužine. The most significant risk in this part of Montenegro is related to possible damage to hydraulic structures, large-scale forest and forest complexes in the open spaces, then the risks in traffic, transport of hazardous goods, avalanches, floods, mudslides and landslides. Berane valley is characterized by a relatively high level of seismic risk (VII degrees on MCS scale) while the territories of other municipalities in the region, have a moderate seismic risk, characterized by the expected maximum intensity of earthquakes of VII degrees on MCS scale (MCS).

2.12. MATERIAL ASSETS

Traffic



Graphic 2.12.-1. Transport infrastructure of Montenegro - the current situation (Source: Physical Development Plan of Montenegro until 2020 (Official Gazette 24/08)

Railway traffic

The existing railway network in Montenegro consists of single track rails of standard width:

- Vrbnica - Bar, part of the Belgrade - Bar railway that passes through Montenegro (electrified).
- Podgorica - Tuzi - state border (part of Podgorica - Skadar railway) (not electrified).
- Podgorica - Nikšić (electrified).

The total length of railways is 248.6 km, and with station tracks it is 327.6 km. The railway network also includes many station and commercial buildings. Important companies are connected to the railway network with industrial tracks in Bar, Podgorica, Spuž, Danilovgrad, Kruševo and Bijelo Polje. The state of the railway network in Montenegro is not satisfactory with its density and by the quality of the network, with the constant threat of the interruption to the system emphasized by the concentration of road and rail transport in the same corridor that passes an extremely difficult terrain.

Physical development plan of Montenegro envisages improvement of the quality of the existing rail network, quality of transport services and network capacity. The plans and designs of the railway network development of the neighboring countries have a strong influence on the development of the railway network in Montenegro. One of the priorities in Serbia is the construction of Valjevo-Loznica railway, which is of strategic importance for Montenegrin railway network and the Port of Bar. Albania plans to modernize the line of the Durres-Tirana and Albania -Skadar- attitudes-state border (Connection in Podgorica with the railroad Belgrade-Bar), as well as the creation of certain studies relating to the corridor VIII. The following activities of reconstruction and construction of railway lines are planned:

1. The reconstruction of the Montenegrin part of the Belgrade - Bar railway;
2. section Podgorica - Nikšić (with relocation of the part of the route through Duklja);
3. a part of the railway Podgorica - Albanian border (connection to Skadar);
4. Pljevlja - Bijelo Polje;
5. Bijelo Polje - Berane – Peć;
6. Nikšić - Bileća.

Road traffic

The total length of road traffic network in Montenegro is 6,928 km (846 km of main roads, 950 km of regional and 5132 km of local roads)[47].

Factors hindering functional linking of Montenegro with the immediate environment are natural conditions, unfavorable topography and mountain passes with difficult crossings, which results in an under-developed transport infrastructure, rank and state of the roads and an insufficient number of border crossings. The problems are partly alleviated by modernization of sections of the highway Budva - Podgorica, Kolašin-Bijelo Polje, construction of Sozina tunnel and connections to the existing highway routes. Northern region, which accounts for just over half of the territory of Montenegro, is especially characterized by underdevelopment of transport (and other) infrastructure, especially in rural areas.

The following bottlenecks that slow the flow of traffic and prevent further development of economic activities, have been identified as follows: Herceg Novi Riviera, Tivat, crossing Verige third line

[47] Source: Physical Plan of Montenegro until 2020 (Official Gazette 24/08)

Kamenari and Lepetane, Kotor, Budva, Bečići, Sutomore, Kufin, Bar, Ulcinj, Podgorica, Bijelo Polje, Nikšić, Rožaje, Kolašin, Berane and Risan-Zabljak Grahovo way[48].

According to the Physical development plan of Montenegro the following major roads are planned:

motorways corridors:

1. The section of the motorway Belgrade - South Adriatic through Montenegro: Boljare - Andrijevica - Mateševo - Bratonožići - west bypass Podgorica - Sozina tunnel - Bar (Đurmani).
2. part of the motorway from the connection with the motorway Belgrade - Bar to the border with Serbia (Kosovo and Metohija): Andrijevica - Murino - Čakor - Bjeluha.
3. Part of the Adriatic - Ionian motorway: border with Bosnia and Herzegovina (in the region of Nudola) - Grahovo - Čevo - Podgorica (bypass - it takes detailed exploration of the route) - tunnel through Dečić (border with Albania).

motorway for fast motor vehicle traffic:

1. Adriatic main road for fast motor vehicle traffic: Debeli Brijeg (border with Croatia) - Herceg Novi - crossing over the Bay of Kotor - Tivat - Budva - Bar - Ulcinj - Fraskanjela (border with Albania).
2. Šćepan Polje (border with Bosnia and Herzegovina) - Plužine - Nikšić - Podgorica.

The development goals of the transport infrastructure of the Physical development plan of Montenegro envisage the development of local roads which should provide good availability to all rural areas, tourist, agricultural and other complexes, national parks, or support planned development.

Other infrastructure

Energy System of Montenegro was part of a unique technological energy system of former Yugoslavia, and built in accordance with it. A major energy network with the voltage of 400 kV, 220 kV and 110 kV was built, as well as transmission network that enables that almost all settlements in Montenegro (except inaccessible villages in the central and northern part of the) are supplied with electricity. With the network of the power line with the voltage of 400 kV and 220 kV, with facilities that are in operation, existing power plants are included, and the connection to the power systems in the region is realized. In this sense, a 400 kV the construction of the transmission line Podgorica-Elbasan initiated.

Waterworks systems of towns mainly supply other urban, suburban and rural settlements from their area. Some of them can be treated as municipal waterworks systems, given that they cover almost all the villages in the municipality. Regional Water Supply of Montenegrin coast, based on the abstraction of water from Skadar Lake basin, has not been completed nor operational although a number of facilities for its needs have already been built.

[48] Source: Transport Development Strategy of Montenegro

3. IDENTIFICATION OF THE AREAS POSSIBLY EXPOSED TO SIGNIFICANT RISKS AND CHARACTERISTICS OF THE ENVIRONMENT IN THESE AREAS

This chapter reviews the locations considered for accommodation of sanitary landfills within the framework of the regional concept of waste management system i.e. of the locations for accommodating the object for heat treatment within the centralized waste management system. For each of the locations indicated in the following table, the specifications of the respective location's environment are described.

Northern region	Central region	Coastal region
Municipality of Bijelo Polje: - Čelinska Kosa 1 - Čelinska Kosa 2 - Kumanica - Loch - Ramčina - Goja	*Municipality of Nikšić*: - Budoš - Greater area of the town of Nikšić	*Municipality of Herceg Novi*: - Duboki Do
Municipality of Berane: - Vasov Do		

3.1. MUNICIPALITY OF BIJELO POLJE

In the area of the Municipality of Bijelo Polje, a total of 6 potential locations for the accommodation of a sanitary landfill were considered, proposed by the SPS of the Municipality of Bijelo Polje (2014). Below is a description of the general features of the municipality of Bijelo Polje and a description of the environment in the narrower area for six potential sites - Čelinska kosa 1, Čelinska kosa 2, Kumanica, Zaton, Ramčina and Goja.

The Municipality of Bijelo Polje has a moderate continental climate with clearly pronounced seasons, whereby autumn is warmer than spring. The mountain massifs surrounding the valley of Bijelo Polje affect the climate (the precipitation regime - frequent snowfalls, wind stillness, temperature differences, fog). Fogs occur in the winter months, although morning fogs are characteristic for other seasons as well, even in the summer. Fog frosts are characteristic for Bijelo Polje, which occur in winter during low air temperatures and in the presence of low temperature inversion. The winds in this area usually blow from the west (about 18%); followed by winds from the north (around 9%), the northeast and east (by about 8% from every direction), the south (about 6%), southwest (4%) and southeast (1%).

In the center of the settlement of Mojkovac of the adjacent Mojkovac Municipality, southwest of the Municipality of Bijelo Polje, there is a measuring station where the concentrations of pollutants have been measured. The average annual and monthly concentrations of sulphur dioxide and nitrogen oxide emissions were below the prescribed limit values. The total content of suspended dust particles in that particular measuring point exceeded the limit values. Also, the maximum annual concentrations for particle deposition exceeded the limit values. The maximum concentrations of ground-level ozone in August exceeded the LV, but August is not an exception because high concentrations of ground-level ozone were also noted in other summer months. The content of heavy metals in dust particles were not

above the set limit values even though a lead and zinc mine (Brskovo) is located in the vicinity; however, PAHs (polycyclic aromatic hydrocarbons) contained in the dust exceed the limit values. It can be concluded from the available data that the air quality in the town of Mojkovac is somewhat representative of the adjacent area of the Municipality of Bijelo Polje, at a satisfactory level. The small amount of heavy metals in dust particles is probably due to the fact that the remains of ore are covered with water and surrounded by lush vegetation, which prevents the spread of particles by the wind.

In terms of biogeography, the area of the Municipality of Bijelo Polje belongs to the alpine/mountain biogeographical region - a mountainous forest area with climatogenous vegetation communities of beech and oak forests, pine and floodplain forests. Pastoral communities are represented by vegetation of mesophilic and xerophilous meadows of the continental areas. Forest vegetation is the most prevalent type of vegetation and it is the main map of this type of vegetation. Meadows and pastures are particularly widespread in the Baričko-Stožerska area, the Vraneš Valley, Donji Kolašin and Pešter but they also exist in one part below Bjelasica in the form of mountain turfs.

The municipality of Bijelo Polje is not located on major regional and global biocorridors or on an IBA area.

The natural and cultural landscape of Bijelo Polje is characterized by high quality due to the high level of preservation and its dynamic structure, while its value is partly diminished as result of anthropogenic interventions.

Although there is a number of finding sites dating from the Neolithic period in the area of the municipality, so far recognized archaeological sites have not been found.

Across the main road M-2 which extends from the border of Serbia (Špiljani) - Berane - Ribarevina-Mojkovac - Podgorica - Virpazar - Petrovac - Herceg Novi, as well as the regional way R-10, the municipality of Bijelo Polje is directly or indirectly connected with all municipal centers in Montenegro. The situation is worst with non-classified roads which have been made in an unplanned manner and which have of extremely modest construction-technical elements, are in bad condition and most of the route consists of dirt roads.

1. Location Čelinska Kosa 1

The site is located on sedimentary rocks of Permian age. The basic rocks are partially or completely covered with a thin layer of Quaternary. In lithological terms, the Permian deposits belong to sandstones, shales, dolomite limestones, dolomites and dark recrystallized limestones. Quaternary sediments are represented by proluvial, diluvial and eluviation-diluvial sediments. The complex of shales and sandstones represents a hydrogeological insulator. The surface of these layers contains lesser quantities of free water, which are discharged through smaller fountains. Inside the complex, in the limestone lenses, there is a possibility for a more substantial accumulation of water. The limestone-dolomite complex can have greater accumulations, which is shown in the existence of a greater number of springs of higher capacity which form the river Čelinska. The alluvial deposits-proluvial can possibly have an insignificant accumulation of water during strong rainfall.

The site is located outside the sanitary protection zone.

The nearest watercourse location - Čelinska river, is located about 780 m W from the site. To the east, the closest watercourse - Rakitska river - is located at a distance of about 900 m. The mentioned watercourses flow into Lepešnica that later flows into the river Lim. On the right side of the Čelinska

River, where the planned location is situated, transversal gullies are formed, through which water flows continuously or intermittently. Surface waters as well as some ground waters flow through these gullies. Runoff is most intense during autumn and spring months, creating floods that carry potentially large amounts of water. The location belongs to the catchment area of the river Lim.

The nearest watercourse at which the water quality is being monitored[49] is the river Lim which is located at a distance of about 8,100 meters NW of the site. The river Lim is sampled two sites downstream from Berane (Skakavac, Zaton, Bijelo Polje and Dobrakovo), and the water quality belongs to A_2, C and K_2 classes. The content of nitrates and phosphates is within the permitted limits. The water quality of the River Lim was estimated as good in terms of many parameters. However, the micro-bacteriological condition of this river can be characterized as "bad" or "very" bad, due to the increased concentrations of fecal and total coliforms, which was found downstream from Berane and Bijelo Polje.

The site is located in an area of brown soil type and an area characterized by a high mountain range, deep canyons and terrains where erosion and landslides are common. According to the area's erosion map[50], the site is located in an area of medium erosion.

The site is located at a distance of about 500 m southeast of the Emerald ecological network area (the Lim valley), at a distance of about 2 km north of the NP Biogradska Gora and at a distance of about 1.5 km from an area under international protection (UNESCO Durmitor - Tara Canyon). On the location, according to the SPS of Bijelo Polje, no significant presence of protected plant species was registered.

The site is located on the western slopes of the mountain, in a mosaic system of pastures and forest areas. The route of the transmission line passes along the site, with cuts in the forest complex. The visual exposure is moderate to low, but the location reveals views from the mountain tops to the south, which due to the area's visual values of and the natural and cultural context represents a potentially strong negative impact.

No elements of cultural heritage were registered in the vicinity of the site. The distance to the closest elements of cultural heritage - the element of sacral architecture in the northeast and pasture in the southeast - is about 3 km.

The site is located in the southwestern part of the municipality of Bijelo Polje and near the border with the municipality Mojkovac. The population density in the municipality of Bijelo Polje is 53.34 inhabitants/km^2, in the municipality of Mojkovac 24.21 inhabitants/km^2, and in the municipality of Kolašić 9.29 inhabitants/km^2. The site is located less than 1000 meters from the village of Rakita (Rakita Upper and Lisičina village), located north of the site, near the traffic route Jaova Luka - Lisičine - Đurđevica. The town of Bijelo Polje is located about 15 km from the site.

The site is located outside the area of agricultural land. According to the map of forest areas of the National Plan of Montenegro by year 2020, the greater area of the site is surrounded by forests of economic purpose of use. The orthophoto snapshots, however, show that it is not a forest area but a mountain grassland area, not overgrown and located in the corridor between two long transmission lines. The site is located within the hunting site Bijelo Polje which covers the entire municipality area, and to a lesser extent the area of the Municipality of Berane. According to the data about the hunting

[49] Source: Information on the environmental situation in Montenegro for 2013, Agency for Environmental Protection, Podgorica, 2014

[50] Water Management Plan of the Republic of Montenegro; Erosion map

site "Bijelo Polje", provided on the official website of the Agency for Environmental Protection[51], there are 4 hunting ban areas in the hunting site Bijelo Polje, but none of them is in the area of the site.

A 10 kV long transmission line passes along the the access road leading to the location (about 100 m from the exit).

2. Location Čelinska Kosa 2

According to the geological map of Montenegro (1: 200,000), the site is situated on metamorphic and sedimentary rocks of Permian age. The Permian rocks are, in regional terms, a hydrogeological barrier i.e. they are considered impermeable complexes of rock masses. The permeability of this complex depends on the tectonisation and crackedness of the rock mass. Metamorphic deposits have low primary porosity, and these are mainly rocks with fracture porosity. Practically, these terrains are without groundwater reservoirs in the basic rock mass. Accumulation of groundwater is possible in the zone of decomposition as well as in the fissure systems.

The site is located outside the sanitary protection zones. The nearest watercourse, the Lepešnica river, is located about 300 m north of the site.

The site is located outside the agricultural areas, on brown, medium deep, acid soil, shales. The terrain is characterized by high mountain ranges, deep canyons and high to low soil erosion.[6]

The site is planned in an area covered with forest vegetation. The site is located within an area of the Emerald network and at a distance of 1,200 m of ecologically important sites.

The site is located at a distance of about 4 km southeast from the Emerald ecological network area and at a distance of about 3 km north from the area under international protection (UNESCO Durmitor - Tara Canyon).

The site is located on the north-western mountain slopes, in an area covered by natural cover and inside the mosaic system of cultural landscape. Since both a traffic route and a railway route pass at a distance of some 500 m in the north, the frequency of the views at the location is high.

No elements of cultural heritage were registered in the vicinity of the site. An element of sacral architecture is about 3.5 km on the northeast and a pasture is about 2.5 km to the southeast.

The site is located in the southwestern part of the municipality of Bijelo Polje, near the border of the suggested site Čelinska Kosa 1. The population density in the municipality of Bijelo Polje is 53.34 inhabitants/km^2. The site is approximately 1,000 meters from the village of Rakita (Rakita and Lisičina village), and it is some 650 meters from the first inhabited buildings. The area around the site is very sparsely populated. The town of Bijelo Polje is located about 7 km from the landfill site.

3. Location Kumanica

According to the geological map of Montenegro (1: 200,000), the site is situated on sedimentary rocks of middle Triassic. In lithological terms, the rocks of the separated geological unit belong to layered limestones with intercalations and chert nodules as well as to ridge limestones. The carbonate rocks of

[51] http://www.epa.org.me/images/lovista2010/lovista/lovackaorganizacijabijelopolje2010.pdf

Middle Triassic are considered to be water-permeable rocks with fracture-cavernous porosity and thus represent aquifers rich in water.

The site is located outside the sanitary protection zones. The nearest water course is a periodic watercourse located at a distance of about 300 m to the south and the river Lim which is at about 400 m east of the site.

The soil of the site is forest soil, brownised, very shallow, with strong rockiness and medium erosion. According to the cartographic representation of the State Spatial Plan, the site is located on arable agricultural soil.

The site is planned in an area covered with forest vegetation. The site is located outside the territory of the Emerald Network and the biocorridor. The site is not in the vicinity of any protected area.

Extremely steep terrain and a deep ravine characterize the landscape around the site Kumanica. The higher slopes have natural cover composed of forests, high macchia and rocky ground while on the less steep hillsides, where the site is situated, apart from forests, there are also fenced pastures. Smaller villages are located to the south of the site. Apart from the Lim River, a traffic route and a railway route pass through the bottom of the gorge. The site is exposed to views from the main traffic routes to a moderate extent and to a high degree to views from the surrounding countryside and the opposite hillsides.

Elements of cultural heritage have not been registered in the vicinity of the site; an element of sacral architecture is located about 2.5 km in the southwest, in the village of Kanje.

The site is located in the northernmost part of the municipality of Bijelo Polje. The population density in the municipality of Bijelo Polje is 53.34 inhabitants/km^2. The area around the site is very sparsely populated. The site is located about 400 meters from the first inhabited buildings. Settlement which is in the immediate vicinity of the landfill site is Dobrakovo (hamlet Lemeš).

4. Location Zaton

According to the geological map of Montenegro (1:200,000), the site is situated on metamorphic and sedimentary rocks of Permian age. In lithological terms, the rocks of the separated geological unit belong to phyllite, argilophyllite, meta-sandstone and conglomerate. The Permian rocks represent, in regional terms, a hydrogeological barrier i.e. they are considered impermeable complexes of rock masses. The permeability of this complex depends on the tectonisation and crackedness of the rock mass. The metamorphic deposits have low primary porosity, and these are mainly rocks with fracture porosity. Practically, these terrains are without groundwater reservoirs in the basic rock mass. Accumulation of groundwater is possible in the zone of decomposition as well as in the fissure systems.

The site is located outside the sanitary protection zones. The nearest watercourse is Duboki potok which is located some 130 m north of the site.

The pedological characteristics of the site are brown, medium deep, acidic soil, sandstone, with very poor erosion.

The site is planned in an area covered with forest vegetation. The site is located outside the territory of the Emerald Network and the biocorridor. The site is not in the vicinity of any protected area.

The surroundings of the site are dominated by natural cover of deciduous forest which results in high landscape value and a relatively low exposure to views. The small, almost non-existing exposure to views can be credited to the site's location in the concave area between the mountain slopes and the great distance from settlements and transportation routes.

Items of cultural heritage have not been registered in the vicinity of the site; an items of sacral architecture is located about 2 km in the southwest, in the settlement Zaton.

The site is located in the northeastern part of the municipality of Bijelo Polje. The population density in the municipality of Bijelo Polje is 53.34 inhabitants/km^2. The site area is extremely sparsely populated, and it is positioned some 1000 m from the first inhabited buildings. Settlement in the immediate vicinity of the location is Zaton.

5. Location Ramčina

According to the geological map of Montenegro (1:200,000), the site is situated on metamorphic and sedimentary rocks of Permian age. In lithological terms, the rocks of the separated geological unit belong to phyllite, argilophyllite, meta-sandstone and conglomerate. The Permian rocks are, in regional terms, a hydrogeological barrier i.e. they are considered impermeable complexes of rock masses. The permeability of this complex depends on the tectonisation and crackedness of the rock mass. The metamorphic deposits have low primary porosity, and these are mainly rocks with fracture porosity. Practically, these terrains are without groundwaters in the basic rock mass. Accumulation of groundwater is possible in the zone of decomposition as well as in the fissure systems.

The site is located outside the sanitary protection zones. The nearest water course is an intermittent watercourse which is located at a distance of some 120 m north of the site. Of the permanent watercourses, the river Lim is the closest one and it is located at a distance of about 970 north of the site.

The soil is brown, medium deep, acidy, shales with low erosion. There is an arable area near the site.[52]

The site is planned in an area covered with forest vegetation. The site is located outside the territory of the Emerald Network and the biocorridor. The site is not in the vicinity of any protected area.

The site is located on the northwestern slope of the hill above the river Lim. The surface cover consists of rare woods and meadows and is located near a small settlement. Apart from the prominent traffic route, there are no significant landscape elements of anthropogenic origin. The location is visually exposed to views from the west i.e. the frequent traffic route following the river Lim.

No elements of cultural heritage were registered in the vicinity of the site. An element of sacral architecture in the northeast, in the village of Zaton, is located about 3.5 km away, while in the village of Brzava there is an element of sacral architecture at a distance of 3.5 km.

The site is located in the southern part of the municipality of Bijelo Polje. The population density in the municipality of Bijelo Polje is 53.34 inhabitants/km^2. The site area is extremely sparsely populated, and it is positioned some 600-800 m from the first inhabited buildings. Settlement which is located nearest to the site is Zaton and associated hamlets (Mostine).

[52] National Spatial Plan, cartographic representation

6. Location Goja

According to the geological map of Montenegro (1:200,000), the site is situated on metamorphic and sedimentary rocks of Carboniferous - Permian age. In lithological term, the Carboniferous rocks belong to sandstones, phyllite and limestones while those of Permian age belong to phyllite, argilophyllite, meta-sandstone and conglomerate. The Carboniferous rocks represent, in regional terms, a hydrogeological barrier i.e. they are considered to be impermeable complexes of rock masses. The permeability of this complex depends on the tectonisation and crackedness of the rock mass. The metamorphic deposits have low primary porosity, and these are mainly rocks with fracture porosity. Practically, these terrains are without groundwaters in the basic rock mass. Accumulation of groundwater is possible in the zone of decomposition as well as in the fissure systems. In some areas of limestone and similar hard rocks, conditions may be created for the formation of smaller sources or seepage springs.

The site is located outside the sanitary protection zones. The nearest watercourse is an intermittent watercourse which is located at a distance of about 120 m north of the site. Of the larger watercourses, the river Lim is the closest and it is located at a distance of about 430 m to the east while the creek Lanjski is about 130 m north of the site.

The site is located in an area of arable land. The site soil is brown, forest land on carbonate base with moderate erosion.

The site is planned in an area covered with forest vegetation. The site is located outside the territory of the Emerald Network and the biocorridor. According to the PUP of Bijelo Polje, the site is near a locality significant for protected plant species. The site is not in the vicinity of any protected area.

The planned location is situated in an area covered by natural forest, on the northern mountain slopes above a gorge. Except for the relief and the natural cover in the landscape, other noticeable feature is the bottom of the gorge. A road stretches through it and around it there are some buildings and farmland. The vertical position of the gorge in relation to the main traffic routes along the river of Lim prevents high frequency of views of the location. An additional hindrance to the views is the relatively high forest cover.

Elements of cultural heritage have not been registered in the vicinity of the site; there is an element of sacral architecture in the settlement Kanje, located about 1 km in the west.

The site is located in the northernmost part of the municipality of Bijelo Polje. The population density in the municipality of Bijelo Polje is 53.34 inhabitants/km^2. The area around the site is very sparsely populated. The site is located about 100-300 meters from the first inhabited buildings. The settlements which are closest to the site are Dobrakovo and Kanje with associated villages (G. Selo).

3.2. MUNICIPALITY OF BERANE

Location Vasov Do

According to the geological map of Montenegro (1: 200,000) the site is located on deposits of Anisian (T_2^1) layered and massive limestones and dolomites. Of permeable rocks Anisian limestones and dolomites should be emphasized. These rocks are of fracture and cavernous porosity, good yields and in the field they function as collector conductors. Their process of karstification is quite pronounced. All

waters that fall on them are quickly absorbed by rapid infiltration and then conducted to lower elevations where they drain over springs. They contain a well-formed discontinuous aquifer.

The site Vasov do is situated outside the sanitary protection zone. The site is located directly on the watercourse of Lučka river which flows into the river Lim. Quality of surface waters and groundwaters: Lim is sampled at 6 points and its waters upstream of Berane should belong to A_1,S, K_1 class (Plav and Andrijevica). As the upper part of Lim belongs to the required class A_1, the shifting of balance is higher and many parameters traverse into A_2, while the middle part of the flow, as well as the lower one, belong to A_2 and most of the parameters are found in it, but the content of nitrites and phosphates in these parts of the current are VC. It is important to note that the microbiology in this part fell into satisfactory class. The water quality of the River Lim was estimated as good based on many parameters. However, the micro-bacteriological condition of this river can be characterized as "bad" or "very" bad, due to the increased concentrations of fecal and total coliforms, which were found downstream from Berane and Bijelo Polje. The local groundwater pollution in continuous and discontinuous aquifers caused by the municipal landfill can be seen through its impact on the water of Lim. They are, basically, polluted and as such they transfer pollution to continuous and discontinuous aquifers with which they are in direct hydrogeological contact. This contamination is of such intensity that it makes these waters unsuitable for almost every use.

Conducted physical - chemical analyses of water during 2013 (*source: Report on the hygienic quality of drinking water in 2013, Public Health Institute, Podgorica, 2014.*), from the total number of analyzed physical-chemical chlorinated water samples, 50 (65.79%) corresponded while 26 (34.21%) did not correspond to current laws. Of the total number of analysed microbiological samples of chlorinated water, 75 (98.68%) met and 1 (1.31%) failed to meet the prescribed standards. Of the total number of physically-chemically analysed samples of chlorinated water, 1 (50.00%) met and 1 (50.0%) failed to meet the prescribed standards. All microbiologically analysed samples of chlorinated water were defective. In addition to the above samples, which were taken in line with the contractual obligations, in the period from 24 August 2013 to 09 October 2013, due to epidemic occurrence of gastroenterocolitis in the municipality of Berane, at the request of the sanitary inspection, 71 samples of chlorinated water and 11 non-chlorinated water samples were analysed within the scope of the basic analysis, while 4 samples of drinking water were analysed for their microbiological suitability and for turbidity.

The municipality of Berane is located in a valley where winter temperature inversions are a frequent occurrence, as wells as the occurrence of fog which, together with the relatively low airing, affects the creation and retention of smog.

The Center for Eco-Toxicological Research of Montenegro (CETI) carried out air quality tests at the site Vasov Do. The measurements include the analysis of the content of SO_2, NO_2, NO_x, total hydrocarbons, ozone, ground level, NH_3, airborne particles, content of heavy metals and PAH's in them. The measurements were performed in order to determine the zones of the landfills' influence, that is, to determine the vulnerability of the population settled in the vicinity of the landfill. Sampling was carried out on 5 selected sites that are representative of the landfill's potential impact on the environment, of which 4 measuring points are in the immediate vicinity of the landfill, and 1 measurement point (the settlement Beranselo - Strane) is not under direct influence of the existing landfill. On all four measuring points in the vicinity of the site, in all 24h-cycle (7 days measurements) the values of the SO_2, NO_2 and total nitrogen oxides concentrations were low and did not exceed the prescribed limits. The measured concentrations of total hydrocarbons and ammonia were higher in areas near the site as a result of the decomposition of the organic matter in the landfill. Total airborne particles occasionally exceeded the prescribed limits at all four stations, as a result of waste transport to the landfill. The content of heavy metals in total airborne particles was above the prescribed norms. The content of polycyclic aromatic

hydrocarbons (PAHs) in the total quantity of particles, in all places near the existing landfill, exceeds standards for PAHs. A comparison of the above measured values of pollutants with the values at the measuring point in the settlement showed a significant difference, which clearly points to the frequent incineration of the disposed waste. The spreading of gases by wind, penetration of hazardous and harmful substances into the soil during the rainy season and the unpleasant odour that spreads around the landfill are all result of poor landfill management that has a measurable impact on the environment.

The broader area is dominated by forest land, brown soil on carbonate - silica substrate and brown acidy soils on sandstone as well as brown acidy soils on sandstone (medium deep). An analysis of the soil in the northeast, northwest, southeast and southwest of the existing landfill was conducted. The results of the physical-chemical analysis showed that the samples taken in the northeast, northwest, southeast and southwest do not meet the requirements of the Regulations on permitted amounts of hazardous and harmful substances in soil and the methods for their testing (Official Gazette of RoM18/97), due to increased levels of cadmium, arsenic, nickel and fluoride (source: EIA Study Landfill Berane, 2009).

The site is located on the already devastated area by the water stream and is surrounded by forest vegetation. It is not located within or near the biocorridor nor the centers of diversity. The site is not located near protected areas and is about 500 m west of the Emerald ecological network (Lim River valley).

According to the division in ambiental zones defined in the SP MNE (2008), the planned location is on the border area of major river valleys of the mountainous part of the area and the zone of economic forests and pastures. The landscape is defined by the ratio of mountainous areas and lowland areas along the settlement Berane. The indented limestone relief, the natural forest cover and the shrubberies as well as elements of cultural landscapes such as pastures, orchards and hedgerows form the basis of the hilly landscape. The steep slopes that end in narrow and deep gorges oriented east-west are in contrast compared with the flat river valley to the east and affect the high dynamics of the landscape. The town of Berane with its surroundings and the river Lim which flows through it define the landscape of the lowland part. Landscape elements such as industrial plants, infrastructure projects and contextually inappropriate construction negatively affect the overall value of the landscape. For this reason, otherwise valuable landscape of the wider project area, can be considered moderately to highly valuable.

The planned location is on physically and visually separate area where potential elements of cultural heritage are not registered or observed and archaeological excavation have not been carried out. The site is located in the northwestern part of the municipality of Berane with a minimum population density of 48.53 inhabitants /km^2. This means that there are no inhabited housing or other objects in the immediate vicinity. The Municipality of Berane and the surrounding municipalities (Andrijevica, Rožaje, Plav,) belong to the less developed areas of Montenegro, with weaker economic development than other areas (coastal and central regions), which resulted in pronounced emigration from the mentioned area.

According to the map of forest areas of the National Plan of Montenegro by year 2020, the greater area of the site is surrounded by forests of economic purpose. The planned location is situated along the northern border of the hunting site "Smiljevica and Bjelasica" which occupies the southwestern part of the municipality of Berane. According to the Decision on the establishment of hunting sites and of a hunting area with special purpose from September 2010 (OG of Montenegro, no. 62/2010), the hunting site "Smiljevica and Bjelasica" is typically mountainous hunting site which covers 40,626 hectares.

3.3. MUNICIPALITY OF NIKŠIĆ

Location Budoš

According to the geological map of Montenegro (1: 200,000), the location is positioned over Lower Cretaceous sediments - layered limestones, rarely dolomites with algae, gastropods and chert. It is significant for this site that the terrain's complex tectonic structure and brokenness enabled development of deep karst erosion and a groundwater hydrology system with plunging surface waters and roads created by the rapid pollution of wells and springs in the area. According to the hydrogeological map of the municipality of Nikšić, the site is located on layered, banked and massive limestones, rarely dolomite limestones and dolomites. According to the hydrogeological categorization, the respective deposits belong to permeable rocks with fracture - cavernous porosity. The site lays on deposits with fracture porosity, collector conductor. The groundwater flow direction is SW. The site Budoš is situated outside the sanitary protection zone.

The water body nearest to the location is Slansko lake, located at a distance of about 1,200 meters to the northwest, while the closest permanent watercourse Slanski channel is located at a distance of about 700 m NE of the landfill site. The waters of the Slanski channel flow into the river Zeta. The Nikšić field is specific due to the flooding with groundwater that periodically occurs in its southern part. The site is located in the Karst region, therefore there may be a weak erosion (*Source: Erosion map and Study on the assessment of impact on the environment of the regional landfill in Nikšić)*.

The site is located on the northern slopes of the mountain Budoš, in a depression with elevation of 813 m, on an enclave of meadow habitat surrounded by oak - oriental hornbeam forest which is spread on a wider area. The area is not recognized as ecologically significant area for the flora and fauna and there are no Emerald areas and natural heritage areas in its vicinity.

According to the division into ambiental zones, as defined in the SP MNE (2008) the site is located in the valley of the upper reaches of the lowland rivers, which in the wider area borders with the zone of karst basins and plateaus as well as larger river valleys of the lowland part. The landscape is characterized by three distinctive parts: the lakes Slano in the west, Nikšić field in the east and the mountain massif of Budoš in the south. The lakes Slano and Krupac resulted from anthropogenic accumulation. Except for the lowlands of the eastern coast, which also serve as a barrier, the other shores are indented with an unsteady water line that depends on the water level. The hill Budoš belongs to the type of karstic relief forms of moderate vertical dissection; relief with numerous micro-relief forms such as sinkholes and cracks. The surface cover is mostly forest and macchia with some elements of cultural landscape, such as enclosed sinkholes and dry stone fences. The site itself is visually exposed to views from the direction of the town of Nikšić and the traffic routes Nikšić - Šavnik - Plužine and Nikšić - Trebinje. There are no protected elements of cultural heritage or recognized archaeological sites in the immediate vicinity of the project. Because of its features, the area cannot be considered a potentially significant example of cultural landscape.

The site is located in the southeastern part of the municipality of Nikšić, which is also the largest municipality in Montenegro (15% of the territory). The population density of the municipality of Nikšić is 35.6 inhabitants/km^2, of the municipality of Savnik - 3.89 inhabitants /km^2, and of the municipality of Plužine - 3.85 inhabitants /km^2. The nearest hamlet is Čelinski do (about 600 meters from the site), where about 10 residents reside permanently while the other residents reside only occasionally. The area location is sparsely inhabited. The nearest urban center, the periphery of the town of Nikšić, is about 5-6 km north of the site. The location is currently not used for any activity. The distance from agricultural fields is minimally 1 km. According to the map of forest areas of the National Plan of

Montenegro until 2020, the wider area of the proposed site is located in an area covered with forests, falling into the category of shrubbery, leafy forests and macchia. The planned location is within the hunting sites "Nikšić" area of 137,857 ha. It is a typical mountain hunting site that covers most eastern part of the municipality. The main power transmission line of 110kV Perućica to HE Trebišnjica passes northeast of the site through. The site is located at a distance of about 1.5 km from the reservoir area Slansko lake whose area is, according to the SUS Nikšić, planned in tourist and recreational purposes (T3 - motels, private accommodation).

Greater area of the town of Nikšić

The geological basis of the terrain in the wider area of the Nikšić field is built of limestone rocks with dolomites and dolomite limestones, of predominantly Cretaceous age, and of Jurassic age in the zone of the Budoš beam. Upper Triassic limestones are located in the parish of Nikšić and Gornje polje. Thick layers of Pleistocene age, composed of lake, river and glacial sediments: clay, sand, gravel and processed talus are deposited over these rocks in the erosional-karst depressions of the Nikšić field and its trunnions. The thickness of the layers varies, but it is generally higher than 15-20 m. The tectonic structure of the terrain is very complex. In the wider area there are numerous fault and folding structures, anticlines and synclines. It is significant for this site that the terrain's complex tectonic structure and brokenness enabled development of deep karstic erosion and a groundwater hydrology system with plunging surface waters and roads created by the rapid pollution of wells and springs in the area. The wider area includes a terrain of weak erosion.

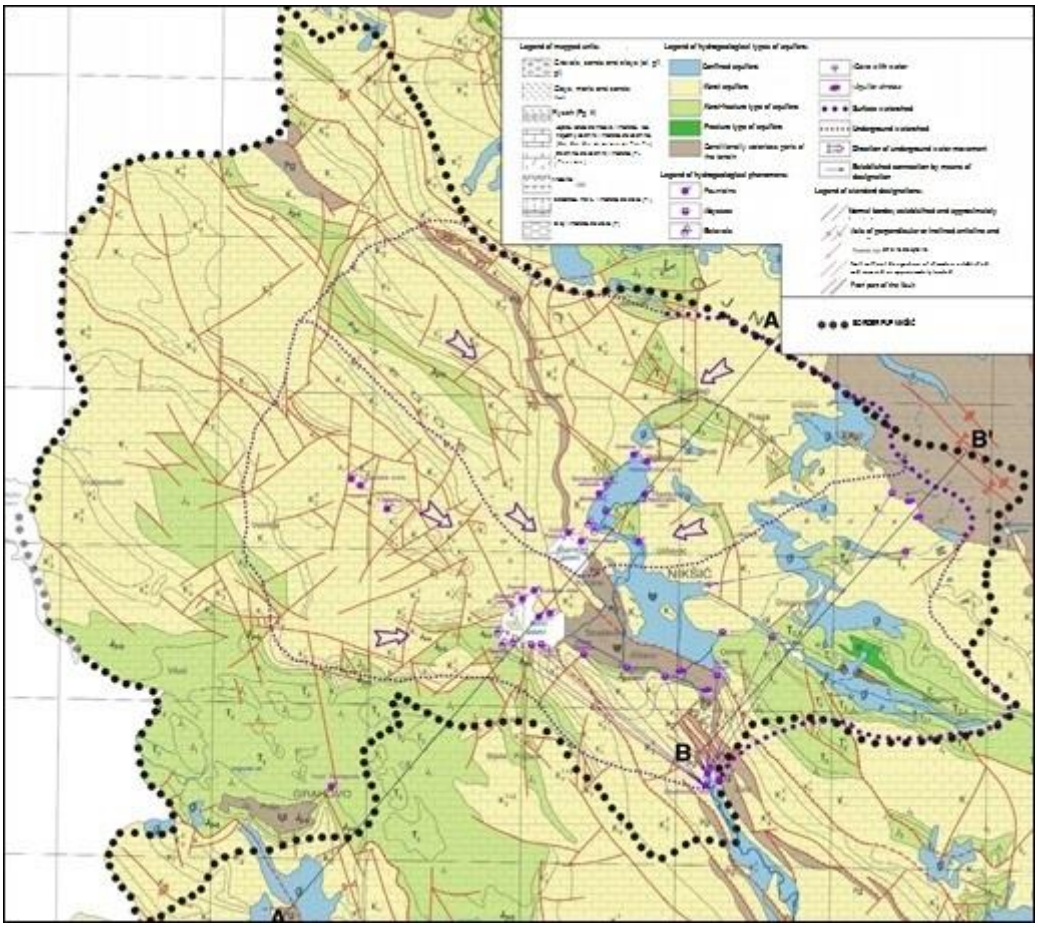
The Nikšić municipality belongs to the deep karst where the land's composition is dominated by limestone on which there are no surface water streams and there are only few of other surface flows. Large amounts of rainfall are lost in the underground up until the lower limit of limestone. In areas where on the surface or in specific depth there are impermeable rocks (Nikšić parish, Gornje polje, Donja zeta, Nudo), there are surface waters. In parts of the municipality where the dominant composition of the rocks is made of limestone, there are no surface flows or they rarely occur. Such parts of the municipality are: bigger part of Pješivace, Nikšićka Rudina, Grahovski kraj, Banjani, Oputne Rudine, Golija and Duga, as well as much of the northeastern and eastern areas like Jasenovo polje, Praga, Lukovo, Vučje, Konjsko, Lukavica, Bare Bojovića, Bršno and Vleđeđe. The central part of the municipality consists of Nikšić field, which stands out for its abundance of surface waters. Also, in the surroundings of Nikšić field there are wells and springs; on Glava zeta around the springs Oboštica, Drenovačka and Milojevićka vrela in Pješivci, around Grahovsko fields, and in the valley of Nudo. Along Golije and Duga, a narrow zone (width of up to 200 m) stretches, and there are a number of smaller springs. In the valley of Gračanica (Nikšić parish) there are also sources of lesser or greater yields, depending on the annual distribution of precipitations. Upon the Pleistocene, relatively impermeable sediments of the Nikšić field, composed of fine sand and marl clay, a relatively dense network of short watercourses developed, which plunge on the edges of the fields. The longest and most important river of Nikšić polje is Zeta. Its largest tributaries are Bistrica, Mrkošnica and Gračanica. There are about 300 springs, 30 small and large flows in Nikšić polje as well as a large number of abysses. Due to the small permeability capacity of the abysses, part of Nikšić polje becomes temporarily flooded during snowfalls. In the immediate vicinity of Nikšić there are the following artificial lakes: Krupac, Slano and Liverovići. The artificial lakes in Nikšić polje are connected by channels, allowing them to be emptied one by one, and much of the river flow is also being channeled. The complex hydrogeological situation of Nikšić polje is shown with graph 3.3-1.

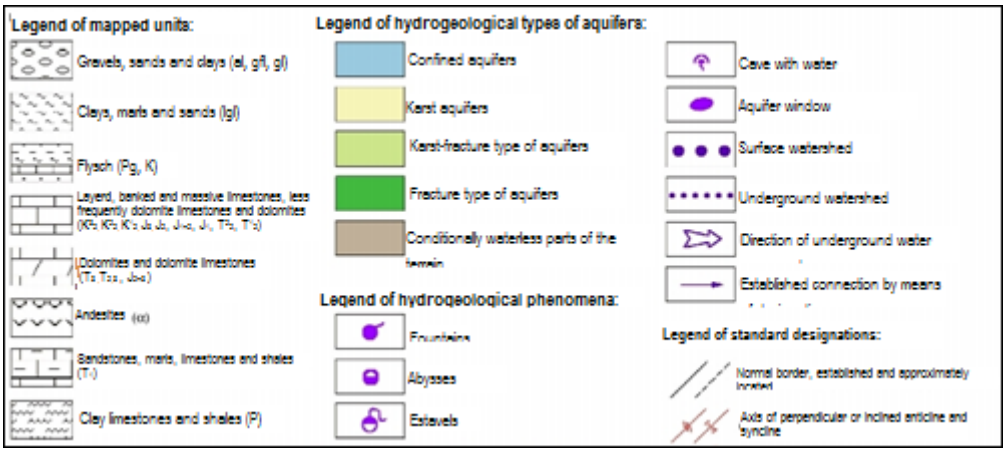
The abysses represent special relief peculiarity of Nikšić field. Some 900 abysses have been registered, some of which have lost the function of abyss after the creation of injection curtains around the lakes Krupac and Slano. When building the reservoir for the hydroelectric power plant Perućica, cylindrical

concrete dams were erected around the larger abysses in Nikšić polje, Slivlje, Misor, Opačica, and some other smaller abysses were blocked by concrete cladding along the fields. Those interventions were aimed at retaining the water, but were unsuccessful because numerous sinkholes appeared in the field (eg. the raising of the accumulation Vrtac). All this points to a complex relief of the Nikišić municipality and the need to take into consideration its natural characteristics in the course of all serious projects and interventions.

The main source of water supply of the Nikšić area is the source Vidrovan (Donji and Gornji Vidrovan). Lately, in the critical dry season, the new source Poklonci gets included. The immediate protection zone for the source Vidrovan is completed and it comprises the catchment area Gornji Vidrovan and the ancillary facilities, and the catchment area Donji Vidrovan and its ancillary facilities. Wells B1 and B2, which were made in 1999. are also located in the protection zone of the Donji Vidrovan. The sanitary protection zones have also been established at the new source Poklonci, on the shore of the reservoir Krupac.

The Nikšić field is specific due to the flooding with groundwater that periodically occurs in its southern part. These floods are exacerbated by the fact that the geological substratum, which should receive naturally inflowing waters in the precipitation period, is filled with water from the reservoir, which makes the flooding lot more dramatic.





Graphic 3.3-1. Hydrogeological map of the municipality Nikšić *(Source: Physical Plan of the Municipality of Nikšić)*

According to the Report on the State of the Environment in 2013 (source: Report on the State of the Environment for 2013, Agency for Environmental Protection, Podgorica, 2014), the Zeta River is sampled at 4 measuring points I. According to the classification, its waters should belong to A1, S, K1 classes upstream from Brezovik (Vidrovan) and to A2, C, K2 classes downstream from Brezovik, to the mouth of the Morača River (Duklov most, Danilovgrad and Vranjske njive). The waters of the measuring profile of Vidrovan showed the best quality compared to other, which is expected, and no parameter was VC; however, the content of ammonia (A3), the ratio Mg/Ca, phosphates, coli and fecal bacteria was in A2 i.e. outside their prescribed class. Further along, the water quality of the river Zeta changes, so the condition on the profile Duklov most is worse and it is outside the prescribed class in 20% of cases, while 6.7% is VC - based on oxygen saturation and the content of phenols. In the lower course of Zeta, after its sinking, the quality is better in comparison to the part near Nikšić (Duklov most). The content of phosphates at both measurement points was VK (Danilovgrad, Vranjske fields). It is important to mention that on the line Duklov most - Vranjske fields, the microbiological parameters were within the prescribed class A2, K2. The water of the Zeta River is of poor quality only when it comes to total coliforms, on the station Duklov most (upstream of the discharge of wastewater in Nikšić) and Danilovgrad. Higher values were recorded at the station Duklov most, although other parameters indicate "high" to "mediocre" quality water. It should be emphasized that the position of the monitoring stations along the river Zeta is not such that would enable full assessment of the impact of the Nikšić waste water on the Zeta River.

The basic climatic characteristics of Nikšić polje are determined by its link to the Adriatic Sea and the relief. The main characteristics are moderately warm summers with small amount of precipitations, mild winters with a lot of rain and frequent changes in air flow and rapid shift of air masses. The most frequent wind is cold, dry northern continental wind blowing in gusts. Jugo (southern wind) is a frequent wind during the spring. The influence of continental element is most visible in higher daily and annual temperature amplitudes. Coastal climate features characterize the area of Skadar Lake, along the Zeta plain, and over the mountain elevations they even reach Nikšić polje.

The air quality in Nikšić during 2013 was measured at the station which is located at the crossroad center - the Nika Miljanjića boulevard. This measurement station is located close to a very busy road so that the measured concentrations are largely caused by vehicles' exhaust emissions. According to the data from the Annual report on the monitoring of air quality on the territory of Montenegro for 2013. (CETI, February 2014), all measured values for SO_2, NO_2, CO, in relation to the limit values (hourly mean values and daily average value) during 2013, were below the prescribed LV. The concentration of PM_{10} particles in the ambient air at this location is significant and exceeds all prescribed limit values and tolerance values. Mean $PM_{2.5}$ on annual basis was above the prescribed limit value. The maximum daily

eight-hour mean ozone value was above the prescribed target value for 30 days. The content of heavy metals in PM_{10} was below the specified lower limit of LVs and the lower evaluation limit for protection of health. The annual mean value of benzo(a)pyrene was above the prescribed target value, and thus above the upper limit of assessment for protection of public health.

The pedological layer in Nikšić polje is characterized by sandy clay horizon, small thickness (≈0,3-1,0 m), below which layers of sand, gravel and talus are spread. In the areas with greatest abysses there are smaller areas of marshland.

The municipality of Nikšić covers a relatively large area with different climatic influences, diversity of geological base, relief, soil type, etc. which had an impact on the great diversity of habitats as well as plant and animal species. On the horizontal and vertical profile of the area, many forest communities are differentiated, being conditioned by the climate (climatogenous forests) and by orographic-edaphic factors (climate-regional forests). Basic forest communities of the area are forests of oak, oriental and hop hornbeam, beech and fir, as well as pine forests in the higher areas. The vegetation of the mountain pastures and bare lands occurs mostly above 1,700 m a.s.l., above the forest zone. As a result of burning and deforestation, pasture and meadow areas occurred at lower altitudes as well: Lukavica, Krnovo, Konjsko, Gornje Vučje and others, and they are characterized by a significant wealth of diverse mountain vascular flora with a considerable number of endemic, relict and rare species which are of particular importance. The wider area of the town of Nikšić does not have any areas belonging to the ecological network.

Given the rich history, which goes back to ancient times, the town and the municipality of Nikšić have a rich cultural heritage. In the wider area there are several valuable cultural and historical monuments. The fortified town Ongošt (Anagustum) is located in Nikšić polje. In the area of Nikšić and its surrounding area there is a number of churches and monasteries. There is also a significant number of Medieval burial monuments-standing tomb-stones.

The Nikšić area is a significant industrial area, and the industries are concentrated in the southern and south-eastern part of the wider area of the town of Nikšić.

3.4. MUNICIPALITY OF HERCEG NOVI

Location Duboki Do

The site of the sinkhole Duboki Do is built of massive, partly stratified to banked limestones. The bottom of the sinkhole is covered with clay sediments (dark fertile soil) with a higher content of calcareous talus (skeleton). The thickness of the soil cover ranges up to about 5 m. The largest distribution in the wider research area has karst-like aquifers developed under limestones with good permeability and dolomites with fracture-cavernous porosity. Confined karst aquifers have much smaller distribution that has been developed in the context of glacial and delluvial sediments of medium permeability.

Location Duboki Do, according to the proposed areas of sanitary protection zones of Morinj, elaborated in the "*Elaborat o određivanju i održavanju zona sanitarne zaštite i ograničenjima u tim zonama za Morinjska izvorišta „Svrčak", „Palić", „Donja voda", „Zminac" i „Vrba"*" (NIK STONE d.o.o. Nikšić, 2015), is situated inside the III sanitary protection zone. In the part of the Elaborate, it is cited:

"...provisions of an Article 21 of the regulation on determinations and limitations in the sanitary protection zones (*Pravilnik o određivanju i održavanju zona i pojaseva sanitarne zaštite izvorišta i ograničenjima u tim zonama,* „Službeni list Crne Gore", No. 66/09 from 2 October 2009), are in collision with the provisions of an Article 5 of the regulation on detailed site characteristics, constraction conditions etc. for landfills (*Pravilnik o bližim karakteristikama lokacije, uslovima izgradnje, sanitarno-tehničkim uslovima, načinu rada i zatvaranja deponija za otpad, stručnoj spremi, kvalifikacijama rukovodioca deponije i vrstama otpada i uslovima za prihvatanje otpada na deponiji,* „Službeni list Crne Gore", No. 84/09 from 22 December 2009 and 46/11 from 16 September 2011).

Hence, an Article 5 of the regulation - *Pravilnik o bližim karakteristikama lokacije, uslovima izgradnje, sanitarno-tehničkim uslovima, načinu rada i zatvaranja deponija za otpad, stručnoj spremi, kvalifikacijama rukovodioca deponije i vrstama otpada i uslovima za prihvatanje otpada na deponiji,* „Službeni list Crne Gore", No. 84/09 from 22 December 2009 and 46/11 from 16 September 2011) stipulates the ban on siting the sanitary landfill inside the sanitary protection zones - I, II or III category.

Due to the fact that the regulation - *Pravilnik o određivanju i održavanju zona i pojaseva sanitarne zaštite izvorišta i ograničenjima u tim zonama* („Službeni list Crne Gore",No. 66/09 from 2 October 2009), is older than the *Pravilnik o bližim karakteristikama lokacije, uslovima izgradnje, sanitarno-tehničkim uslovima, načinu rada i zatvaranja deponija za otpad, stručnoj spremi, kvalifikacijama rukovodioca deponije i vrstama otpada i uslovima za prihvatanje otpada na deponiji* („Službeni list Crne Gore",No. 84/09 from 22 December 2009 and 46/11 from 16 September 2011), the developer of the Elaborate is obliged to follow the newer regulation, because both are of the same legal force. Therefore, it is prohibited to dispose waste even on the sanitary landfill, in the III sanitary protection zone."

The temporary watercourse of Veliki potok is nearest to the site and it is about 1,100 m S of the site.

The basic climatic characteristics of the site area consist of mixing of the coastal and mountainous climate impact, i.e. a large quantity of precipitations and prolonged snow cover (on the slopes of Orjen in some years it can last six or more months). The seasonal precipitation regime is very different and the average precipitation quantity is distributed unevenly. According to the data from the rain gauge station on Crkvice, 5,000 mm/year of precipitation was measured, which ranks this region the first in Europe in terms of precipitation. The average multi-annual sums of precipitation at the rain gauge stations Vrbanj and Jelovi is over 4,000 mm, and in the area of Herceg Novi a little less than 2000 mm. The temperature regime is directly linked to the proximity of the sea and the altitude. Depending on the distribution of air pressure, which is lower during the summer and much higher in the winter, there are several types of winds in this area. The annual characteristic is the occurrence of a large percentage of calm periods (41%). The most common annual directions are E, SE, NW, which are represented with 10 - 12%, while the incidence of other directions is much lower, around 5%.

The Tivat station for measuring air quality is closest to the observed location (distance of about 11 km airway). At the Tivat station, during 2013 only the $PM_{2.5}$ particle concentration was measured. Valid measurement of particles $PM_{2.5}$ in 2013 at the site were conducted over 351 days. The mean value on an annual basis was below the prescribed limit value but it exceeded the lower evaluation limit for protection of public health.

It can be seen from the pedological map of Montenegro, that the broader site area is mostly covered with shallow woodland brownised rendzina (depth to 15 cm). At the very bottom of the sinkhole, the

depth of the rendzina is significantly higher (up to about 5 meters) than in the walls of the sinkhole. The soil of the sinkhole is characterized by the presence of skeletons; it is a very permeable soil. On the sides of the sinkhole, the soil is subject to erosion. According to the erosion map, the site lays on a terrain of moderate erosion. Rendzina represents a type of dark fertile soil that is usually formed on loose carbonate substrate. Rendzina contains humus horizon of predominantly black colour which gradually turns into wasteful surface. The physiologically active layer and the possibility of rooting plants with rendzina are considerably deeper as opposed to the usual humus present over the compact carbonate rocks (Fuštić 2005). The land at the bottom of the sinkhole Duboki Do is arable and has good production values. It is most suitable for growing potatoes, but also for other agricultural crops.

The land of the bottom of the sinkhole Duboki Do is characterized by a significant presence of skeletons represented by calcareous talus. It is a very permeable soil. On the sides of the sinkhole, the soil is subject to erosion. The quality of land at the site of the designed sanitary landfill so far has not been studied.

The wider area of the site is characterized by karst cliffs which sharply divide the coastal from the central part of Montenegro. The lower, eumediterranean belt of Orjen is characterized by Mediterranean macchia vegetation, bushes and rocks. This evergreen belt is connected to deciduous forest hornbeam (*Carpinus orientalis*) and thermophilic oaks (*Pubescens* and *Quercus ilex*). At higher altitudes, there are communities of hornbeam (*Ostrya carpinifolia*), black ash (*Fraxinus ornus*), and bear hazel (*Corylus colurna*). The site Duboki Do is predominantly characterized by beech community (*Fagus moesiaca*).

In relation to the biocorridors, the project site is located next to the biocorridor of coastal mountains Orjen-Lovćen-Rumija. The Orjen area, in addition to being nominated for protection as a national park, represents a center of biodiversity for mammals as well as for amphibians and reptiles. The site is located at a distance of about 1 km east of the area of the proposed ecological network (Orjen) and along the part of the western border of UNESCO protected area, Bay of Kotor – Risan.

According to the division in ambiental zones defined in the PP MNE (2008), the site is located in the zone of coastal mountains, which in the wider area borders with the coastal zone, the subalpine and alpine mountains. Its main characteristic is the mountainous karst relief and the rare vegetation. In larger sinkholes i.e. valleys there are less arable surfaces to which only rare objects are connected. The surfaces are terraced and enclosed by the application of the dry-wall method. In some places macadam roads can be noticed, which are also the only spatial communication. Steeper parts are completely covered with a mosaic of rocks and vegetation. The dynamics of the landscape is high, resulting in a relatively high visual quality while the viewing area varies from high to low, depending on the situation on the ground. Taking into consideration the level of natural, anthropogenic interference and its structure, the landscape and the wider project area can be assessed as of moderate to high value. The site in question is located in a relief depression i.e. sinkhole and is not visually exposed to views from the surrounding region.

In the vicinity of the planned project there are no elements of tangible and intangible heritage. The nearest recognized archaeological site - graves is in the village of Žlijebi, located about 2.5 km southwest of the project site.

The site is located in the eastern part of the municipality of Herceg Novi, near the border with the municipality of Kotor. The population density in the municipality is 132.75 inhabitants /km^2, but the site is outside the urban area, in the unpopulated mountain area of Orjen. The nearest populated place is Bunovići about 1600 m away and Vukasović is about 2300 m away. The first nearest occasionally populated place is Šćepan at a distance of about 800 m.

The land of the bottom of the sinkhole Duboki Do is arable and has good production values. According to the map of forest areas of the National Plan of Montenegro until 2020, the wider area of the proposed site is located in economic forest which is not overgrown - the nearest forest areas are located about 1 km to the west and north of the site. The site is located in the area of the hunting site "Orjen", the boundaries of which overlap (are identical) with the boundaries of the Municipality of Herceg Novi. It is a typical mountain hunting site, with area of 23,324 ha. The site is outside the existing and planned tourism purposes.

The location of the landfill Duboki Do is reached by road from the route that goes to Crkvice (which separates from the road Kameno - Ubli, and it is an old paved road that leads to Crkvice).

4. EXISTING ENVIRONMENTAL PROBLEMS IN CONNECTION WITH THE PLAN, PARTICULARLY THOSE RELATED TO AREAS WHICH ARE OF PARTICULAR SIGNIFICANCE FOR THE ENVIRONMENT

Existing illegal dumpsites

In most towns of Montenegro, municipal waste is disposed of at town landfills, but there is also a big number of dumpsites (*source: Strategy of eco-remediation in Montenegro and Action Plan for 2014-2020, MSDT, 2014*.), which are sources of environmental pollution. Particularly hazardous are leachate waters from landfills, contaminated with high concentrations of different types of pollutants (heavy metals, organic pollutants, etc.), and which, when passing through the soil, pollute both groundwater and surface waters. Previously disposed various kinds of waste (including medical and infectious waste), which were often incinerated or are still incinerated at the landfills represent additional threat to the living environment. According to the information from the municipality areas (*source: MSDT, 2015.*), on the territory of the country there are 155 dumpsites with volume <100 m^3, 68 with capacity of 100-1000 m^3 and 50 with capacity > 1000 m^3. According to the data of the Environmental Movement "OZON" (List of dumpsites by municipalities, 2015), at least 158 dumpsites were identified (Table 4-1). The list for the area of the Municipality of Rožaje states that there are "*Over 100 dumpsites - (From the Information on the environmental situation in Montenegro, Agency for Environmental Protection),"* while for the area of the Municipality of Ulcinj it is stated that there are such dumpsites "*in the immediate vicinity to all beaches."* According to the Report on the Implementation of the National Waste Management Plan in 2013 (MSDT, 2014), of the total amount of waste generated on an annual basis, about 30% of waste ends up in unregulated dumpsites, and about 30% in illegal dumpsites. Article 78 of the Waste Management Act provides for the possibility that local governments, which do not have a landfill built in accordance with the law, temporarily store the municipal waste (for a period of one year from the date of receipt of the waste) on locations especially arranged for such purposes. In accordance with this provision, some 4,998 tons of waste has been temporarily stored.

As a result, it is a priority to find economically feasible solutions and to start with adequate waste disposal as well as with simultaneous closing down of inadequate landfills.

Table 4-1. Locations of illegal dumpsites by municipalities

Municipality		Location name	Type of waste	Landfill capacity (m^3)	Geographic coordinates
ANDRIJEVICA					
	1.	Glavica Rive	Municipal	1,000	
	2.	Prla	Wood waste - sawdust	2,000	
	3.	**Sućeska** (Town landfill)	Mixed municipal waste	3,000	
	4.	Dungyard	Wood waste - sawdust	5,000	
	5.	Bojoviće		1,000	
BAR					
	1.	Ćafe	Mixed municipal, electrical waste	>1000	
	2.	Sutomore, Rutke	Different types of waste		
	3.	Good water	Different types of waste		
	4.	Utjeha	Different types of waste		
BERANE					
	1.	Luge, near the hotel "Berane"	Construction waste	30	
	2.	Location "Vodenica" in Luge	Wood waste	10	
	3.	Martić Milovan's private property		>500	
	4.	Donja Rženica, in immediate vicinity of the village cemetery	Wood and utilities	>200	
	5.	Donja Rženica, Dević Vesko's sawmill	Wood waste	>500	

	6.	Location "Pobljenici", in immediate vicinity of the asphalt base	Municipal, wood and construction waste	>2000	
	7.	Donja Rženica, Čukića bridge	Wood waste	30	
	8.	Location in immediate vicinity of Radomir Anđić's sawmill	Wood waste	300	
	9.	Location "Rančˇ", in the immediate vicinity of the former brick factory	Municipal waste	20	
	10.	Location of the "Vodice", "Ciciban" and "Zekina Glavica" in the village Dapsiće	Municipal waste	20	
	11.	Location bridge on the Brnjica River, waste along the riverbed	Municipal waste	100	
	12.	Dapsićka river	Different types of waste	200	
	13.	Location "Stjenice"	Municipal waste	200	
	14.	Location "Laza Adrović"	Municipal waste	100	
	15.	Location "Klisura", on the road Berane-Crni vrh	Municipal waste	200	
	16.	Location "Lubnice"	Municipal waste	100	
	17.	Location "Pilana Praščevića"	Wood waste	1.300.	
	18.	Location "Vinicka", towards the Lim River	Municipal waste	100	
	19.	**Location "Vasove vode" (The former town dump)**	Mixed municipal, electrical, medical, animal	> 55,000	
BIJELO POLJE					
	1.	Kumanica	Utilities, except bulky waste	about 6,600 t/ year	
			Waste from companies and institutions - except industrial	about 2,200 t/ year	
			Industrial waste	550 t/ year	
			Waste from public areas	1,100 t/ year	
BUDVA					
	1.	Krusevice, the cottage "Old school", on the road Petrovac-Podgorica	Ground and rock	1,500	
	2.	Blizikuće - Sveti Stefan, on the road Sveti Stefan and Petrovac	Land and rock	2,500	
	3.	Above the village Mažići, on the road Budva-Markovići	Land and rock	2,500	
CETINJE					
	1.	Old road Cetinje - Rijeka Crnojevića, 7 km, location near pines (Dobrsko village)	Construction material - rubble, bags with household waste (plastic containers, cans, etc.), waste of animal origin	100	
	2.	Travel direction Cetinje - Ljubotinj, distance 15 km, mountain location "Obod"	Construction material - rubble, bags with household waste (plastic containers, cans, etc.), waste of animal origin	100	
	3.	Travel direction Cetinje - Čeklići, distance 15 km, location "Starac"	Construction material - rubble, bags with household waste (plastic containers, cans, etc.), waste of animal origin	100	
	4.	Travel direction Cetinje - Njeguši, distance 21 km, location "Erakovići"	Construction material - rubble, bags with household waste (plastic containers, cans, etc.), waste of animal origin	100	
	5.	Travel direction Cetinje - Njeguši, distance 23 km, location "Krstac"	Construction material - rubble, bags with household waste (plastic containers, cans, etc.), waste of animal origin	100	
	6.	**Vrteljka, town landfill**	Different types of waste	1.000	
	7.	Ševrlja	Construction, Mixed municipal	100	
DANILOVGRAD					
	1.	Lazine	Construction waste	1,500	

	2.	Klikovače, on the stretch of 500 m on the left side of the non-categorized road Stologlav - Klikovače -main road	Construction waste mixed with municipal waste	150	
	3.	Pažići, from the upper side of the railway line (facing AD "Mermer", at the base of Taraš)	Construction waste	200	
	4.	Lalevići, on the stretch of 100 m on the left and right side of the local road	Construction waste mixed with municipal waste	150	
	5.	Luke, on the 5th km of the road Martinići-Gostilje	Construction waste mixed with municipal waste	60	
	6.	The head of Zeta	Waste vehicles, scrap iron and other metals	<100	
GUSINJE					
	1.	Lugovi (Gusinje-Grnčar)	Wood waste	25,000	
HERCEG NOVI					
	1.	Igalo - Village Žvinje	Mixed municipal waste and construction waste	>1.500	
	2.	Igalo - Sutorina river	Mixed municipal waste and construction waste	>150.000	
	3.	Igalo, communication Njivice-Žvinje	Mixed municipal waste and construction waste	700	
	4.	Igalo, Igalo communication - village Mojdež	Mixed municipal waste and construction waste	1,000	
	5.	Travel direction Meljine Kameno	Mixed municipal waste and construction waste	500	
	6.	The old road Podi - Kameno above the quarries	Mixed municipal waste and construction waste	700	
	7.	Road Kameno - village Ubli at the motel Borići	Mixed municipal waste and construction waste	200	
	8.	Location Dizdarica, towards the village Ubli more locations	Mixed municipal waste and construction waste	800	
	9.	Local road village Kruševice - village Vrbanj, 3 locations	Mixed municipal waste and construction waste	200	
	10.	village Kruševice, /private land/	Metal waste	100	
	11.	Herceg Novi, Manastirska St. /private land/	Mixed municipal waste and construction waste	300	
	12.	Herceg Novi /Savina/ along the town cemetery	Mixed municipal waste and construction waste	100	
	13.	Kumbor /private land/	construction waste	500	
	14.	Baošići /private land/	construction waste	1,000	
KOTOR					
	1.	Regional road Kotor - Njeguši, Beneath the bridge, located between the 10th and 11th curve, on the left and on the right side	Various types of municipal waste	>150	
	2.	Regional road Kotor - Njeguši, before the 10th curve		50	
	3.	Local road to Mirac, 3rd curve from the turning from the regional road Kotor - Njeguši to Mirac	Mixed municipal,	150	
	4.	Local path to Mirac, around the fortress at Goražd - Mirac	Mixed municipal,	50	
	5.	Local road to Vrmac, the first sharp curve to Vrmac	Land with stone	100	
	6.	Troica, 3rd curve on the old road Kotor - Troica			
	7.	Economic Zone, "Stara deponija" (Eng. The old landfill) of the public utility company		>3.000	

		Kotor the reconstruction of which is in progress			
	8.	Economic Zone, "Nova deponija" (Cro. New landfill) rubble and bulky waste of the public utility company			
	9.	Gornji (Upper) and Donji (Lower) Grbalj, under the bridge in Nalježići	Mixed municipal,	50	
	10.	Gornji i Donji Grbalj, Crossroad for the spring Grbalj - Pobrđe	Mixed municipal,	50	
	11.	Gornji i Donji Grbalj, under Majdan - Pobrđe	Mixed municipal, scrap metal	50	
	12.	Main road Lipci - Knež Laz	Fine sand	100	
	13.	Main road Lipci - Knež Laz to the right of the main road Lipci - Knež Laz, and opposite the local road Poljica	Mixed municipal waste, construction	100	
	14.	Main road Lipci - Knež Laz Metkova voda I	Mixed municipal waste, construction	100	
	15.	Main road Lipci - Knež Laz Metkova voda II	Mixed municipal waste	<1.000	
	16.	The old road Risan - Nikšić, quarry at Peliničkog bridge	Waste tires	<1.000	
	17.	The old road Risan - Nikšić, Smokovac	Rubble, dirt with stone	50	
	18.	The old road Risan - Nikšić, the first curve above Smokovac	Different types of waste	100	
	19.	The old road Risan - Nikšić, after the largest landfill on Smokovac followed by two smaller	Different types of waste	20	
	20.	The old road Risan - Nikšić, at the former monument Lazović, right curve	Construction, Mixed municipal	100	
KOLAŠIN					
	1.	Landfill in the place Bakovići	Municipal waste	2,500	
	2.	Yellow rocks, settlement Crkvine, along the local road to the ski center "Jezerine"	Municipal waste	Landfill of smaller volume	
	3.	Settlement Lipovo,	Municipal waste	Landfill of smaller volume	
	4.	Industrial zone Bakovići,	Municipal waste	Landfill of smaller volume	
	5.	Along the local road Mateševo - Jabuka,	Municipal waste	Landfill of smaller volume	
	6.	Settlement Drijenak	Municipal waste	Landfill of smaller volume	
MOJKOVAC					
	1.	Zakršnica (Local Community Podbišće)	Mixed municipal waste	32,000	
	2.	Settlement Ravni	Mixed municipal waste	20	
	3.	Babića Polje 1	Mixed municipal waste	10	
	4.	Babića Polje 2	Mixed municipal waste	10	
	5.	Fields near the watermill	Mixed municipal waste	15	
	6.	Fields near the cemetery	Mixed municipal waste	10	
	7.	Podbišće - next to the school	Mixed municipal waste	15	
	8.	Podbišće - Donje selo	Mixed municipal waste	10	
NIKŠIĆ					
	1.	Mislov Do, Budoš, the town landfill	Mixed municipal waste, animal, slaughter waste,		
	2.	Along the riverbed of Gračanica, 2	Construction, Mixed municipal	>3.000	

		km from the town core			
	3.	Kapino field, 4 km from the town core, across the road from "Tehnobaza", on the main road to Trebinje	Construction, Mixed municipal	>1.500	
	4.	Settlement Rubeža, on the right side of Gračanica riverbed, so-called Halda, 3 km from the steel mills of Nikšić	Coal ash, slag, scrap metal, sludge from the waste water treatment plant, bag filters dust, casting sand, components that contain PCBs, materials containing asbestos	Area 12 ha, depth 30 m	
	5.	The bed of the river Bistrica, at Gordin bridge, behind the brewery, Trebjesa "	Construction, mixed municipal, electrical waste, waste tires, animal		
	6.	Home of the Revolution, the town center, opposite the Municipality of Nikšić	Mixed municipal, medical		
	7.	The old fortress Bedem	Mixed municipal,		
	8.	Brlja, near NECKOM	Construction waste and, electrical waste, solid municipal waste		
	10.	The road Nikšić-Risan, more locations immediately by the road	Construction waste and, electrical waste, solid municipal waste		
PODGORICA					
	1.	Konik, Husinskih rudara Street, forest park	Construction, Mixed municipal	>5.000	
	2.	Konik, Spanish soldiers St., the space between the landfills	Construction, mixed municipal	>2.000	
	3.	The old airport, between Radovan Zogović St. and Cvijetna St.	Construction, mixed municipal	>3.000	
	4.	Main road Podgorica - Danilovgrad, near the turn for Marez	Construction, mixed municipal, animal	>5.000	
	5.	Čemovsko field	Construction, mixed municipal, animal	>2.000	
	6.	GO Golubovci Ljajkovići, locality Tamnik	Construction, mixed municipal, electrical waste, waste tires, animal		
	7.	GO Golubovci On the bank of Morača, local road Ljajkovići-Botun	Construction waste and rubble, electrical waste, garden waste, solid municipal waste	>200	
	8.	GO Golubovci The settlement Mitrovići, estuary of the river Cijevna into the river Morača	Construction waste and rubble, electrical waste, garden waste, solid municipal waste	>1.100	
	9.	GO Golubovci Location on the left side of the road direction Cijevna-Rakić House	Construction waste and rubble, electrical waste, garden waste, solid municipal waste	>500	
	10.	GO Golubovci settlement Golubovci, place Daljevac	Construction waste and rubble, garden waste, glass, solid waste, waste plastic, waste tires, bulky waste	>2.000	
	11.	GO Golubovci The settlement Balabani, Mamulja	Construction waste and rubble, solid municipal waste, garden waste, bulky waste	>200	
	12.	GO Golubovci Korovića mulberry	Construction waste and rubble, solid municipal waste, garden waste, bulky waste	>250	
	13.	GO Golubovci The settlement Mataguži, location in the place Stari (Old) Viganj	Construction waste and rubble, solid municipal waste	>500	
	14.	GO Golubovci The settlement Vukovci - next to the Vukovački bridge on the river Morača	Construction waste and rubble, solid municipal waste	>1.200	
	15.	GO Tuzi	Earthworks excavations, rubble,	>1.100	

		The settlement Šipčanik, near the vineyards	municipal waste, branches - homogenized		
	16.	GO Tuzi The settlement Šipčanik, near the old well	Rubble, earthworks excavations, municipal waste	>250	
	17.	GO Tuzi The settlement Elezovići, near the vineyards	Rubble, municipal waste, part of the waste is overgrown with plants	>750	
	18.	GO Tuzi Road Tuz and- Dinoši, near the bridge	Earthworks excavations, rubble, municipal waste, branches - homogenized	>3.000	
	19.	GO Tuzi Road Tuz and- Dinoši, in front of private houses	Earthworks excavations and rubble, a large amount of brick	>500	
	20.	GO Tuzi Road Tuz and- Dinoši, across the car service	Earthworks excavations and rubble (in length of about 200m)	>500	
	21.	GO Tuzi The settlement Sukuruć, at the pump station	Rubble, municipal waste, earthworks excavations, some garden waste	>100	
PLAV					
	1.	Vusanje (Vusanski creek)	Municipal waste	150	
	2.	Martinoviće (creek)	Municipal waste	150	
	3.	Kruševo (creek)	Municipal waste	200	
	4.	Pepić (creek)	Municipal waste	100	
	5.	Rženica (stream)	Municipal waste	100	
	6.	Dolja (river)	Municipal waste	100	
	7.	Plav (Komarača)	Wood waste	40,000	
	8.	Brezojevice (old town landfill)	Wood waste	10,000	
PLUŽINE					
	1.	Donja Brezna	Solid waste wood, sawdust	700 m^3 5.000m^2	
PETNICA					
	1.	Location "Duljkova stanica", on the route Polica-Petnjica	Municipal waste	150	
PLJEVLJA					
	1.	Gotovuša	Different types of waste	> 1.000	
	2.	Dajević Han	Different types of waste	> 1.000	
	3.	Židovići	Different types of waste	> 1.000	
	4.	Komini	Different types of waste	> 1.000	
	5.	Vodice	Different types of waste	> 1.000	
	6.	Odžak	Different types of waste	> 1.000	
	7.	In the town area, next to the Jugopetrol gas station	Different types of waste	> 1.000	
	8.	The settlement Gradac, by the regional road Gradac - Šula	Different types of waste	> 1.000	
	9.	Factory for wood processing "Vektra"	Wood waste	> 100.000	
ROŽAJE					
	1.	Town landfill Besnik	Different types of waste		
	2.	The bed of the river Ibar	Different types of waste		
	3.	Lovnička	Different types of waste		
	4.	Ibarčanska	Different types of waste		
	5.	Županica	Different types of waste		
	...	Over 100 dumpsites - (From the Information on the environmental situation in Montenegro, Agency for Environmental Protection)	Different types of waste	From 2 to over 100	
ŠAVNIK					
	1.	The town landfill at the entrance to Šavnik, on the right side, the area of the former quarry	Municipal solid waste, medical waste, packaging waste, waste vehicles, construction waste and agricultural waste	1.000	
TIVAT					

	1.	Sinjarevo (aka Lovanja 1), in its larger part this site includes the territory of the municipality of Kotor, the dumpsite for the municipalities of Tivat, Kotor and Budva	Different types of waste	Several thousands	
	2.	Grabovac, the former town landfill, closed in 2001, the reconstruction project is done, but needs to be revised	Different types of waste	Several thousands	
	3.	The settlement Gornji Đurašević	Different types of waste	150	
	4.	The road along the route of the pipeline Topliš - Radovići	Different types of waste	100	
ULCINJ					
	1.	The old landfill and its greening (on the 4th kilometer long, on the right side of the road Ulcinj-Bar)	Municipal waste, rubble	about 24 m^3 of municipal waste - about 60 m3 of rubble	
	...	In the immediate vicinity of all beaches	Municipal waste,		
ŽABLJAK					
	1.	Town dump, Klještina	Different types of waste	53,000	
	2.	Njegovuđa	Different types of waste	80,000	

Source: "List of dumpsites by municipalities" (Ecological movement "OZON", 2015)

5. ENVIRONMENTAL OBJECTIVES ESTABLISHED AT THE NATIONAL OR INTERNATIONAL LEVEL THAT ARE IMPORTANT FOR THE PLAN AND THE MANNER IN WHICH THESE OBJECTIVES, AND ALL OTHER ASPECTS RELEVANT FOR THE ENVIRONMENT, WERE TAKEN INTO CONSIDERATION DURING THE PREPARATION PROCESS

5.1. Environmental objectives established upon the conclusion of international treaties and agreements, which are important for the Plan

The text below (Table **5-**1) defines the environmental objectives established upon the conclusion of international treaties and agreements, which are relevant for the plan. The following documents have been analysed:

- United Nations Framework Convention on Climate Change (UNFCCC)
- Convention on Long Range Trans-boundary Air Pollution (CLRTAP)
- Assessment of technological needs for climate change mitigation and adaptation for Montenegro - A national strategy with an action plan (MSDT, 2012)
- Second National Communication of Montenegro on climate change
- The EU Directive on industrial emissions (Directive 2010/75 / EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
- EU Water Framework Directive 2000/60 / EC-WFD
- Strategy for eco-remediation in Montenegro and Action Plan for the period 2014-2020
- Directive of the European Parliament and of the Council on establishing a framework for the protection of soil and amending Directive 2004/35 / EC
- Action plan to combat land degradation and to mitigate the effects of drought in Montenegro, Podgorica, December 2014
- EU Birds Directive 79/409/EEC
- The EU Habitats Directive 92/43/EEC
- The Convention on Conservation of European Wildlife and Fauna and Natural Habitats (Bern Convention)
- The Convention on Biological Diversity
- The Ramsar Convention on Wetlands
- The European Convention on landscape
- Convention on the Protection of World Cultural Heritage
- National Biodiversity Strategy and Action Plan for the period 2010-2015; The National Strategy for Sustainable Development of Montenegro (2007)
- Report on the Millennium Development Targets 2010 - 2013
- EU Sustainable Development Strategy (Sustainable Development Strategy, 2006)
- The new European policy for health - Health 2020
- The National Strategy for Sustainable Development of Montenegro.

Table 5-1. Environmental objectives

Environmental aspects	Environmental objective	Compliance with relevant documents
Air quality	• Prevent the deterioration of air quality due to particulate emissions (PM), landfill gas (carbon dioxide (CO_2), methane (CH_4)) and odours (hydrogen sulfide (H_2S), ammonia (NH_3), mercaptans, gaseous lower hydrocarbons, etc.) • Prevent the deterioration of air quality due to excessive pollutant emissions from power plants (PM, SO_2, NO_x, HCl, HF, ...)	Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control); The National Strategy for Air Quality Management with Action Plan for the period 2013-2016 Convention on Long Range Trans-boundary Air Pollution (CLRTAP)
Climate factors	• Reduce greenhouse gas emissions from landfills (carbon dioxide (CO_2), methane (CH_4)) • Prevent cross-border transport of air pollution • Protect buildings and facilities against flooding and extreme precipitation	United Nations Framework Convention on Climate Change (UNFCCC); Law on ratification of the Kyoto protocol (Fig. Gazette of the Republic of Montenegro 17/07); Convention on Long Range Trans-boundary Air Pollution (CLRTAP) Assessment of technological needs for climate change mitigation and adaptation for Montenegro - A national strategy with an action plan (MORT, 2012); Second National Communication of Montenegro on climate change
Water	• To improve the ecological and chemical status of surface water bodies and groundwater chemical status • Reduce the concentration of PA5/COD, ammonia, suspended solids and heavy metals in leachate waters	EU Water Framework Directive 2000/60/EC-WFD; Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020; Second National Communication of Montenegro on climate change
Soil	• Reduce emissions and particles in the soil • Protect high quality agricultural land • Protect and ensure the free area for livestock purposes • Prevent soil erosion	Directive of the European Parliament and of the Council on establishing a framework for the protection of soil and amending Directive 2004/35/EC; Action plan to combat land degradation and to mitigate the effects of drought in Montenegro, Podgorica, December 2014; Strategy for eco-remediation in Montenegro and Action Plan for the period 2014-2020

Environmental aspects	Environmental objective	Compliance with relevant documents
Biological and landscape diversity, protected areas	• Reduce the direct pressures on forest and freshwater habitats as well as habitats of dry grasslands and karst and ensure the protection of "hotspots" of biological diversity • Prevent the spread of invasive species • Preserve local values and specific features of the landscape • Enable the planned expansion of protected areas	EU Birds Directive 79/409/EEC; The EU Habitats Directive 92/43/EEC; National Biodiversity Strategy and Action Plan for the period 2010-2015; The National Strategy for Sustainable Development of Montenegro (2007) Berne Convention; Report on the Millennium Development Targets 2010 - 2013
Population, cultural heritage	• Increase employment opportunities for local people • Protect areas of tourist interest • Protect archaeological and architectural heritage	EU Sustainable Development Strategy, 2006; Regional Development Strategy of Montenegro 2010 - 2014; National Strategy for Sustainable Development of Montenegro; Convention on the Protection of World Cultural Heritage
Health	• Reduce the exposure of the population to infectious and respiratory diseases	The new European Health Policy - Health 2020; Health Development Strategy of Montenegro by 2020 (2003)
Traffic	• Increase the possibility of using rail to transport waste	EU Sustainable Development Strategy, 2006; National Strategy for Sustainable Development of Montenegro;
Industry, energetics	• Ensure the use of waste as an energy feedstock	EU Energy Strategy (2020 Energy Strategy); Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control); Health Development Strategy of Montenegro by 2030 (2003)

5.2. The analysis of compliance of the proposed options with environmental objectives

This analysis provides an overall assessment of the proposed options concerning the relevant environmental objectives. The proposed options are planned in order to meet the relevant obligations, but some options may include risks which are summarised and shown in the table below.

Environmental aspects	Environmental objective	Comment
Air quality	• To prevent the deterioration of air with particulate emissions (PM), landfill gases (carbon dioxide (CO_2), methane (CH_4)) and odours (hydrogen sulfide (H_2S), ammonia (NH_3), mercaptans, gaseous lower hydrocarbons, etc.) • To prevent the deterioration of air quality due to excessive pollutant emissions from power plants (PM, SO_2, NO_x, HCl, HF, …)	The reconstruction and renovation of the existing landfill at the site Vasov Do (Berane) will contribute to the improvement of local air quality. At the Budoš location, the operation of the sanitary landfill may have a negative impact on the existing local air quality since the landfill is positioned on a location where the wider area is affected by air pollution from industrial sources and relatively unfavorable meteorological conditions. The sites in the northern region are mainly located in an elevated area which is a better solution than their location in valleys due to the frequent occurrence of temperature inversions which cause poorer ventilation and can thus cause a local reduction of air quality. The operation of the thermal waste treatment plant results in gases which may, to a greater or lesser extent, undermine the existing air quality, while the scope of the area affected by pollution also depends on the current meteorological conditions, particularly on wind direction and strength. During regular operation of the thermal waste treatment plant, using technology based on procedures with best available techniques for incineration of municipal waste (including plant maintenance), with highest level of protection and purification of flue gases, a significant impact on the existing air quality is not expected. Using technology that is not at the level of BAT procedures for heat treatment and which does not include the highest level of protection and purification of flue gases, can result in significant air pollution in the course of the plant's normal operation (i.e. outbursts from the system) and/or maintenance of the plant. The occurrence of accidents can cause significant air pollution in the area, which can, in unfavorable meteorological conditions, expand to a much wider area.
Climate factors	• To reduce greenhouse gas emissions from landfills (carbon dioxide (CO_2), methane (CH_4)) • To prevent cross-border transmission of air pollution • To protect buildings and facilities against flooding and extreme precipitation	The share of waste management is of relatively small importance in terms of contribution to the total GHG emissions. In the total greenhouse gas emissions of Montenegro during the period 1990-2011, the contribution of the WM sector accounted for - depending on the year - between 2 and 7%. Methane emissions from the waste management sector accounted for 17% of total methane emissions, while the greatest potential methane emission comes from agriculture (over 50%). Currently, the waste management sector emits 4Gg methane. In the case of full implementation of sanitary landfills option (regional concept - Initial proposal and Option 1), which includes the use of primary and secondary selection and collection as well as controlled incineration of landfill gas, the annual emissions from the WM sector will be reduced. Assuming that the total quantity of waste over the years is to be increased, it is also assumed that the ratio of methane emissions from the WM sector in total emissions will remain unchanged. Incineration of waste does not produce methane, but it increases the amounts of CO_2 developed as a result of oxidation. Since methane has a much higher GHG potential, the incineration of waste will help reduce the overall contribution of the WM sector to GHG emissions. As part of the proposed activities, only two sub-options in the area of Bijelo Polje (Kumanica location, location Goja) which are located near the border with the Republic of Serbia can have a smaller impact (in terms of odours).

Environmental aspects	Environmental objective	Comment
		Considering the possible flood plains, the most risky area is the area of Berane (location Vasov Do), which was originally proposed and later dismissed from further planning and analysis. Other potentially hazardous location is Duboki Do, located on top of the mountain where weather conditions are very extreme (average multi-annual total precipitation amounts to over 4000 mm), and precipitation amount is expected to increase due to expected changes in the climate conditions. Also, the centralized option (plant for thermal waste treatment in Nikšić) includes location in a potentially flood area hence it is necessary, within this project's development framework, to take into account this aspect as well. All other options of proposed sanitary landfill sites are located in areas that are potentially at risk of flooding.
Water	• To improve the ecological and chemical status of surface water bodies as well as the groundwater chemical status. • To reduce the concentrations of BPK_5/KPK, nutrients, heavy metals and suspended solids in leachate waters	The reconstruction of the landfill at the site Vasov Do will bring improvements in relation to the current state of quality of surface water and groundwater in the landfill area. The framework of sanitary landfills project anticipates usage of technologies for collection and processing precipitation and leachate from the landfill body, which will thus enable prevention of potential contamination of surface and ground waters. All locations of the regional landfills, except for the location Duboki Do which is situated in zone III of sanitary protection of drinking water[53], are located outside sanitary protection zones. In the event of accident at the location Duboki Do, the pollution can very quickly infiltrate in both the groundwater and the surface water and it can also expand and threaten drinking water sources in the area.
Soil	• To reduce emissions and particles in the soil • To protect high quality agricultural land • To protect and ensure the free area for livestock purposes • To prevent soil erosion	The reconstruction and renovation of the existing dumpsites will reduce the possibility of further soil contamination at the site around the landfill which is especially important for the location Vasov Do (Berane), where soil contamination has been detected, emanating from the existing waste disposal activities. Application of technical protection measures in sanitary landfills which, among others, include measures of covering the disposed waste, will prevent the dispersal of particles and coarser types of waste to the countryside and possible soil contamination. Landfills and accompanying facilities are not located on or near locations that are used or planned for some form of agricultural production. In this manner, any possible negative impact on the quality of the soil or on other surfaces for the purpose of plant and livestock breeding will be directly and indirectly prevented. The landfill sites as well as the locations of other facilities for the most part are situated in places with poor distinct erosion, hence no adverse impact on soil erosion is expected.
Biological and landscape diversity,	• To reduce the direct pressures on forest and freshwater habitats as well as habitats of dry grasslands and karst and to ensure	Landfills and other facilities are mostly located on sites that are not relevant to the biodiversity of Montenegro. The sites are not located in protected areas except for the sub-option Čelinska Kosa 2 (Bijelo Polje) which is located within the Emerald Network (valley of the river Lim). The site Duboki Do is located

[53] According to the proposed boundaries of the Protection Zone of Morinje springs (Study on determination and maintenance of sanitary protection zones and restrictions in these zones for Morinjska springs "Svrčak", "Palić", "Donja voda", "Zminac" and "Vrba", NIK STONE d.o.o. Nikšić 2015).

Environmental aspects	Environmental objective	Comment
protected areas	the protection of "hotspots" of biological diversity • To prevent the spread of invasive species • To preserve local values and specific features of the landscape • To enable the planned expansion of protected areas	in the area of karst sinkholes and poses a potential threat to possible karst habitats in its vicinity. The site is also located near the biocorridor of the coastal mountains Orjen-Lovćen-Rumi, the area of the proposed national park and the Emerald Network Orjen as well as immediately along the border of the UNESCO protected area of Kotor - Risan bay. The site Vasov Do is atop an intermittent watercourse and poses a threat to the aquatic habitats. Choosing sites that are not near areas important for biodiversity will prevent the negative impact of invasive plant and animal species on indigenous species. The sites are mostly found in sheltered positions, and thus do not have a significant impact on the landscape characteristics of the area.
Population, cultural heritage	• To increase employment opportunities for local people • To protect areas of tourist interest • To protect archaeological and architectural heritage	The construction of facilities while setting up a waste management system will increase employment opportunities for the population at both local and regional level, which is particularly important in the northern region where a negative trend in the number of inhabitants and the migration extent has been recorded. The sites are outside the areas of existing and/or planned tourist purpose as well as outside areas that are significant for the cultural heritage. Area of extraordinary importance for tourism is the area of the coastal region while the area of the northern region continues to get more and more tourist significance.
Health	• To reduce the exposure of the population to infectious and respiratory diseases	The reconstruction and renovation of the existing landfills will significantly contribute to the protection of the possible spread of infectious and respiratory diseases. The reconstruction of the landfill Vasov Do (Berane) is a priority, in order to prevent further contamination of air, and surface and ground waters. The construction of sanitary landfills and other facilities in accordance with the latest technology, including a high level of protection of human health and the environment, should contribute to a reduction of the possible occurrence of respiratory and infectious diseases associated with waste management activities.
Traffic	• To increase the possibility of using the railway to transport waste • To enhance the road infrastructure	The existing railway line Nikšić - Podgorica will represent also in the future the primary railway network of Montenegro, and the plan is to enhance the quality of the tracks, the quality of the transport services and its overall capacity. The Montenegrin part of the Belgrade - Bar railway route passes through the territory of the northern region, the reconstruction of which is also projected in the physical planning documents. Using the railway, as the cheapest, safest and most environmentally friendly form of transport, to transport municipal waste, would contribute to relieving the burden of main and regional roads. The possibility of using the railway to transport municipal waste in the territory of Montenegro should be considered within the relevant technical and economic studies and other documentation. In order to prevent further environmental burdening as a result of intensified traffic caused by waste transportation, the reconstruction and construction of the necessary road infrastructure (bottlenecks requiring rapid response, the rural area of the northern region) shall be considered as prerequisite for the above mentioned activities.

Environmental aspects	Environmental objective	Comment
Industry, energetics	• To ensure the use of waste as energy feedstock	In the case of construction of thermal waste treatment, the technology of heat treatment will involve the use of waste in order to obtain energy (electricity, heat). The potential sites for this kind of facility will be near major towns (Nikšić, Podgorica).

6. POSSIBLE SIGNIFICANT CONSEQUENCES TO HUMAN HEALTH AND THE ENVIRONMENT

During the strategic environmental assessment procedure, the comments obtained during the workshop with relevant stakeholders, on 15 December 2014, were taken into account as well as the consultation results obtained during the second and third visit of the SEA team, in particular workshops and additional consultations, so the SEA team and MSDT representatives decided to include the following possible impacts and risks into the assessment scope:

- Air (air emissions, inconveniences such as odors, dust and noise, greenhouse gas emissions, possible cross-border impacts)
- Water (risks of pollution of surface water, groundwater pollution, pollution of sea water, flooding)
- Land, soil (change of the existing land use, soil contamination)
- Biodiversity and landscape (loss and fragmentation of the habitat, loss of ecological network area, loss of protected areas, disturbing of protected, rare and threatened species)
- The health of the population (risk of contamination with chemicals, hazardous materials, microorganisms, pollution of drinking water, the cumulative risks to public health)
- Material assets (pressures during the reconstruction or construction of new supporting infrastructure, changes in the value of ownership)
- Cultural heritage (possible damage to archaeological sites and other objects of cultural heritage, other disturbances).

The SEA is first and foremost focused on key decisions with regard to the following four options for waste management system:

- Initial proposal based on the first NWMP draft 2014: This option recommends that 5 waste management regions with 5 sanitary landfills be constructed. It includes the existing landfill in Podgorica, Ulcinj/Bar and the proposed landfills in Berane, Nikšić and Herceg Novi as well as the development of the supporting infrastructure for continuous operation.
- Alternative proposal NWMP - option 1: This option recommends that 5 waste management regions with 5 sanitary landfills be constructed. It includes the existing landfill in Podgorica, Ulcinj/Bar and the proposed landfill in Bijelo Polje, Nikšić and Herceg Novi as well as the development of the supporting infrastructure for continuous operation.
- Alternative proposal NWMP - option 2: The option recommends the formation of 3 regions for waste management with 3 sanitary landfills -it includes the two existing landfills in Podgorica, Lucan/Baru and a proposed landfill in Bijelo Polje for the area of the Northern region. It also includes the necessary investments in the supporting infrastructure for the operation of the system.
- Alternative proposal NWMP - option 3: This option recommends 1 waste management region which would cover the entire country and it would also include a thermal waste treatment plant (waste-to-energy plant), which would most likely be located in Nikšić. The proposal includes the necessary investments in the supporting infrastructure that will be needed for the operation of the system throughout the country.

The assessment of the mentioned options included a review of existing information on the environment (national and municipal physical development plans, state of environment reports, thematic studies and primary data provided by the relevant bodies), a review of specific characteristics of proposed locations for the waste management facilities, a compilation of relevant maps and spatial data in the GIS and assessment of possible risks and impacts of proposed planning options based on expert evaluation.

The text below provides general comments regarding the suitability of individual locations for the proposed facilities for the waste management system.

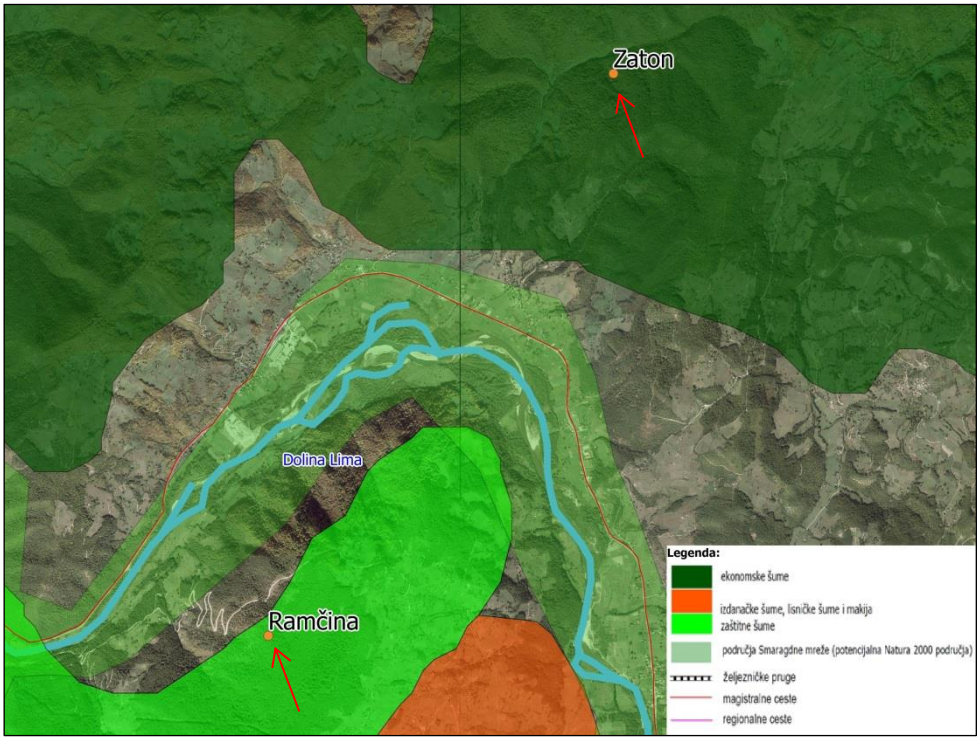
In section 6.5. detailed comments are given on the potential environmental effects of the proposed facilities of waste management.

6.1. MUNICIPALITY OF BIJELO POLJE

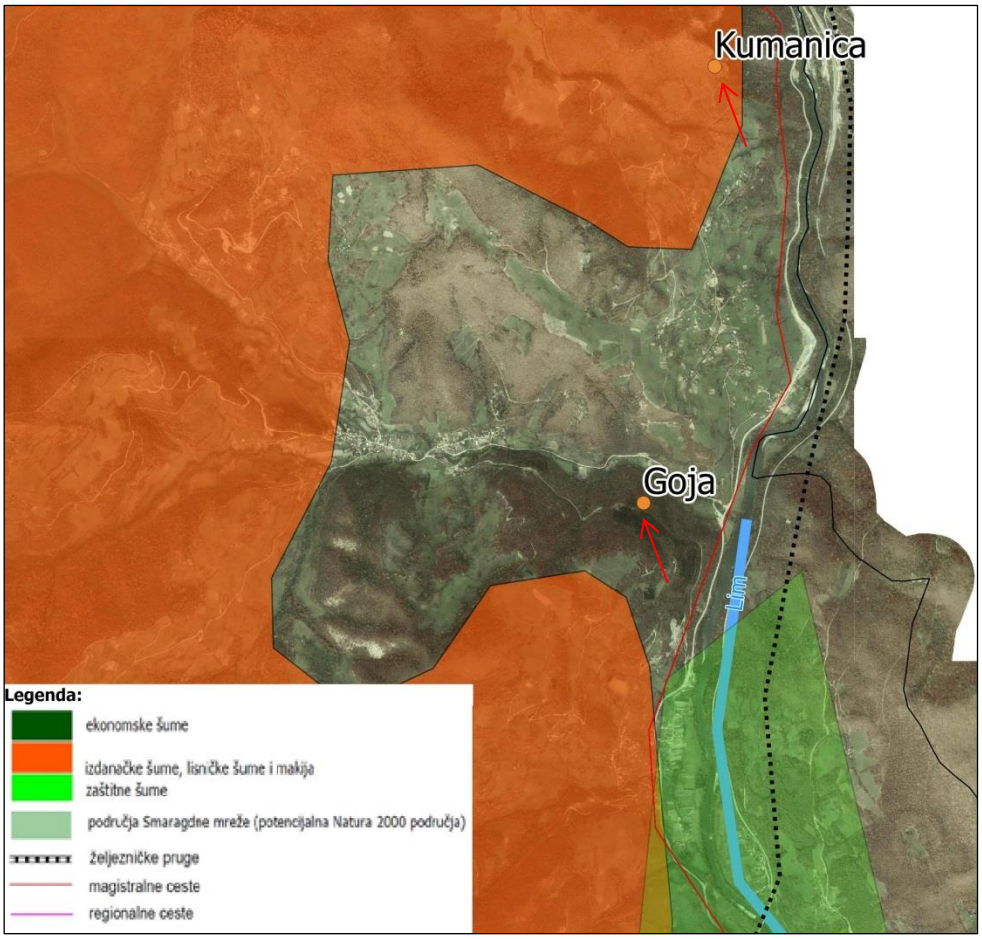
After the location Čelinska Kosa 1 in the municipality of Bijelo Polje was rejected by the Municipality as unsuitable for the environment, physical planning documents proposed 5 new locations to be considered. The study analyzed all six locations (graphic 6.1-1a-c), proposed as locations for the sanitary landfill. After analyzing the potential impacts/risks for each of the proposed locations (Table 6-1), locations are ranked according to the advantages:

1. Ramčina
2. Zaton
3. Goja
4. Kumanica
5. Čelinska Kosa 2
6. Čelinska Kosa 1.

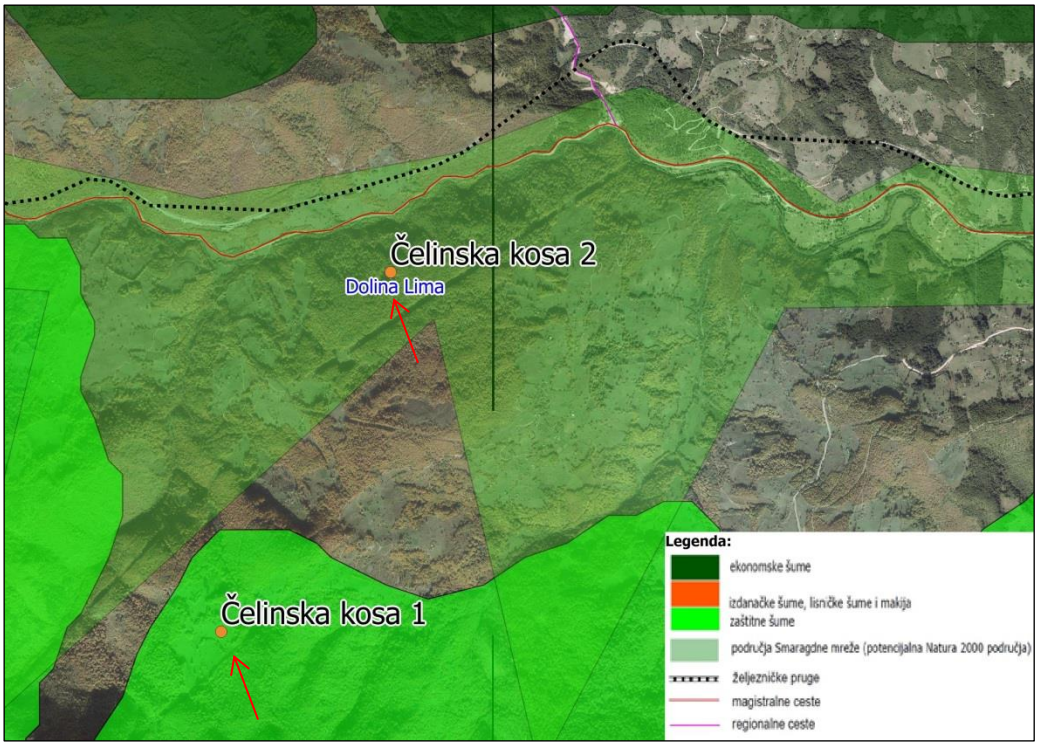
The best locations according to the analyzed relevant criteria (environmental aspects, micro-location conditions), were Ramčina and Zaton. Location Čelinska Kosa 1 is located on the river and is considered to be unfavourable, and location Čelinska Kosa 2 is located within the area of the ecological network, and is also considered unfavorable. Locations Čelinska Kosa 2, Kumanica and Goja are not favorable in terms of landscape, because they are visible from the nearby roads. The advantage of the location Ramčina compared to the location of Zaton has a better connection with the regional road. Also, for better transport connection the location Goja is more favorable than the location Kumanica. Location Čelinska Kosa 2 is located near the regional and the main road, while the location Čelinska Kosa 1 is on the area more difficult to access.



Graphic 6.1-1a Locations Ramčina and Zaton



Graphic 6.1-1b Locations Goja and Kumanica



Graphic 6.1-1c locations Čelinska Kosa 1 and Čelinska Kosa 2

Table 6-1. The characteristics of the effects and risks associated with a potential sanitary landfill in the municipality of Bijelo Polje (North Region)

Impacts / Risks	Sanitary landfill - Bijelo Polje						Clarifications and recommendations (e.g. The best option, mitigation measures)
	Čelinska Kosa 1	Čelinska Kosa 2	Kumanica	Zaton	Ramčina	Goja	
Air	-						In terms of air quality, the municipality of Bijelo Polje belongs to the northern critical zone which is generally assessed as being absolutely in need of the improvement of air quality. The sites are located on the hills which is considered as an advantage due to the microclimate conditions (temperature inversion phenomena), more suitable than in the valleys. Potential locations are located outside the zone of influence of industry and trade.
Climate factors	-						The convenience of the location for the planned landfill cannot be considered because there is no difference in terms of amount of generated landfill gas.
Water	Location on intermittent watercourse	-	The proximity of watercourses	-	-	The proximity of watercourses	In terms of protection of surface waters, most favorable locations are Čelinska Kosa 2, Zaton and Ramčina because they are furthest from watercourses. The location Čelinska Kosa 1 is located on the occasional watercourse and is considered unfavorable.
Land, soil	The frequent occurrence	The frequent occurrence	Arable area	-	Arable area	Arable area	All locations are dominated by very similar soil characteristics with the brown soil type.

Impacts / Risks	Sanitary landfill - Bijelo Polje						Clarifications and recommendations (e.g. The best option, mitigation measures)
	Čelinska Kosa 1	Čelinska Kosa 2	Kumanica	Zaton	Ramčina	Goja	
	of erosion and landslides	of erosion and landslides					
Biological and landscape diversity, protected areas	Close to biocorridor of southeast Dinarides, proximity to the Emerald net Dolina Lima, visible from the mountain routes	Within the Emerald Network of Lim Valley, visible from the road	The vicinity to the Emerald Network, partially visible from the road	proximity to the Emerald Network of Lim Valley	proximity to the Emerald Network of Lim Valley	proximity to the Emerald Network of Lim Valley, seen up close	In terms of biodiversity, the best options are Zaton and Ramčina considering they are outside of the biocorridor and outside the Emerald Network, and the least acceptable is Čelinska Kosa 2 because it is located within the area of the Emerald Network. Given the importance of the landscape, favorable locations are visually hidden and they cannot be seen from frequent traffic routes. Unfavourable locations are Kumanica and Goja.
Population, public health	Rural area	Rural area	Rural area	Rural area	Rural area	Rural area	Since there were no significant differences in the distance from residential buildings (up to 1000 m), the locations are equally favorable. Location Goja is nearest to residential buildings and is considered the least favorable.
Cultural heritage	-	-	-	-	-	-	Based on the elements of the cultural heritage, all locations are equally favourable because they are not near the elements of cultural heritage, but special attention to elements of cultural heritage should be taken into account in the broader area of Goja.
Material assets	Difficult to access	The proximity of regional and main roads	Difficult to access	The proximity of the regional road	The proximity of the regional road	The proximity of the regional road	The locations closer to the regional road were rated as favorable - Čelinska Kosa 2, Zaton, Goja and Ramčina, and as less favorable - Čelinska Kosa 1 and Kumanica.

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impact / risk description

Air quality

The potential impact of sanitary landfills on air quality is reflected in the possible spreading of solid particles and landfill gases. The intensity and direction of the spreading of the said parameters is largely dependent on current weather conditions in the observed area. Temperature inversions characteristic of the wider area have an impact on air quality as they reduce not only air circulation but also eliminations of pollutants. Given the assumed existing air quality condition of the planned locations (precise data on microlocations air quality are not available), i.e. in accordance with the assumption of satisfactory existing air quality condition, the operation of the sanitary landfill can affect the air quality in the nearest surrounding areas with increased emissions of dust particles i.e. particulate matter (PM_{10}) and unpleasant smell (H_2S, mercaptans, ...) developing at the landfill site due to waste decomposition processes. These emissions can be expected from the composting areas as well; however, these impacts can be significantly reduced by constructing a closed composting system. Greater distance from landfills reduces the possibility of the impact of odors and dust from the landfill on the quality of people's lives even though quantity of pollutants in the landfill remains the same.

Increased traffic on the access roads, generated by the need for waste disposal, results in increased levels of pollutant emissions from vehicle exhaust fumes into the air.
Accidental situations are possible in case of a fire, explosion etc. at the landfill, which would potentially increase the levels of pollutants emitted into the air above the limit concentrations. Such situations will, should they occur at all, presumably be dealt with in the shortest possible time so that their impact on air quality will be localized and limited in their duration.

Climate factors

The impact of the sanitary landfill on climatic factors is reflected in the greenhouse gas emissions that occur during the process of microbial degradation of waste. In this sense, methane (CH_4) and carbon dioxide (CO_2) are extracted; these two gases make between 40% and 60% of the total amount of gases generated at the landfill, or a total of nearly 100%. Generation of greenhouse gases can be reduced with certain procedures (e.g. aeration of the composting plant) or the already produced greenhouse gases, especially methane, can be used for power generation. Due to the global characteristics of climate changes, the impact of a lower capacity landfill on climatic factors is negligible.

Waters

All the potential sites are located outside the sanitary protection zones for drinking water sources.
With the construction of an impermeable sealing layer and the controlled collection and disposal of rainwater and leachate, a negative effect on the quality of surface waters and of groundwater in the regular operations of the landfill is not expected.
Leachate from municipal waste landfills is loaded primarily with organic matter and nitrogen compounds. However, a wide range of substances can be found in traces. The eluate developing on landfills results from precipitation on the landfill and chemical and biochemical processes of waste decomposition. Pollution of aquifers and surface bodies of water is mostly a result of poor drainage, i.e., uncontrolled chemical contamination from leachate and precipitation water on the landfill surface. Leachate waters are characterised by high ammonia concentration being produced when proteins break down in the landfill slope and by elevated or high levels of heavy metals.
Accidents can result in uncontrolled leaks/spills of leachate from the landfill slope into groundwater and surface water and inorganic chemical contamination. Surface and ground waters located in the vicinity of the landfill are particularly at risk of possible contamination caused by accidents.

Soil

As the soil on all locations is of similar pedological characteristics without any very fertile land, the difference between the observed locations in terms of pedology and agriculture is not significant. Sanitary landfill has the same impact on the soil on all locations and this impact is significant during landfill construction because of setting up of a landfill structures. A sealing system set up on the landfill base soil prevents contact between filtrate water and waste with the soil and environment, and no significant impact of the landfill on the soil is expected during the regular operation of the landfill. Based on the PDP of Montenegro, Ramčina, Kumanica and Goja sites are located in the area of arable land. Consequently, land reallocations are possible for the purpose of landfill construction. To a certain extent, land erosion is possible on all sites in question.

Biological and landscape diversity, protected areas

After the analysis, it was concluded that all the locations are mainly in forest habitats or in the area of meadows - enclaves within forest habitats. All the sites are located on a completely natural,

undeveloped area. The risk involved in the construction of the landfill at these locations is reflected in the potential spread of invasive species. The spread of invasive species is recognized as a direct driver of biodiversity loss in dry pastures and it is associated with dumpsites. Although the project, in terms of its characteristics, is going to be a regulated landfill, there is still a risk of spreading invasive species due to the fact that a new habitat type of exclusively anthropogenic nature is being introduced in an almost "intact" natural habitat.
As it is located within Emerald Network of Lima Valley, Čelinska Kosa 2 site is considered the least favourable option. If the location is planned to be near watercourses, it will pose a risk for aquatic ecosystems which is contrary to objectives of NBDSAP and PDP of Montenegro.
The project will cause a fragmentation of mosaic landscape structure as well as degradation and reallocation of forests and meadows. The project will be visually prominent thus diminishing landscape features in the surrounding area. Impact on visual landscape qualities ranges from lower to significant.

Cultural heritage

Given that the location is further away from the registered elements of cultural heritage and is physically isolated, the construction of the sanitary landfill can have no major impacts on the elements of the cultural heritage.

Population, public health

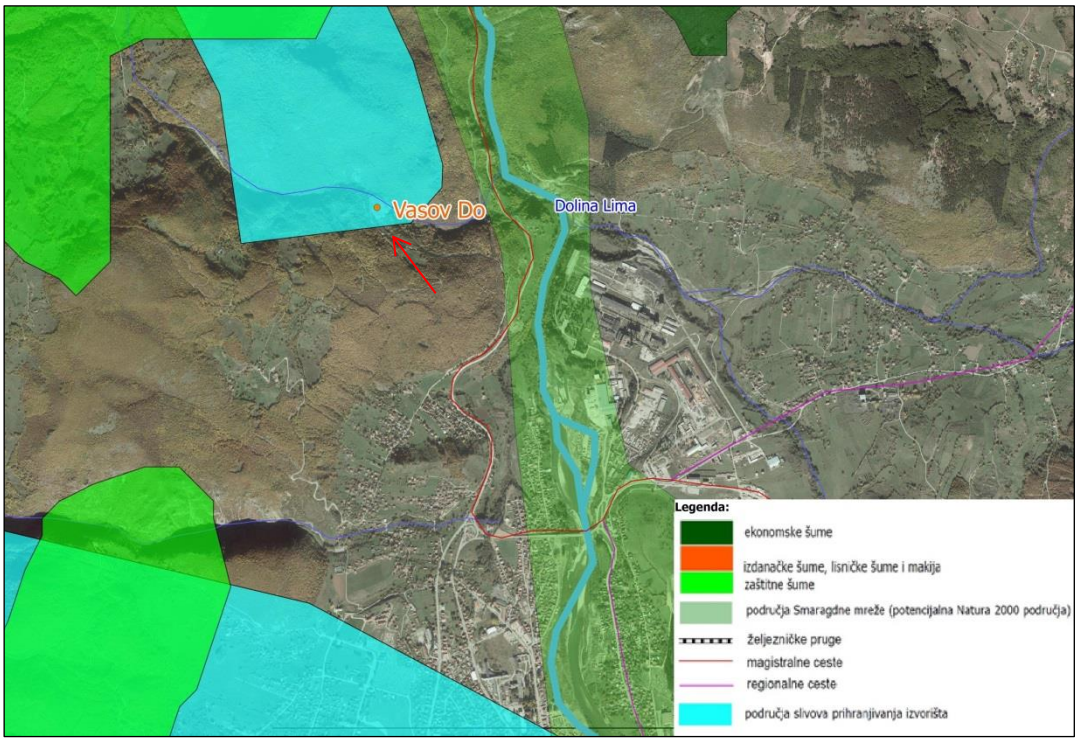
The impact of construction and operation of landfills and associated infrastructure facilities of waste management system on the population, is seen as positive because of awareness of local people about the importance of the introduction of regulated municipal waste management system. The implementation of such a system is necessary to prevent the current practice of improper and irresponsible disposal of various types of waste in areas where this method of disposal is a direct source of pollution of air, soil and water, such as the existing illegal dumpsites.
The assessment of the impacts on the local population included analyses of adverse effects such as odors, dust and noise. Controlled disposal of waste in the landfill, using landfill covers, will significantly reduce the possible spreading of unpleasant odors. The landfills are not located in a densely populated area, which significantly reduces the number of residents who will be exposed to the negative influences described above.
Undesirable impact in the form of unpleasant odors in the vicinity of the landfill is inevitable. Spreading of odors largely depends on the local weather conditions.
Placing the landfill near the populated area will increase the likelihood of infectious diseases being spread by disease carriers or vectors. Possible carriers of diseases from the landfill include birds and rodents, especially rats. Managing risk to human health from the existing micro-organisms originating from waste can be achieved by applying appropriate disposal technologies (covering with inert material on daily basis), preventing dispersion of garbage by wind, establishing protection zones, systematic rat extermination and disinfection of the landfill space as well as disinfection of equipment and facilities.
Increased transport of materials and equipment will lead to more intense traffic on nearby roads, which will consequently increase the noise and deteriorate the quality of life of the residents in that area.
Although the impact of the landfill on the residents' quality of life cannot be measured directly, negative effects can be reduced and limited with appropriate measures ensuring air, water, and soil quality.
A direct positive impact is expected through an increased number of jobs for the local populations, i.e. creating new jobs required for the activities during the construction and operation of the landfill and other facilities.
The risk for the local population resulting from accident situations can occur in the event of fire, explosion, etc. on the landfill, which could directly affect the health of residents in the area particularly due to the emission of gases and other pollutants into the air and water.

Material assets

Because of the landfills being constructed along the local or regional roads, it will be necessary to reconstruct the existing and/or, where appropriate, build additional access roads in order to improve conditions for the transportation of waste; therefore, the traffic density or traffic load is not likely to increase. Since these are mostly minor roads, the connection to major local roads will leave no permanent consequences, in accordance with the traffic conditions prescribed by the competent authority.
As there is no infrastructure on these sites, landfill construction will require that connections or connectors to public infrastructure grids be built.

6.2. MUNICIPALITY OF BERANE

The site Vasov Do is located to the northwest of the town of Berane on the already devastated area near the water stream and is surrounded by forest vegetation. The wider area of the site is shown in Graphic 6.2-1.



Graphic 6.2-1. Location Vasov Do

Table 6-2. The characteristics of the effects and risks associated with a potential sanitary landfill in the municipality of Berane (North Region)

Impacts / Risks	Sanitary landfill - Vasov Do	Clarifications and recommendations (e.g. the best option, mitigation measures)
Air	-	Given the fact that, in terms of air quality, the entire area of Berane municipality belongs to the northern critical zone for which the general assessment was that air quality needs improvement, and the fact that air quality

		measurements at landfill site showed elevated concentration of total hydrocarbons, ammonia, airborne particles and level of polycyclic aromatic hydrocarbons (PAH) in total particles, current adverse effect on air quality is noticeable. The reconstruction of the existing landfill is expected to improve the local air quality. Temperature inversions occur in the municipality area.
Climate factors	-	
Water	The site is located directly along the watercourse of Lučka river; outside the sanitary protection zone	Landfill caused the pollution of ground and surface waters in the narrow site area.
Land, soil	The site is located on brown acid soil on sandstone (eutric and dystric brown soil); low erosion	Soil pollution by landfills was identified on the location.
Biological and landscape diversity, protected areas	The vicinity of watercourses, about 500 m away from the Emerald area (Lim Valley)	Given the existing pollution of watercourse, impact in terms of biodiversity loss in watercourse and the Lim River is possible. After the landfill is no longer to be used, it is necessary to conduct biological rehabilitation in order to restore the original near-natural state to the highest possible extent, in accordance with the guidelines of the environmental remediation strategy.
Population, public health	Rural area	The nearest village is Beran Selo (<1 km). The landfill caused local pollution of ground waters.
Cultural heritage	-	The location is not in the vicinity of any elements of archaeological and architectural heritage.
Material assets	Vicinity of main road, vicinity of planned section route Bar - Boljare	The site is about 500 m away from the highway.

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impact / risk description

Air quality

The potential impact of sanitary landfills on air quality is reflected in the possible spreading of solid particles and landfill gases. The intensity and direction of the spreading of the said parameters is largely dependent on current weather conditions in the observed area. The existing air quality near the landfill supports the assumption that the landfill contributes to increased concentration of some pollutants and to poorer air quality of surrounding area. Frequent temperature inversions in the observed area contribute to air pollution retention. The reconstruction of the existing sources of pollution is expected to improve the air quality in the local area.

The operation of the sanitary landfill can generally affect the air quality in the nearest surrounding areas with increased emissions of dust particles i.e. particulate matter (PM_{10}) and unpleasant smell (H_2S, mercaptans...) developing at the landfill site due to waste decomposition processes. These emissions can be expected from the composting areas as well; however, these impacts can be significantly reduced by constructing a closed composting system. Greater distance from landfills reduces the possibility of the impact of odors and dust from the landfill on the quality of people's lives even though quantity of pollutants in the landfill remains the same.

Increased traffic on the access roads, generated by the need for waste disposal, results in increased levels of pollutant emissions from vehicle exhaust fumes into the air.

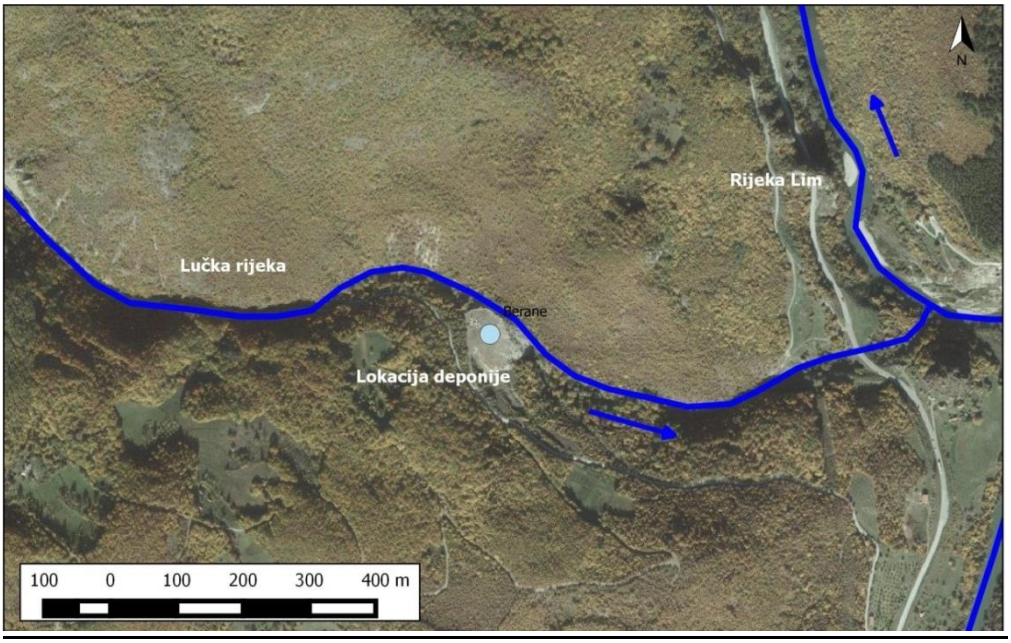
Accidental situations are possible in case of a fire, explosion etc. at the landfill, which would potentially increase the levels of pollutants emitted into the air above the limit concentrations. Such situations will, should they occur at all, presumably be dealt with in the shortest possible time so that their impact on air quality will be localized and limited in their duration.

Climate factors

The impact of the sanitary landfill on climatic factors is reflected in the greenhouse gas emissions that occur during the process of microbial degradation of waste. In this sense, methane (CH_4) and carbon dioxide (CO_2) are extracted; these two gases make between 40% and 60% of the total amount of gases generated at the landfill, or a total of nearly 100%. Production of greenhouse gases can be reduced with certain procedures (e.g. aeration of the composting plant) or the already produced greenhouse gases, especially methane, can be used for power generation. Due to the global characteristics of climate changes, the impact of a lower capacity landfill on climatic factors is negligible.

Waters

The site is located outside the sanitary protection zones for drinking water sources. The existing landfill is located directly along the watercourse of Lučka rijeka which after 700 m flows into the river Lim (Graphic 6-1). Based on data in the Physical Development Plan of Berane municipality, the existing landfill for municipal waste causes local contamination of ground and surface waters through filtering of waste waters from the landfill slope.



Graphic 6-1. Location in relation to the nearest surface watercourses

Reconstruction of the existing landfill will have a positive impact, as opposed to the current state, particularly with the construction of waterproof sealing system and controlled collection and disposal of rainfall and leachate. Regular operation of the landfill is not expected to have an adverse impact on the quality of ground and surface waters.
Negative impacts on surface and groundwater may occur due to the occurrence of an accident that can cause uncontrolled leaks/spills of leachate from the landfill slope into groundwater and surface water and cause inorganic chemical contamination. Given the vicinity of Lučka rijeka, if an accident occurs,

contamination may spread very quickly into watercourse which could cause significant pollution of surface and ground waters.

Soil

Taking into account the analysis of current soil quality at the landfill site (*source: EIS for the construction of regional sanitary landfill in the Berane municipality*), which shows elevated concentration of heavy metals (cadmium, arsenic and nickel) and fluoride, remediation and reconstruction of the landfill are expected to have a positive impact on the soil as this will reduce current pollution caused by inadequate waste disposal.

Biological and landscape diversity, protected areas

The construction of the sanitary landfill on that site is not expected to have a significant impact on the loss of habitat. Possible impact might be the pollution of both the watercourse next to the site and the Lim River into which this watercourse flows. So the biodiversity of these watercourses is already threatened which could only get worse if waste disposal continues. This is contrary to the objectives of NBSAP which deals with the reduction of water pollution.
Given the fact that NBSAP and PDP of Montenegro already recognize water ecosystems as polluted by waste and waste waters, it is believed that this project may have a significant adverse effect in the event of accident, i.e., uncontrolled discharge/leakage of leachate.
The site is located on the area with degraded landscape which is relatively isolated from the view of the surrounding region. Therefore, significant adverse effects are not expected, and the landfill is expected to improve current condition, to a certain extent.

Cultural heritage

Since the site is not located near the registered elements of cultural heritage locations and is physically isolated, the construction of the sanitary landfill can have no major impacts on the elements of the cultural heritage.

Population, public health

In the area of the landfill in Berane, groundwater polluted by the landfill has a negative impact on the quality of life of the local population. The contamination is of such intensity that it excludes the water from any use. Remediation of the existing pollution may reduce this adverse effect.
The impact of construction and operation of landfills and associated infrastructure facilities of waste management system on the population, is seen as positive because of awareness of local people about the importance of the introduction of regulated municipal waste management system. The implementation of such a system is necessary to prevent the current practice of improper and irresponsible disposal of various types of waste in areas where this method of disposal is a direct source of pollution of air, soil and water, such as the existing dumpsites.
The assessment of the impacts on the local population included analyses of adverse effects such as odors, dust and noise. Controlled disposal of waste in the landfill, using landfill covers, will significantly reduce the possible spreading of unpleasant odors. The landfill is located outside the populated area, which significantly reduces the number of residents potentially exposed to negative influences. Undesirable impact in the form of unpleasant odors in the vicinity of the landfill is inevitable while spreading of odors largely depends on the local weather conditions.
Placing the landfill near the populated area will increase the likelihood of infectious diseases being spread by disease carriers or vectors. Possible carriers of diseases from the landfill include birds and

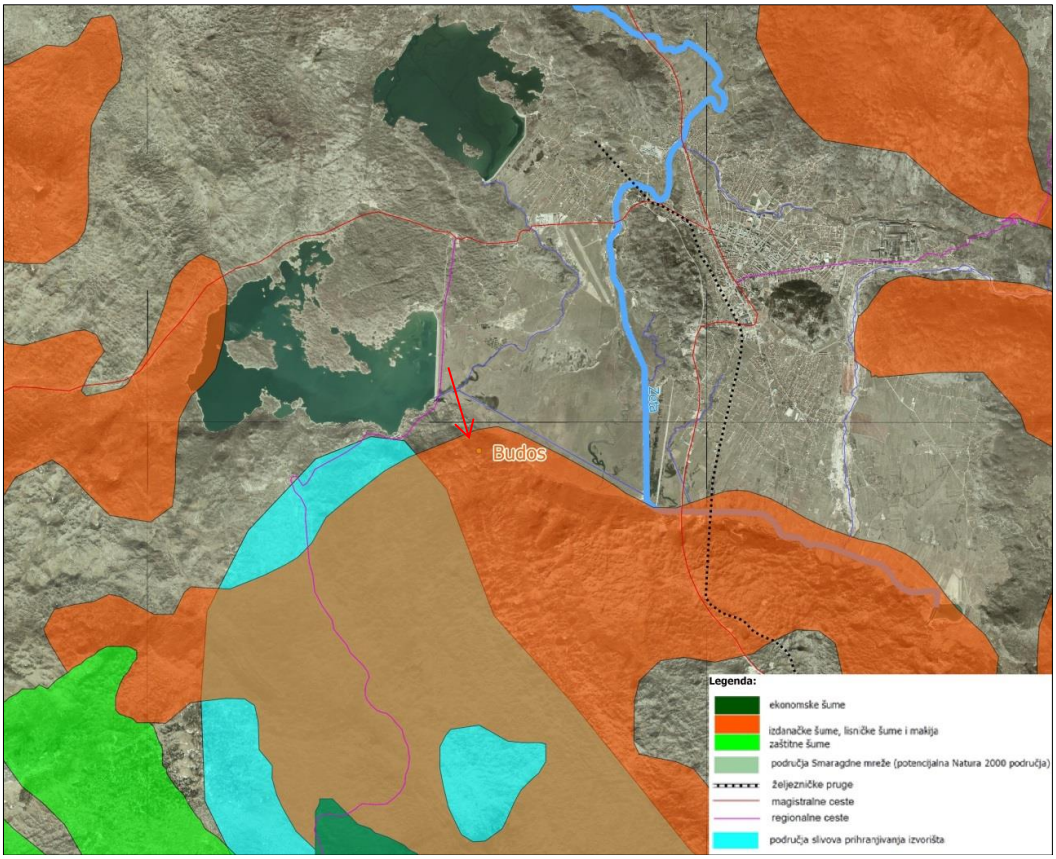
rodents, especially rats. Managing risk to human health from the existing micro-organisms developed from waste can be achieved by applying appropriate disposal technologies (covering with inert material on daily basis), preventing the spread of garbage by wind, establishing protection zones, systematic rat extermination and disinfection of the landfill space as well as disinfection of equipment and facilities.
Increased transport of materials and equipment will lead to more intense traffic on nearby roads, which will consequently increase the noise and deteriorate the quality of life of the residents in that area.
Although the impact of the landfill on the residents' quality of life cannot be measured directly, negative effects can be reduced and limited with appropriate measures ensuring air, water, and soil quality.
A direct positive impact is expected through an increased number of jobs for the local populations, i.e. creating new jobs required for the activities during the construction and operation of the landfill and other facilities.
The risk for the local population resulting from accident situations can occur in the event of fire, explosion, etc. on the landfill, which could directly affect the health of residents in the area particularly due to the emission of gases and other pollutants into the air and water.

Material assets

Because of the landfills being constructed along the local roads, it will be necessary to reconstruct the existing and/or, where appropriate, build additional access roads in order to improve conditions for the transportation of waste; therefore, the traffic density or traffic load is not likely to increase. Since these are mostly minor roads, the connection to major local roads will leave no permanent consequences, in accordance with the traffic conditions prescribed by the competent authority.
The existing local asphalt road leads to the site and is connected to the motorway/main road M2. As this road fails to meet the requirements necessary for access road to the landfill, the road is planned to be reconstructed. Since this is a minor local road, the connection to major local roads will leave no permanent consequences, in accordance with the traffic conditions prescribed by the competent authority.

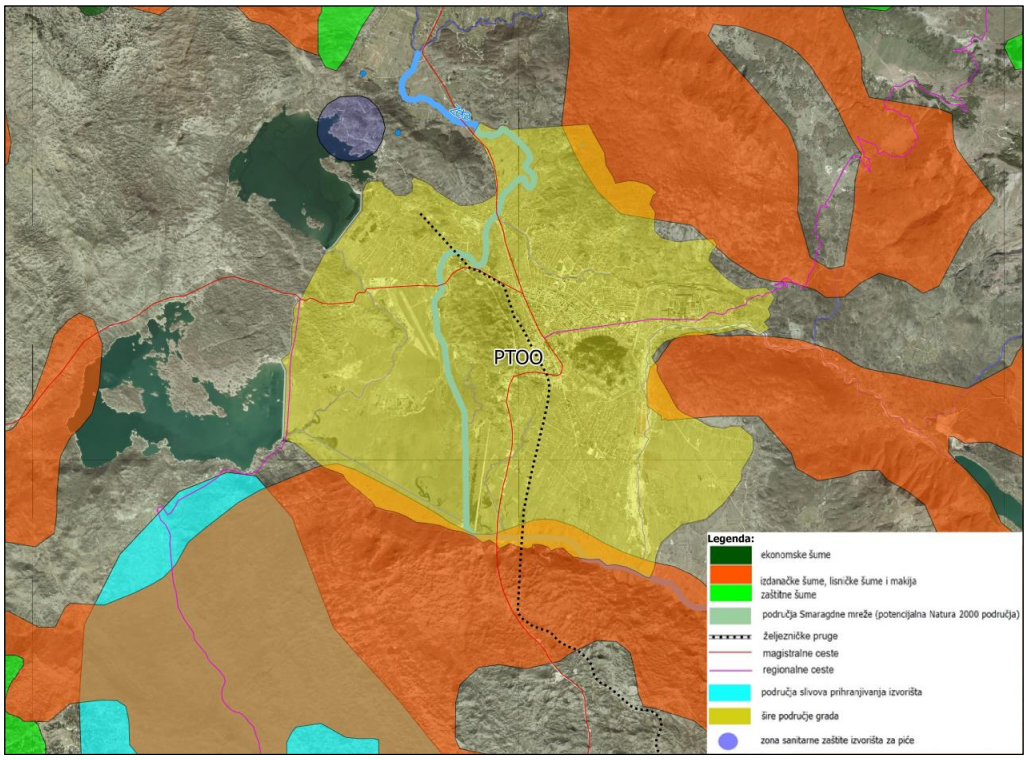
6.3. THE MUNICIPALITY OF NIKŠIĆ

The Budoš site is located at the southeast border of the Nikšić valley and southwest of the town of Nikšić. The site is located in a rural area on the slopes of the Budoš mountain. The wider area of the site is shown in the Graphic 6.3.1.



Graphic 6.3-1a Budoš Site

The Nikšić site covers a wider area of the town of Nikšić of about 61 km^2. The town of Nikšić is situated in the karst valley of the same name at an altitude of 630 m above sea level. The broader area is shown in Graphic 6.3.1b.



Graphic 6.3-1b The Nikšić site (wider town area)

Table 6-3. Characteristic effects and risks associated with a potential sanitary landfill site in the municipality of Nikšić (the regional center) and a potential plant for thermal treatment of waste in the municipality of Nikšić (single region)

Impacts / Risks	Sanitary landfill - Budoš	Clarifications and recommendations (e.g. the best option, mitigation measures)	Thermal treatment - Nikšić (wider town area)	Clarifications and recommendations (e.g. the best option, mitigation measures)
Air	-		Frequent occurrence of precipitation (rainy/very rainy area); frequent change of wind direction (the most common is the north wind); presence of industrial facilities	The measured concentrations of air pollutants in the area around Nikšić indicate lower air quality so that the municipality of Nikšić belongs to the southern critical zone for which a general assessment has been given that the air quality there absolutely requires improvement.
Climate factors	-		-	
Water	The nearest watercourse is at about 700 meters away from the site; outside the sanitary protection zone	The terrain is made up of permeable sediments with fracture-cavernous porosity.	Complex hydrogeological and hydrological situation	Nikšić valley is rich in surface waters and numerous hydrogeological phenomena. On the observed territory, sanitary protection zones have been proclaimed for water springs Vidovran and Poklonci. The southern part of the valley is periodically flooded.
Land, soil	Soil of low production capacity		Soil of low production capacity	In the wider area of the town, especially in areas with existing industrial facilities, soil can be burdened with pollutants.
Biological and landscape diversity, protected areas	-	After the landfill closure, it is necessary to conduct biological rehabilitation in a way to restore the original near-natural state to the highest possible extent, in accordance with the guidelines of the environmental remediation strategy.	IBA site in the Nikšić accumulation (Slano, Krupac, Liverovići) IPA site - Trebjesa, Protection proposal - Studenačka glavica; strong visual impact	It is recommended to use the existing industrial areas or exploitation fields as the location of the thermal treatment plant. Chance of a cumulative effect with the existing industrial landscape elements.
Population, public health	Rural area	The nearest hamlet is located about 600 m from the irrigation area.	Urban area	The facility will be located in an urban area, with population density of around 35 inhabitants per km^2.
Cultural heritage	-	The location is not in the vicinity of any elements of archaeological and architectural heritage	-	As recommended, the thermal processing plant should be placed on an archaeologically inactive area.
Material assets	Easily accessible area.	The site is about 1.5 km from the regional road and about 4.5 km from the highway.	The central position with regard to traffic connections within the state, vicinity of the railway line	The thermal treatment plant is in the vicinity of the railway line, and the location is considered favorable. It is recommended to explore the possibility of waste transportation by rail because it is the cheapest, safest and most environmentally friendly form of transportation.
Accident			Accident at the site - air pollution; risks connected with transportation of	

			waste; systemic risks and the implications relating to the necessity of continuous operation	

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impact / risk description

Air quality

Regional management system

The potential impact of sanitary landfills on air quality is reflected in the possible spreading of solid particles and landfill gases. The intensity and direction of the spreading of the above parameters is largely dependent on current weather conditions in the observed area. The existing air quality status throughout the municipality of Nikšić pertains to the critical zone in the south which was generally assessed as a zone where air quality needs necessary improvement. Given the smaller capacity of the landfill, its construction is not expected to cause significant deterioration of the current air quality.
The operation of the sanitary landfill can generally affect the air quality in the nearest surrounding areas with increased emissions of dust particles i.e. particulate matter (PM_{10}) and unpleasant smell (H_2S, mercaptans, ...) developing at the landfill site due to waste degradation processes. These emissions can be expected from the composting areas as well; however, these impacts can be significantly reduced by constructing a closed composting system. Greater distance from landfills reduces the possibility of the impact of odors and dust from the landfill on the quality of people's lives even though quantity of pollutants in the landfill remains the same.
Increased traffic on the access roads, generated by the need for waste disposal, results in increased levels of pollutant emissions from vehicle exhaust fumes into the air.
Accidental situations are possible in case of a fire, explosion etc. at the landfill, which would potentially increase the levels of pollutants emitted into the air above the limit concentrations. Such situations will, should they occur at all, presumably be dealt with in the shortest possible time so that their impact on air quality will be localized and limited in their duration.

Centralized management system

Centralized management system includes thermal treatment of municipal waste which results in increased emissions of air pollutants, particularly NOx, then SO_2, particlulate matter, CO, volatile organic compounds (VOCs), HCl, HF, heavy metals, mercury, dioxins and furans. The resulting gases can undermine the existing quality of air. To which the extent gases will disturb the existing air quality depends primarily on the selection of thermal treatment technology and composition of the processed waste. Furthermore, the extent of the area affected by pollution depends on the current meteorological conditions, particularly wind direction and strength.

No significant impact on the existing quality of air is expected during regular operation of the plant for thermal treatment of waste because it will apply technologies based on BATs for municipal waste incineration (including the maintenance of the plant) with highest level of protection, i.e. treatment of flue gases. Applying a technology which is not on the BAT level and does not include the highest protection level i.e. flue gas purification could lead to significant air pollution resulting from regular operation and/or maintenance of the plant. Should an accident occur, this might cause significant pollution of the air in the surrounding area, which can extend to a much wider area if combined with unfavorable weather conditions.

Climate factors

Regional management system

The impact of the sanitary landfill on climatic factors is reflected in the greenhouse gas emissions that occur during the process of microbial degradation of waste. In this sense, methane (CH_4) and carbon dioxide (CO_2) are extracted; these two gases make between 40% and 60% of the total amount of gases generated at the landfill, or a total of nearly 100%. Generation of greenhouse gases can be reduced with certain procedures (e.g. aeration of the composting plant) or the already produced greenhouse gases, especially methane, can be used for power generation. Due to the global characteristics of climate changes, the impact of a lower capacity landfill on climatic factors is negligible.

Centralized management system

In addition to possible negative effects that the plant for thermal treatment of waste can have on climate factors (increased direct emissions of greenhouse gases and greenhouse gas precursors (NO_x)), there is also a possibility of the total greenhouse gas emission reductions, if the thermal treatment is performed in order to produce energy. In that case, the demand for energy from conventional sources (fossil fuel) is reduced. Furthermore, the thermal treatment of the waste affects the generation of greenhouse gases at sanitary landfills and, in overall, reduces their generation.

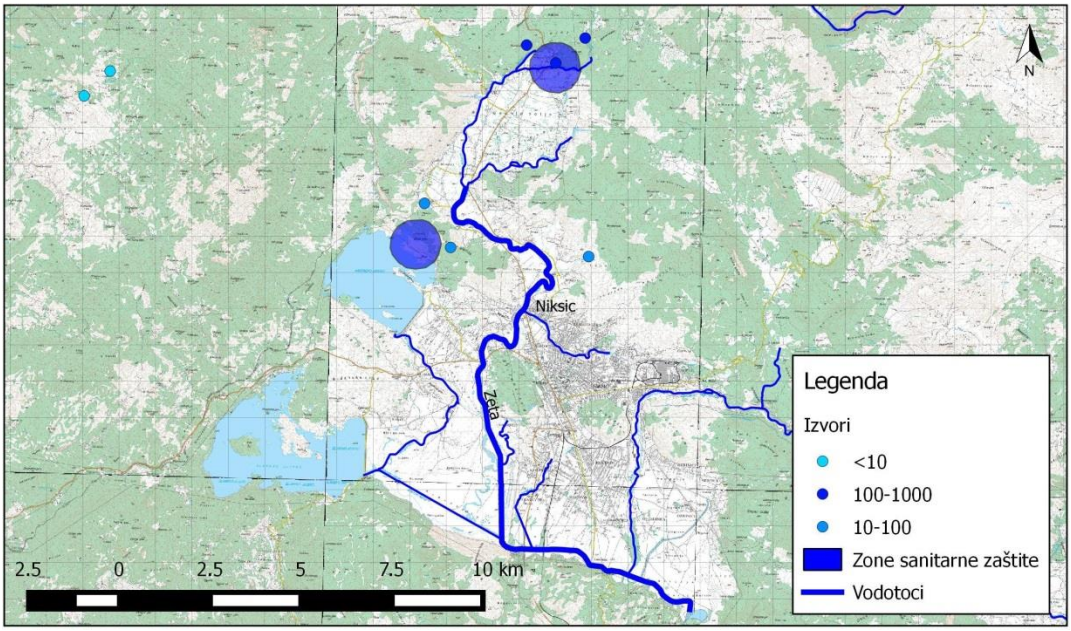
Water

Regional management system

The site is located outside the sanitary protection zones for drinking water sources. The nearest watercourse is about 700 meters away from the planned landfill site. According to data from the Environmental impact study of regional landfill in Nikšić, the landfill is located on the deposits with fracture porosity.
The construction of an impermeable sealing layer and the controlled collection and disposal of rainwater and leachate from the landfill will prevent possible contamination of groundwater. Negative impacts on surface and groundwater may occur due to the occurrence of accidents that can cause uncontrolled leaks/spills of leachate from the landfill into groundwater and surface water and cause their inorganic chemical contamination. According to the information in the above mentioned Study, if an accident occurs and leachates from the landfill penetrate into the underground, the geological features of the terrain will probably cause the pollution to move towards the water springs of Oboštičko and Glava Zete.

Centralized management system

During the operation of the waste treatment plant, the surface and ground waters in the surrounding area can be affected by sedimentation of harmful substances emitted into the atmosphere together with floating particles during combustion process. Sedimentation depends on local weather conditions (wind rose, rainfall, etc.). In the Nikšić valley, the most common winds have the north and south direction, and the annual rainfall is around 2000 mm. Rinsing of the sediments from the area may lead to contamination of surface and ground water, which can cause a significant adverse impact in the event of an accidental situation when larger volumes of such sediment can arise. Graphic 6-3. shows water springs and sanitary protection zones in the Niksić valley.



Graphic 6-3. The physical distribution of watercourses, springs and sanitary protection zones

Soil

Regional management system

The impact of the sanitary landfill on the ground is important because the construction of the landfill gives rise to repurpose and loss of land. As the landfill site is located on the ground with soil of low agricultural value (Source: The assessment study of the impact on the environment of the local sanitary landfill in Nikšić), the impact is not assessed as significant. The construction of the landfill involves placing a sealing system on the foundation ground which prevents contact of the filtrate water and waste with the soil and the environment, so that no significant impact on the ground during normal operation of the landfill is expected. Soil erosion is possible to a certain extent because the site is situated in the deep karst erosion area (low and medium erosion).

Centralized management system

The waste treatment plant will be situated inside the wider town area and therefore no major impact on the agricultural land is expected in most parts of the area. Arable land is mostly present in the southern part of the observed area. If the plant site is located in the southern part of the observed area, a direct adverse impact on the arable land will be possible in case of an accident situation, which could combine with the existing and potential future burdens in the soil (agriculture, industry) coming from the surrounding area and thus cause a cumulative impact on the soil.

Biological and landscape diversity, protected areas

Regional management system

The construction of the sanitary landfill at the Budoš will cause a partial loss of meadow and forest habitats; however, due to the fact that similar habitats are present in the wider area, this does not constitute a significant impact. Moderate impact can be expected to result from the construction of the

access road due to the steep terrain and the fact that the PDP of the town of Nikšić has proclaimed this area to be a protected forest. Due to the steepness of the terrain, the construction of the access road will have to include more area.
The site is located on a completely natural, undeveloped area. The risk involved in the construction of the landfill at this location is reflected in the potential spread of invasive species. The spread of invasive species is recognized as a direct driver of biodiversity loss in dry pastures and it is associated with dumpsites. Although the procedure, according to its characteristics, is going to be a regulated landfill, there is still a risk of spreading invasive species due to the fact that a new habitat type of exclusively anthropogenic nature is being introduced in an almost "intact" natural habitat.

Centralized management system

Implementation of a centralized waste management system in the municipality of Nikšić includes construction of a thermal waste treatment in the wider town area. The construction of the new plant involves some possibly significant impacts in terms of emissions into the air and water pollution, indirectly affecting flora and fauna in the area around the construction site. The observed area or its closer vicinity includes IBAs, i.e. important areas for birds living in the wet eco-systems (the Nikšić accumulation). Therefore, in the process of defining the exact location of the landfill, it must be made sure not to place it near the IBAs and to ensure that the watercourses connected with the IBAs are not polluted.
Due to contrast proportions between the big planes and volumes, colors and textures of the surface vegetation, the landscape of the Nikšić area is relatively dynamic. In the dry part of the year, partial physical degradations in the form of a dried lake shore are visible, whereas the permanent degradations primarily pertain to infrastructural interventions and contextually maladjusted construction. This partially decreased the value and the unique character of the landscape. Accordingly, the visual quality is of a moderate value and dependent on the position in space. The value and sensitivity of the landscape are therefore assessed as moderate, whereas the landscape has a mixed character, it is both natural and man-made. From the aspect of reducing the adverse impacts on the landscape, the optimal location for the waste treatment plant would be within already deteriorated landscape units or low value landscapes (e.g. industrial area in the central and southern part of the Nikšić valley, exploitation fields east of the town of Nikšić).

Cultural heritage

Regional management system

Since the site is not located near the registered elements of cultural heritage locations are physically isolated, the construction of the sanitary landfill can have no major impacts on the elements of the cultural heritage.

Centralized management system

The construction of the thermal treatment plant will have no impact on the cultural heritage if the location of the plant is located outside the registered areas of importance for cultural heritage (archaeological or building blocks of cultural heritage, archaeologically active regions) or areas with such potential.

Population, public health

Regional management system

The impact of the construction and operation of the landfills and of the associated infrastructure waste management system facilities is perceived as positive because of the increased awareness of local population regarding the importance of the introduction of a regulated municipal waste management system. The implementation of such a system is necessary to prevent the current practice of improper and irresponsible disposal of various types of waste in areas where this method of disposal is a direct source of pollution of air, soil and water, such as the existing illegal dumpsites.
The assessment of the impacts on the local population included analyses of adverse effects such as odors, dust and noise. Controlled disposal of waste in the landfill, using landfill covers, will significantly reduce the possible spreading of unpleasant odors. The landfill will not be located in a heavily populated area, which will significantly reduce the number of residents who will be exposed to the negative influences described above. Undesirable impact in the form of unpleasant odors in the vicinity of the landfill is inevitable. Spreading of odors largely depends on the local weather conditions.
Setting the landfill near the populated area will increases the likelihood of infectious diseases being spread by disease carriers or vectors. Possible carriers of diseases from the landfill include birds and rodents, especially rats. Managing risk to human health from the existing micro-organisms originating from waste can be achieved by applying appropriate disposal technologies (covering with inert material on daily basis), preventing dispersion of garbage by wind, establishing protection zones, systematic rat extermination and disinfection of the landfill space as well as disinfection of equipment and facilities.
Increased transport of materials and equipment will lead to more intense traffic on nearby roads, which will consequently increase the noise and deteriorate the quality of life of the residents in that area.
Although the impact of the landfill on the residents' quality of life cannot be measured directly, negative effects can be reduced and limited with appropriate measures ensuring air, water, and soil quality.
A direct positive impact is expected through an increased number of jobs for the local populations, i.e. creating new jobs required for the activities during the construction and operation of the landfill and other facilities.
The risk for the local population resulting from accident situations can occur in the event of fire, explosion, etc. on the landfill, which could directly affect the health of residents in the area particularly due to the emission of gases and other pollutants into the air and water.

Centralized management system

Emissions of air pollutants from the plant for thermal treatment of waste have a negative impact on air quality and thus the quality of life of residents. Highly toxic substances can develop during the thermal treatment of waste and, to a lesser extent, penetrate the environment.
Risks associated with the thermal treatment of waste can be reduced by choosing the best available technologies that are based on the standards and values of emissions and primarily designed to protect human health and the environment. In this respect, the reputation of the Trebjesa Brewery could be put at risk, because they produce the most popular beer brand in Montenegro and export it, too. The economic interests of the food and beverage industries whose facilities are located in the vicinity of the plant for thermal treatment of waste can be interpreted in two ways, considering the fact that the public could have a negative perception of the whole project and develop fear of possible industrial accidents or the presence of contaminants in food products.

Material assets

Regional management system

Because of the landfills being constructed along the local roads, it will be necessary to reconstruct the existing and/or, where appropriate, build additional access roads in order to improve conditions for the transportation of waste; therefore, the traffic density or traffic load is not likely to increase.
No access roads lead to the Budoš site - the foot of the site can be reached by local asphalt road Nikšić - the Vrtac dam - Lake Slano (from the Budoš tunnel to lake Slano), about 2 km long, while at the location itself the ground must be prepared and a new access road (1,604 m long) needs to be built. Since these are mostly minor roads, the connection to major local roads will leave no permanent consequences, in accordance with the traffic conditions prescribed by the competent authority.

Centralized management system

The area around the town of Nikšić well connected with a traffic network of main and regional roads and the railway line, so that the potential location of the thermal treatment plant would be inside a circle, no more than 5 km away from the main road or the railway line.
The backbone of the railway traffic in the future will still be the railway line Podgorica - Nikšić (with a possible relocation route through Duklja). The repair, modernization and electrification[54] of this railway line has been finished and it is now used for passenger and freight traffic (mainly for the purpose of the Nikšić' steelworks, bauxite mine, brewery, and the aluminum plant in Podgorica. The total length of the line is 66.3 km: 56.6 km of open railway and 9.7 km running through the train stations. Approximately 17 km of the railway line run through the territory of the town of Nikšić. The railway line Podgorica - Nikšić is now categorized as D4 (maximum permissible load of 22.5 tons per axle and 8 t per meter). Physical Development Plan of Montenegro envisages improving the quality of the existing rail network, transport services and network capacity, whereas the Urban Development plan of the town of Nikšić provides for the improvement and development of railways, passenger and cargo transport. In the planning period, the railway line Nikšić - Podgorica remains on the current route with its existing features and regular maintenance as part of the primary railway network in Montenegro. This line will gain its full significance after the construction of the railway line Čapljina - Trebinje - Nikšić[55] and it will then become an important international railway corridor, together with the line Podgorica - Albanian border.
Using the railway to transport municipal waste would bring multiple benefits because it is the cheapest, safest and most environmentally friendly form of transportation[56], and it would also help relieve the burden from main and regional roads[57]. If the waste is transported by the railway, it will be necessary to construct an industrial track of the railway line/station leading as far as the site of thermal processing plant.

[54] The railway is electrified and has a 25 kV/50 Hz mono-phase power system. During the last reconstruction of the Podgorica-Nikšić route, telecommunications canals carrying optical cables were laid down along this railway line: the canals and the cable are both owned by "Railway Transport of Montenegro"; the canal can hold 48 optical fibers.

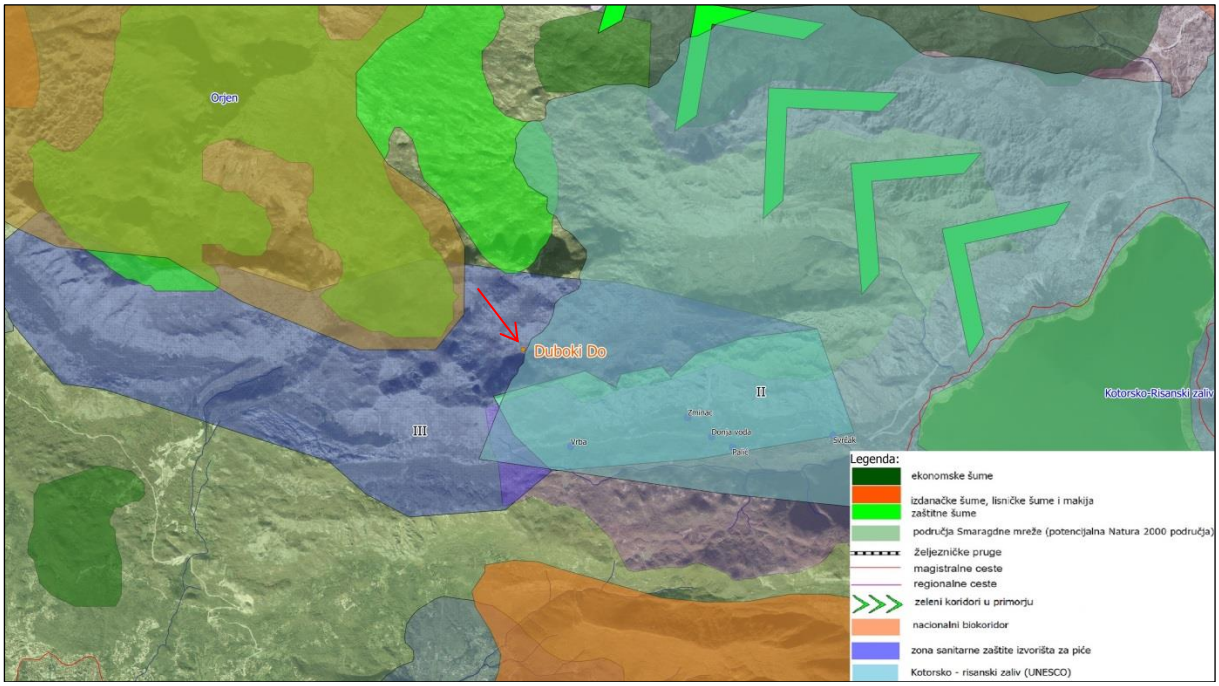
[55] This corridor is of great importance for Montenegro because it established traffic connections with countries in the region, contributes to economic development and to the opening of the port of Bar toward the countries in the region, providing intermodal transportation, i.e. the combination of rail and water transport. The construction of the railway would provide for better and easier transportation of a large number of passengers, particularly in the tourist season, supporting the realistic character of this railway route. The route through the territory of the town of Nikšić coincides with the route of the old railway line Nikšić - Bileća. (Source: Report on strategic assessment of environmental impact of the Urban Development Plan of the town of Nikšić, REC Montenegro, July 2014).

[56] This is particularly interesting because 50% of freight traffic on the railways is to be diverted to electric power (Source: Physical and urban development plan of the town of Nikšić).

[57] In addition to railways, waste can be transported with special trucks. In this case, the dynamics of the waste delivery will have to comply with the agreement on transportation achieved with the relevant institutions for road transport and it will also have to be adjusted to tourist, cultural and similar activities in the town of Nikšić and the surrounding area to the highest possible extent.

6.4. MUNICIPALITY OF HERCEG NOVI

The site of Duboki Do is located in high mountain region of the eastern part of the Orjen massif. The site is located in the karst sinkhole, a natural depression, whose bottom is at 1050 meters above sea level. The wider area around the site is shown in Graphic 6.4-1.



Graphic 6.4-1. The Duboki Do site

Table 6-4 Characteristics of the effects and risks associated with a potential sanitary landfill site in the Municipality of Herceg Novi (coastal region)

Impact / risk	Sanitary landfill - Duboki Do	Clarifications and recommendations (e.g. the best option, mitigation measures)
Air	-	In terms of air quality, the whole area of the municipality of Herceg Novi belongs to the air quality maintenance area, which means that air quality is at a satisfactory level.
Climate factors	-	
Water	Within zone III relating to sanitary protection of drinking water soruces[58]	Because of the highly permeable substrate there is a potential risk of infiltration of pollutants into groundwater and pollution of downstream water wells (Morinje springs), in the event of an environmental accident.
Land, soil	The existing soil contamination, sinkhole soil with good production capacity	The soil contamination found at the site is a result of inadequate waste disposal; the ground is water-permeable and the sinkhole sides are susceptible to erosion.
Biological and	Karst area - rocky terrains and pastures, vicinity of the bio-coridor pertaining to the	According to the PDP of Montenegro, rocky areas and pastures should be treated as protected areas; location of

[58] According to the proposed boundaries of the Protection Zone of Morinjski izvori i.e. Morinje springs (Study on determination and maintenance of sanitary protection zones and restrictions in these zones for Morinje springs of "Svrčak", "Palić", "Donja voda", "Zminac" and "Vrba", NIK STONE d.o.o. Nikšić 2015).

landscape diversity, protected areas	coastal mountains of Orjen-Lovćen-Rumija vicinity of the Emerald Network and the National Park Orjen, next to the border of the Bay of Kotor and Risan (UNESCO protected area)	major development projects (including landfills) must be planned outside of protected areas, especially those which are of international importance.
Population, public health	Rural area	The nearest inhabited place, Bunovići, is about 1.6 km away from the site.
Cultural heritage	-	The site is located along the border of the UNESCO protected area of the Kotor and Risan Bay
Material assets	The area is difficult to access.	The location is outside the existing and planned tourist resorts. The distance from the main road is about 5 km.

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impact / risk description

Air quality

The potential impact of sanitary landfills on air quality is reflected in the possible spreading of solid particles and landfill gases. The intensity and direction of the spreading of the above parameters is largely dependent on current weather conditions in the observed area. Given the existing good air quality in Herceg Novi area, the construction of sanitary landfills could adversely affect the air quality of the surrounding area; however, since this is a smaller capacity landfill, the existing air quality is not expected to deteriorate significantly.

The operation of the sanitary landfill can generally affect the air quality in the nearest surrounding areas with increased emissions of dust particles i.e. particulate matter (PM_{10}) and unpleasant smell (H_2S, mercaptans...) developing at the landfill site due to waste degradation processes. These emissions can be expected from the composting areas as well; however, these impacts can be significantly reduced by constructing a closed composting system. Greater distance from landfills reduces the possibility of the impact of odors and dust from the landfill on the quality of people's lives even though quantity of pollutants in the landfill remains the same.

Increased traffic on the access roads, generated by the need for waste disposal, results in increased levels of pollutant emissions from vehicle exhaust fumes into the air.

Accidental situations are possible in case of a fire, explosion etc. at the landfill, which would potentially increase the levels of pollutants emitted into the air above the limit concentrations. Such situations will, should they occur at all, presumably be dealt with in the shortest possible time so that their impact on air quality will be localized and limited in their duration.

Climate factors

The impact of the sanitary landfill on climatic factors is reflected in the greenhouse gas emissions that occur during the process of microbial decomposition of waste. In this sense, methane (CH_4) and carbon dioxide (CO_2) are extracted; these two gases make between 40% and 60% of the total amount of gases generated at the landfill, or a total of nearly 100%. Generation of greenhouse gases can be reduced with certain procedures (e.g. aeration of the composting plant) or the already produced greenhouse gases, especially methane, can be used for power generation. Due to the global characteristics of climate changes, the impact of a lower capacity landfill on climatic factors is negligible.

Water

The landfill project includes the construction of an impermeable sealing layer, controlled drainage of rainwater and leachate as well as their disposal; therefore, no major adverse impact on the groundwater quality is expected to happen during the regular operation of the landfill. In the event of inadequate operation and maintenance of the landfill, leakage/spillage of small quantities of leachate may occur, which may have a negative impact on the quality of groundwater. A significant negative impact on the groundwater may occur due to uncontrolled outflow of larger volumes of leachate and rainwater from the landfill in case of an environmental accident or intense rainfall. In case of an accident, pollution can be transfered to water sources, which qualifies as a major impact.

Soil

Given the contamination existing at the site (Source: Environmental Impact Assessment of the sanitary landfill "Duboki Do") as a result of inadequate waste disposal, remediation and construction of landfills are expected to have positive impacts on the ground as it will prevent further pollution due to improper waste disposal. The soil has a very good production capacity, but given the existing pollution is not used for agricultural purposes. The soil on the sides of the sinkhole is susceptible to erosion to some extent.

Biological and landscape diversity, protected areas

The site of Duboki Do is situated in a vulnerable biodiversity area (vicinity of the coastal mountains biological corridor Orjen-Lovćen-Rumija, vicinity of a proposed national park and Emerald network of Orjen, and immediate vicinity to the border of the UNESCO protected area of Kotor-Risan Bay) and therefore it is considered hazardous, both during regular operation and in the event of an environmental accident at the landfill. With regard to the vulnerability of the karst eco-systems as well as to the statement provided in the PDP of Montenegro saying that „*… rocky terrains and pastures must be treated as protected areas (until required physical planning documents have been completed) and location of major development projects (including landfills) must be planned outside of protected areas, especially those which are of international importance*“, the impact is assessed as significant. Another risk associated with the construction of the landfill is the potential spreading of invasive animal species. Although the planned facility, according to its characteristics, is going to be a regulated landfill, there is still a risk of spreading invasive species due to the fact that a new habitat type of exclusively anthropogenic nature is being introduced in an almost "intact" natural habitat.
The landscape is highly dynamic, resulting in a relatively high visual quality and the clarity of a view varies from high to low, depending on the situation on the ground. Taking into consideration the level of natural features, anthropogenic interferences and the landscape structure, the wider area surrounding the site can be assessed as moderately to highly susceptible.
The site is located in a relief depression i.e. sinkhole and is not visually exposed to views from the surrounding region. Because the location is only visible at close range and from mountain peaks in the north, the impact on the visual features of the landscape will not be significant.

Cultural heritage

The site is located along the border of the UNESCO protected area of the Kotor and Risan Bay Basic phenomenon relating to the protection of this area is the bay with coastal zone, while in the area along the border toward the Duboki Do site the protection is fragmented. Because of that and because the site is in a sheltered area of the sinkhole, there will be no significant impact on the features of the protected area.

Population, public health

The impact of the construction and operation of the landfill and of the associated infrastructure waste management system facilities is perceived as positive because of the increased awareness of local population regarding the importance of the introduction of a regulated municipal waste management system. The implementation of such a system is necessary to prevent the current practice of improper and irresponsible disposal of various types of waste in areas where this method of disposal is a direct source of pollution of air, soil and water, such as the existing illegal dumpsites.
The assessment of the impacts on the local population included analyses of adverse effects such as odors, dust and noise. Controlled disposal of waste in the landfill, using landfill covers, will significantly reduce the possible spreading of unpleasant odors. The landfill will not be located in a heavily populated area, which will significantly reduce the number of residents who will be exposed to the negative influences described above. Undesirable impact in the form of unpleasant odors in the vicinity of the landfill is inevitable. Spreading of odors largely depends on the local weather conditions.
Setting the landfill near the populated area will increases the likelihood of infectious diseases being spread by disease carriers or vectors. Possible carriers of diseases from the landfill include birds and rodents, especially rats. Managing risk to human health from the existing micro-organisms originating from waste can be achieved by applying appropriate disposal technologies (covering with inert material on daily basis), preventing dispersion of garbage by wind, establishing protection zones, systematic rat extermination and disinfection of the landfill space as well as disinfection of equipment and facilities.
Increased transport of materials and equipment will lead to more intense traffic on nearby roads, which will consequently increase the noise and deteriorate the quality of life of the residents in that area.
Although the impact of the landfill on the residents' quality of life cannot be measured directly, negative effects can be reduced and limited with appropriate measures ensuring air, water, and soil quality.
A direct positive impact is expected through an increased number of jobs for the local populations, i.e. creating new jobs required for the activities during the construction and operation of the landfill and other facilities.
The risk for the local population resulting from accident situations can occur in the event of fire, explosion, etc. on the landfill, which could directly affect the health of residents in the area particularly due to the emission of gases and other pollutants into the air and water.

Material assets

Because of the landfills being constructed along the local roads, it will be necessary to reconstruct the existing and/or, where appropriate, build additional access roads in order to improve conditions for the transportation of waste; therefore, the traffic density or traffic load is not likely to increase. Since these are mostly minor roads, the connection to major local roads will leave no permanent consequences, in accordance with the traffic conditions prescribed by the competent authority.
The location of the landfill Duboki Do can be reached by road from the route that leads to Crkvice (which separates from the road Kameno - Ubli, and it is in fact an old paved road that used to lead Crkvice).

6.5. ANALYSIS OF THE IMPACT / RISK OF THE PROPOSED WASTE MANAGEMENT OPTIONS

The assessment covers the risks associated with regular operation, as well as the risks associated with possible accident situations and determines their relative significance. Results are visually presented in a matrix that summarizes the risks and impacts of each option under consideration. Results are visually presented as tables which include identified risks and impacts of each option involved. The assessment did not include any limitations caused by major uncertainties, other than those arising from the strategic nature of the planning documentation. The only major uncertainty arose from the lack of detailed information about the potential plant for thermal treatment of waste (a waste-to-energy plant), because at the moment there is neither detailed information about specific technologies that can be used nor on the possible locations to accommodate such a plant and the supporting infrastructure.

1) The initial proposal - 5 regions

Table 6.5.1. Impacts and risk features related to the initial proposal

Impact / risk	Sanitary landfill - Vasov Do (Berane)		Sanitary landfill - Budoš (Nikšić)		Sanitary landfill - Duboki Do (Herceg Novi)	
	Regular operation	Environmental accident	Regular operation	Environmental accident	Regular operation	Environmental accident
Air						
Climate factors						
Water						
Land, soil						
Biological and landscape diversity, protected areas						
Population, public health						
Cultural heritage						
Material assets						

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impacts / Risks

The construction of the sanitary landfill at the location of Budoš is not expected to have a highly significant impact on any of the analyzed aspects of the environment and the location is considered low-risk compared to other analyzed sites. Environmental accidents can have a significant impact on the local air quality, groundwater and biological diversity of the wider area. The planned sanitary landfill at the Duboki Do site can have a significant - and in case of an environmental accidents a very significant - adverse impact on groundwater and the drinking water springs in the area (Morinjski izvori), and consequently on the population health. Duboki Do is situated in a vulnerable area in terms of biological diversity (karst habitats, the nearby bio-coridor of the coastal mountains of Orjen-Lovćen-Rumija, the

proposed national park and the Emerald network of Orjen, and the immediate vicinity to the border of UNESCO protected area Kotor - Risan Bay) and is therefore considered risky both during normal operation and in the event of an accident in the landfill. The location is also potentially risky because it is situated on top of the mountain where extreme weather conditions are present and the rainfall is likely to increase because of the expected climate changes. Considering the fact that the site is located on a mountainous area that is difficult to access, this might be a significant problem in the event of an accident, as the location may be difficult to access. Furthermore, increased traffic on the local road and the access road leading to the landfill poses a threat to the environment in case of an accident or disaster.

The site of Vasov Do is situated right next to a watercourse and causes contamination of local surface and groundwater through seepage of wastewater from the landfill. The surrounding ground and air are also contaminated and the neighboring land and water habitats are also threatened. Removal of the pollution and subsequent rehabilitation of the polluted resources should result in improved quality of air, ground and water in the local area. Although the situation is expected to improve after the planned rehabilitation, possible cumulative effects need to be taken into consideration due to planned construction of other infrastructure facilities in the area, such as the section of the Bar - Boljare highway. Consequently, this location is not considered acceptable for further use as a sanitary landfill.

The construction of the transfer station facilities, materials recovery facilities (MRFs) and recycling yards will have a permanent impact through reallocation of the existing land; however, since these facilities are mostly built within the construction area, this impact is not considered significant. Due to increased transportation of waste, the operation of these facilities will intensify traffic on nearby roads and bring about increased levels of noise and local air pollution through emissions of exhaust gases and particulate matter, thus deteriorating the quality of life of the local population. In addition to that, increased traffic operations can cause accidental spilling/leakage of hazardous substances, leading to possible contamination of the surrounding soil and water; furthermore, a fire and/or explosion can also increase the concentration of pollutants in the air.

The sanitary landfill site will also include a green waste composting plant. In the northern region, a composting plant is planned not only withing the sanitary landfill but as a separate facility in the municipality of Pljevlja. The composting plant can cause pollution of surface and groundwater if leachate is improperly treated. Air pollution can be caused by emissions of gases (GHG), particulate matter and unpleasant smells, if the composting plant is an open-type facility. The advantage of placing a composting plant within a sanitary landfill site instead of a separate location lies in the more effective surveillance and control of wastewater discharge and emissions, as well as in the reduced number of green waste transport routes needed.

Having considered all the circumstances relating to waste transportation, the exploitation of the Duboki Do site is a better and less risky solution than the transportation of waste along the Kotor Bay shore and sea coast to the landfill in the town of Bar. Therefore, this is a more acceptable solution for the municipalities of Kotor and Herceg Novi, especially during the tourist season. Transportation of waste within the 5 regions concept mainly involves transport over a short distance and therefore smaller volumes of waste to be transported. This type of transport is not a significant risk to the environment, except for the fact that there will be some increase in traffic around the location of the waste management system.

2) Option 1 - 5 regions

Table 6.5-2. Impacts and risk features related to Option 1

Impact / risk	OPTION 1					
	Sanitary landfill - Bijelo Polje (Ramčina, Zaton)		Sanitary landfill - Budoš (Nikšić)		Sanitary landfill - Duboki Do (Herceg Novi)	
	Regular operation	Accident	Regular operation	Accident	Regular operation	Accident
Air						
Climate factors						
Water						
Land, soil						
Biological and landscape diversity						
Population, public health						
Cultural heritage						
Material assets						

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impacts / Risks

The difference between this option of the waste management system and the initial proposal is the change of the center for the Northern Region, from the municipality of Berane to the municipality of Bijelo Polje. Based on a comparative analysis of six possible sub-options (section 6.1.) in the municipality of Bijelo Polje, the locations Ramčina and Zaton have been selected as the most suitable. Selection of the municipality of Bijelo Polje to accommodate the sanitary landfill is an advantage compared the area of Berane, due to a better transport position which includes a central accommodation in the northern region and thus a shorter distance (100 km) needed to transport the waste from different municipalities of the northern region. Furthermore, the site in the area of Bijelo Polje, primarily its sub-options Ramčina and Zaton, is a favorable solution considering the other options related to the traffic connections within and between the regions, such as the vicinity of the planned highway section (Bar - Boljare) and the railway line.

The construction of the sanitary landfill at the location of Budoš is not expected to have a highly significant impact on any of the analyzed aspects of the environment and the location is considered as the lowest-risk compared to other analyzed sites. In an accident occurs, it might have a potentially

significant impact on the local air quality, groundwater and biological diversity of the wider area. The planned sanitary landfill at the Duboki Do site can have a significant - and in case of an environmental accidents a very significant - adverse impact on groundwater and the drinking water springs in the area (Morinjska izvorišta), and consequently on the population health. The site of Duboki Do is situated in a vulnerable biodiversity area (vicinity of the coastal mountains biological corridor Orjen-Lovćen-Rumija, vicinity of a proposed national park and Emerald network of Orjen, and immediate vicinity to the border of the UNESCO protected area of Kotor-Risan Bay) and therefore it is considered hazardous, both during regular operation and in the event of an environmental accident at the landfill. Furthermore, the site is considered hazardous because it is located on the top of the mountain where weather conditions are very extreme, and the precipitation is likely to increase even more due to the expected climate changes. Considering the fact that the site is located on a mountainous area that is difficult to access, this might be a significant problem in the event of an accident, as the location may be difficult to access. Furthermore, increased traffic on the local road and the access road leading to the landfill poses a threat to the environment in case of an accident or disaster.

The construction of the transfer station facilities, materials recovery facilities and recycling yards will have a permanent impact through reallocation of the existing land; however, since these facilities are mostly built within the construction area, this impact is not considered significant. Due to increased transportation of waste, the operation of these facilities will intensify traffic on nearby roads and bring about increased levels of noise and local air pollution through emissions of exhaust gases and particulate matter, thus deteriorating the quality of life of the local population. In addition to that, increased traffic operations can cause accidental spilling/leakage of hazardous substances, leading to possible contamination of the surrounding soil and water; furthermore, a fire and/or explosion can also increase the concentration of pollutants in the air.

In the northern region, a composting plant is planned not only withing the sanitary landfill but as a separate facility in the municipality of Pljevlja. The composting plant can cause pollution of surface and groundwater if leachate is improperly treated. Air pollution can be caused by emissions of gases (GHG), particulate matter and unpleasant smells, if the composting plant is an open-type facility. The advantage of placing a composting plant within a sanitary landfill site instead of a separate location lies in the more effective monitoring and control of wastewater discharge and emissions, as well as in the reduced number of green waste transport routes needed.

Having considered all the circumstances relating to waste transportation, the exploitation of the Duboki Do site is a better and less risky solution than the transportation of waste along the Kotor Bay shore and sea coast to the landfill in the town of Bar. Therefore, this is a more acceptable solution for the municipalities of Kotor and Herceg Novi, especially during the tourist season. Transportation of waste within the 5 regions concept mainly involves transport over a short distance and therefore smaller volumes of waste to be transported. This type of transport is not a significant risk to the environment, except for the fact that there will be some increase in traffic around the location of the waste management system.

3) Option 2 - 3 regions

Table 6.5-3. Characteristics of the effects and risks related to Option 2

Impact / risk	Sanitary landfill - Bijelo Polje (Ramčina, Zaton)	
	Regular operation	Accident
Air		
Climate factors		
Water		
Land, soil		
Biological and landscape diversity, protected areas		
Population, public health		
Cultural heritage		
Material assets		

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impacts / Risks

The difference between this waste management option and the option with 5 regions lies in the merger of the two central and two coastal sub-regions into one with center in Podgorica and Bar. Reducing the number of regions from 5 to 3 will change the waste transport patterns in the central and coastal region. The waste from the central region will be transported directly to the sanitary landfill Livade (Cetinje, Danilovgrad) or via transfer stations and MRFs (Nikšić, Šavnik, Plužine). A number of recycling yards will be established in the central region - in the territory of Cetinje, Danilovgrad, Nikšić and Podgorica, as well as Plužine and Šavnik. Shortening the transport routes from Plužine and Šavnik via the transfer station in Nikšić will prevent intensification of traffic due to an increased number of transport routes in the direction of Podgorica, thus reducing the potentially adverse impact on the population and the environment as well. Transportation of waste from the coastal region to Duboki Do is a less threatening solution than the transportation of waste along the Kotor Bay shore and sea coast to the landfill in the town of Bar, especially during the tourist season. Regardless of this fact, the increased transport of waste to the Duboki Do site implies a risk to the environment because it is a vulnerable karst mountainous area.

The adverse impact of waste transportation refers to the penetration of hazardous substances in the environment (soil, water) as a result of an accident (leakage/spillage) or of an intentionally induced situation. Systematic monitoring of such occurrences has proven that the cumulative impact of frequently occurring minor spills constitutes a much more important environmental threat than major

disasters (Source: European Environment Agency Report, No 7/2014). Transportation activities lead to increased emissions of dangerous substances such as particulate matter ($PM_{2.5}$, PM_{10}) and gases (NO_x), which under the influence of unfavorable geography (mountain valley) and micro-climate effects (poor air streaming) can deteriorate the existing air quality at the local level. Furthermore, the transport activities lead to introduction of invasive species into areas where they were not present previously and thus can significantly endanger native species and biological diversity of a particular area.

4) Option 3 - Centralized system

Table 6.5-4. Characteristics of the effects and risks related to Option 3

Impact / risk	**Thermal treatment (incineration)**	
	Regular operation	**Environmental accident**
Air		
Climate factors		
Water		
Land, soil		
Biological and landscape diversity, protected areas		
Population, public health		
Cultural heritage		
Material assets		

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Impacts / Risks

Emissions from plants

The waste water resulting from the operation of the system come from the so called "wet processes" and such water will have higher concentrations of salts (such as chloride), and soluble heavy metals[59]. The actual concentration depends on the composition of waste as feed material. The amount of discharged waste water depends on the applied technology and can vary from zero if the water is used for cooling the ashes to 0.3 m^3/metric tonne of waste if scrubbers are used for wet treatment of flue gases. Apart from waste waters discharged from the technological processes, there is also waste water from washing machines etc. and contaminated rainwater. Waste water is contaminated with waste

[59] Source: Technical guidance report - Municipal Solid Waste Incineration (World Bank, 1999)

residues and contains relatively high concentrations of organic matter. It is treated at a waste water treatment plant before being discharged into the recipient.

Heat treatment of municipal waste generates ash, which represents about 10% of the volume and 25-35% weight of the treated waste. Within the thermal waste treatment plant it is necessary, in an early stage of the project, to plan how and where to dispose of the ashes in an environmentally friendly way. The ash from the thermal treatment can contain concentrations of heavy metals such as lead, cadmium, mercury, arsenic, copper, zinc, derived from plastics, printing inks, batteries, some rubber products and hazardous waste from households and small industrial generators. Organic compounds such as dioxins and furans were also discovered in the ashes. Most of the heavy metals (e.g. mercury, cadmium and lead) come from objects that are usually found in waste such as household batteries, thermostats, fluorescent lamps, plastic and other objects (e.g. consumer electronics). Removing these items from the waste directly at the household, commercial and industrial sources of the waste significantly reduces metal content in the ash after thermal treatment. The ash from the heat treatment can have a significant impact on the environment, in the event that after its deposition metals and organic compounds are washed away and enter the groundwater and nearby surface water. In addition to the possible contamination of the water supply system, the ash can directly affects human health, by inhalation or ingestion of air or deposited ash. The ash from the thermal treatment process (floating and sitting at the bottom) is usually disposed of in a landfill of municipal solid waste (ideally in a separate section) or on a separate landfill for disposal of this type of waste. As the ashes from thermal treatment are usually disposed of in a municipal waste landfill, conventional environmental protection measures that are used in sanitary landfills (collection and treatment of leachate), gain on importance. Alternatively, landfills intended only for the disposal of ashes from thermal treatment processes can be specially designed in order to prevent the possibility of migration of heavy metals in the environment. Finally, the ash can be stabilized and solidified before disposal, which significantly reduces the possibility of migration of pollutants. Such sites are often located near the thermal treatment plant or the existing landfills to reduce transportation distance and other problems related to location.

In order to meet the current environmental standards, modern equipment for pollution control is designed and is able to effectively remove the vast majority of emissions that may pose a threat to the environment. Appropriate control of air emissions, however, requires more than the presence of emission control technologies. The plants for thermal treatment of municipal solid waste must have good operational management and proper maintenance in order to ensure the lowest possible emissions levels. Good practice applied during the incineration process can help control emissions by ensuring that the temperature in the incineration chamber and the stay-time of the waste in the chamber is maintained at the optimum level. Major oscillations in those or other thermal treatment operations could cause limited but significant emissions into the air. More modern incineration plants are equipped with control systems to maintain a high degree of consistency in the operation of the plant. Equipment for the control of air pollution must be carefully maintained to prevent emissions of polluting substances. These demanding technical circumstances represent an obstacle for the thermal treatment technology in most developing countries. The need to maintain the emission control system at the highest level for a prolonged period of time is challenging enough even in developed countries. Small errors in the operation of such facilities can easily lead to significant emissions of pollutants.

Risks connected with transportation of waste

The activity of a thermal waste treatment plant (waste-to-energy plant) requires transport of significant volumes of waste over long distances (up to 200 km). Transportation of waste is the most expensive part of the waste management system. Given the state of the economy of Montenegro, such comprehensive requirements for the transport of waste allow a continuation of illegal waste disposal.

Furthermore, transportation over long distances involves significant risks for the environment and the population.

System-related implications relating to the necessity of continuous operation

The operation of a single centralized waste-fueled power plant as the only waste management option in the country, establishes a system that relies on continuous operation of such a plant. Such situation can have several adverse implications. First of all, the planned waste-fueled power plant as the only waste management option in the country, makes placing any kind of restrictions on the operation of such facilities difficult, even if it does not work properly. Such monopoly situation makes it difficult (or even impossible) to close the plant down in the event that it does not meet the conditions and environmental standards. The need for continuous operation of the plant will make it difficult to close such a facility temporarily, even for the purpose of longer lasting repairs or modifications. Finally, possible financial problems of the operator of such a facility would create unfavorable conditions for the operation of the national waste management system. Reference can be made to the crisis situation with waste management in the city of Naples which culminated in the summer of 2008.

Cumulative/synergistic effects

In the wider area of the town of Nikšić, there are several important industrial and supporting facilities which, according to the results of the existing air quality monitoring, show that allowed values for certain substances are frequently exceeded (SO_2, PM, CO, NOx). These are the following plants and facilities (Figure 6.5-1.):

- Ironworks Nikšić
- Transfer station and warehouse of the bauxite mine Nikšić,
- Landfill Halda,
- Brewery Trebjesa AD,
- Asphalt base.

The construction of the plant for thermal waste treatment allows for a cumulative effect of these plants on the air quality that could result in its quality reduction. Taking into consideration the current situation with poor air quality in the wider area, the cumulative effect could have a significant negative impact on the health and quality of life of local residents. With the modernization and the introduction of measures for improvements as well as with control and monitoring of these plants, it is possible to reduce or even prevent the emission of air pollutants and significantly improve the existing air quality.

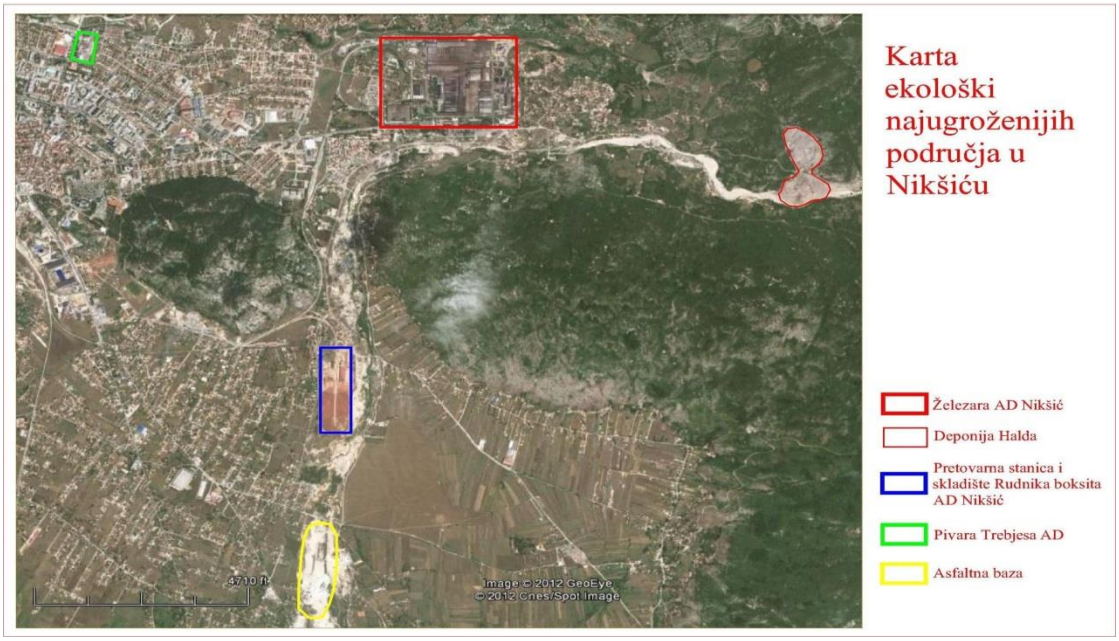


Figure 6.5-1. Map of the contaminated sites (source: *PUP Opštine Nikšić, Nacrt Plana, 2014.*)

The surface waters of the wider area of the town of Nikšić are burdened by pollutants, mainly originating from industrial sources. The industrial plants of Željezara (Ironworks) Nikšić discharge waste water (technological, sanitary and atmospheric) in the rivers Gračanica and Bistrica without prior treatment, wherefrom waste waters flow into the Zeta River. The analysis of the water of the river Zeta confirmed anthropogenic pollution which reaches the watercourse. Also, there is a great danger in case of contamination of drinking water sources, and the analysis of the quality of drinking water also showed that certain quality parameters of the drinking water were exceeded at the measuring point Vidrovan, where the water supply zone of the town of Nikšić is situated (upper and lower Vidrovan) (source: Draft Plan of PUP of the Nikšić Municipality, 2014).

The construction of a plant for thermal waste treatment allows for cumulative effect with regard to discharges of waste water from the existing and planned facilities, hence considering the existing poor water quality, a significant negative impact on the quality of surface water and groundwater is possible. The pollution could threaten drinking water sources i.e. areas of water supply for the population and the food industry.

5) Summary of the proposed options

The table below provides an overview of the proposed waste management options (Initial proposal, Option 1, Option 2 and Option 3) and their impact/risk to the environment.

Impact / risk	INITIAL PROPOSAL						OPTION 1						OPTION 2		OPTION 3	
	Sanitary landfill - Vasov Do (Berane)		Sanitary landfill - Budoš (Nikšić)		Sanitary landfill - Duboki Do (Herceg Novi)		Sanitary landfill - Bijelo Polje (Ramčina, Zaton)		Sanitary landfill - Budoš (Nikšić)		Sanitary landfill - Duboki Do (Herceg Novi)		Sanitary landfill - Bijelo Polje (Ramčina, Zaton)		Thermal treatment (incineration)	
	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Reg. operation	Accident	Regular operation	Accident
Air																
Climate factors																
Water																
Land, soil																
Biological and landscape diversity																
Population, public health																
Cultural heritage																
Material assets																

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

7. AN OVERVIEW OF REASONS USED AS A BASIS FOR THE SELECTION OF CONSIDERED ALTERNATIVE SOLUTIONS, AND A DESCRIPTION OF ESTIMATES METHODS AND OF POSSIBLE DIFFICULTIES IN THE FORMULATION OF REQUIRED DATA

The strategic study analysed the waste management option in Montenegro that is at proposed in the draft Waste Management Plan of Montenegro for the period 2014-2020. (2014) and the options proposed in the draft Waste Management Plan of Montenegro for the period 2014-2020. (2015).

The "Initial proposal" proposed in the draft Waste Management Plan of Montenegro for the period 2014-2020. (2014) refers to the establishment of 5 regions and regional centers within the system of regional waste management.

Options "1, 2 and 3" proposed in the draft Waste Management Plan of Montenegro for the period 2014-2020. (2015) refer to the formation of 5 and 3 regions and regional centers within the system of regional management and the formation of a single region, and one center within the framework of a single centralized system of waste management.

The strategic study analysed the alternative solutions of technologies considered in the Plan and relate to the technology of thermal treatment of municipal waste and sewage sludge treatment technology from the plant for purification of urban waste water.

7.1. OPTIONS PROPOSED IN THE PLAN

1) Initial proposal (draft NWMP, 2014)

The initial proposal includes the planning of municipal solid waste management in Montenegro by setting up **five regional centers** (Center 1, Center 2, Littoral 1, Littoral 2 and North 1). The centers of these regions would be positioned in Podgorica, Nikšić, Berane, Kotor and Bar.

Waste Management Region - Center 1 consists of the municipalities of Podgorica**,** Danilovgrad and Cetinje. There is no need to establish a transfer station. Various waste streams have to be transported separately to the existing, operating plant in central Podgorica (Meadows). Central composting of green waste will be conducted at the same location. All waste, upon selection and sorting, will be disposed of in the sanitary landfill Livada. Minimization of the amount of organic waste at its source will be implemented by introduction of courtyard (home) composting.

Waste Management Region - Centre 2 includes Nikšić, Šavnik and Plužine. Transfer of waste from Plužine shall be required, while the collection and transportation of waste in Šavnik is incorporated in the activities carried out by the municipality of Nikšić. Waste Transfer from Plužine to Nikšić will require the installation of a transfer station. Nikšić takes over all quantities of green waste as well as the processing of all waste streams. The transfer of waste from Plužine will be implemented in accordance with different waste streams. Yard composting is a planned activity in Plužine and Šavnik, with the aim of reducing the amount of biological waste. Nikšić, as a central treatment plant and waste treatment plant, requires that facilities for the return of materials, as well as composting facility, be set up (separation and selection).

Waste Management Region - Coastal area 1 consists of the municipalities of Tivat, Kotor, Budva and Herceg Novi. The whole coast already has a significant infrastructure for waste management. Yard (home) composting is not significant because of the structure of the population and the population density. The municipalities of Budva, Tivat and Kotor will direct their joint activities towards the existing plant for waste processing on the site Lovanja II. Herceg Novi provides an already set up and operational facility for classification/selection of the plant for waste reception.

Waste Management Region -Coastal area 2 has the most modern sanitary landfill which has sufficient capacity to service the entire region. Because of tourism activity along the coastal belt, it is recommended that, during the peak of the tourist season, the waste remaining after processing from the entire region of Coastal area 1 is transported to the sanitary landfill in Herceg Novi, and outside the tourist season to the sanitary landfill Možura (Littoral 2). In that case, Herceg Novi would transport only green waste to Kotor (Lovanja I). It is necessary to establish a central composting plant at the site Možura (Coastal area 2) for processing green waste from Ulcinj and Bar. It is necessary to establish a transfer station in Herceg Novi for transport of the remaining amount of waste to the sanitary landfill in Kotor (Lovanja I). In addition, it is necessary to expand the existing transfer station in Kotor so it would be able to accommodate additional quantities from Budva. Material recovery plant (MRF) operates at full capacity. For the sanitary landfill Možura it is necessary to build a material recovery plant as well as a plant for composting green waste.

Waste Management Region - North 1 divided into sub-areas such as 1a (Žabljak and Pljevlja), 1b (Kolašin, Mojkovac and Bijelo Polje) and 1c (Berane, Andrijevica, Plav and Rožaje). All amounts of waste from Žabljak are transported to a material recovery plant in Pljevlja. Green waste is transported separately from household waste. Green waste is treated in Pljevlja, in the plant for composting green waste because of the distance to the central plants in Berane. Household waste from Pljevlja and Žabljak, which is collected separately based on the system of two buckets, is separated into recyclable materials and residual components. Due to the rural character of these municipalities, a significant potential for minimizing the amount of waste through backyard composting can be noted. In addition, the plan should anticipate transportation of all previously selected waste from Žabljak to Pljevlja so that the waste can be jointly processed and stored in the transfer station for one month in cases when weather conditions do not permit safe transport of waste. Due to insufficient capacity, and available land, the plan is to combine the transfer of waste from Kolašin and Mojkovac over a transfer station, from where the waste is transported to a central facility for treatment and disposal of waste in Berane. This is also true for green waste to be composted at a central area of a sanitary landfill.

2) Option 1 (Draft NWMP, 2015)

Option 1 includes planning of municipal solid waste management in Montenegro through the establishment of **five regional centers** (Center 1, Center 1, Coastal area 2, Coastal area 1 and North 2). The centers of these regions would be positioned in Podgorica, Nikšić, Bijelo Polje, Bar and Herceg Novi.

Waste Management Region - Center 1 consists of the municipalities of Podgorica**,** Danilovgrad and Cetinje. There is no need to establish a transfer station. The center of the region will be on the location of the sanitary landfill Livade. Setting up of recycling yards in the territory of Cetinje and Danilovgrad is planned. Within the sanitary landfill complex, or in a different location, a modern plant for composting will be built. On the territory of Podgorica, it is necessary to determine the location for the setting up of a solar drying plant for pre-treatment of sewage sludge coming from the waste water treatment plant.

Waste Management Region - Centre 2 includes Nikšić, Šavnik and Plužine. The regional centre in Nikšić should include regional waste management center (MRF plant). In order to transfer waste from Plužine and Šavnik to Nikšić installation of a transfer station is required. Yard composting is a planned activity in Plužine and Šavnik, with the aim of reducing the amount of biological waste. Nikšić, as a central treatment plant and waste treatment plant, requires that facilities for the return of materials, as well as composting facility, be set up (separation and selection). Construction of recycling yards on the territory of all municipalities is also planned. In the municipality of Nikšić, it is necessary to determine the location for the establishment of solar driers for sewage waste that will be generated by the operation of the planned plant for purification of waste water.

Waste Management Region - Coastal area 1 consists of the municipalities of Bar and Ulcinj. The Regional Center in Bar should include a regional waste management center (MRF plant). Construction of additional transfer stations is not planned. Within the sanitary landfill complex in Bar, construction of facilities for composting, anaerobic digestion and mechanical-biological treatment is envisaged. Establishment of recycling yards in all municipalities of the region is also planned, provided that the recycling yard is part of the MRF plant, if it is to be built even after its construction is completed. It is necessary to determine the location, in the municipality of Bar, for a solar drying plant for pre-treatment of sewage sludge, which will be generated by the planned wastewater treatment plant.

Waste Management Region - Coastal area 1 consists of the municipalities of Herceg Novi, Kotor, Tivat, and Budva. The regional Center in Herceg Novi should include a regional waste management center (MRF plant). Both MRF facility and transfer station exist in Kotor and the waste and the municipalities of Kotor, Budva and Tivat will be treated at the site. Construction of additional transfer stations is not planned. As part of the recycling center complex in Kotor, construction of composting facilities is planned i.e. it is already underway. This facility is planned primarily for treatment of green waste as well as for treatment of part of organic waste fractions from mixed municipal waste. Establishment of recycling yards in all municipalities of the region is also planned, provided that the recycling yard is part of the MRF plant, if it is to be built even after its construction is completed. It is necessary to determine a location, in the municipality of Herceg Novi and Budva, for the establishment of a solar drying plant for pre-treatment of sewage sludge, which will be generated by the planned wastewater treatment plant. Given that Budva is almost equally distant from Kotor and from Bar and that larger traffic congestions are known to be created at the entrance to Kotor during the summer season, Budva must be allowed to determine for itself whether it would be more suitable to be part of the region of Coastal area 1 or Coastal area 2. This decision will of course be determined also by the economic aspect, i.e. the price level established for services of secondary selection and disposal.

Waste Management Region - North 1 includes the municipalities of Bijelo Polje, Žabljak, Pljevlja, Kolašin, Mojkovac, Berane, Andrijevica, Plav and Rožaje. The regional center in Bijelo Polje should include a regional waste management center (a MRF plant). As part of the future sanitary landfill complex, or in a different location, facilities for composting, anaerobic digestion and mechanical-biological treatment will be built. Establishment of recycling yards in all municipalities of the region is also planned, provided that the recycling yard is part of the transfer station or the MRF plant, if it is to be built even after its construction is completed. This is a region where the construction of the largest number of transfer stations is planned and, due to its specific characteristics, there is a need for planning certain alternative solutions for some parts of the planned management system. A feasibility study must carefully consider both the main and the alternative solutions. It is necessary to determine a location, in the municipality of Bar, for the establishment of a solar drying plant for pre-treatment of sewage sludge, which is generated by the planned wastewater treatment plant.

3) Option 2 (Draft NWMP, 2015)

Option 2 involves the setting up of **three regional centers** (Center, North, Coastal area). The centers of these regions would be positioned in Podgorica, Bijelo Polje and Bar.

Waste Management Region - Center consists of the municipalities of Podgorica, Cetinje, Danilovgrad, Nikšić, Plužine and Šavnik. The regional center in Podgorica will include a center for secondary selection of the components of mixed waste, a sanitary landfill, a plant for dismantling vehicles out of use and preparation for reuse and/or for recycling of their parts, as well as two recycling centers. Establishment of recycling yards on the territory of Cetinje, Danilovgrad, Nikšić and Podgorica, Plužine and Šavnik is also planned. Construction and green waste management would be conducted in the same manner as described in Option 1.

Waste Management Region – North consists of the municipalities of Polje, Mojkovac, Kolašin, Pljevlja, Žabljak, Berane, Rožaje, Plav, Andrijevica. It is planned that the regional centre is located in Bijelo Polje. The region will be fully functional just as the Region North will, which is presented within the framework of Option 1, as described in the previous section.

Waste Management Region - Coastal area consists of the municipalities of Bar, Ulcinj, Budva, Kotor, Herceg Novi, and Tivat. It is planned that the regional centre is located in Bijelo Polje. The region will function fully just as the Region North will, which is presented within the framework of Option 1, as described in the previous section.

4) Option 3 (Draft NWMP, 2015)

Option 3 involves the establishment of **a single region** at the country level. The regional centre would be located in Nikšić and would involve the construction of a thermal waste treatment plant. It would involve all municipalities in Montenegro in order to achieve safe provision of waste quantities necessary for operation and maintenance of the plant. The operation of the plant for thermal waste treatment will include sewage sludge from the waste water treatment plant. The establishment of a single regional waste management center will serve to transport waste from transfer stations and plants for secondary waste selection (MRF) to the single waste management facility in Nikšić. In the waste management centre in Nikšić, next to the plant for thermal waste treatment, an area for temporary waste storage will be built, as well as area for storage of sewage sludge brought to the location, area for storage of ash and slag left over after the heat treatment, but also a line for secondary selection of mixed municipal waste brought to the territory of Nikšić.

Before the construction of a waste thermal treatment, it is planned that secondary selection will be performed by the existing MRF plants in Podgorica, Herceg Novi and Kotor. Construction of additional three (3) centers for secondary waste selection (MRF) is planned for the purposes of processing waste from the municipalities of the northern part of the country: in Bijelo Polje, Berane and Pljevlja, as well as the construction of one (1) MRF plant in Bar. Construction of the MRF plant in Nikšić, for the purposes of the municipality of Nikšić, Plužine and Šavnik is also planned.

After the construction of the thermal waste treatment, secondary selection is planned to be performed in the existing MRF plants, but also in the MRF plants in Bijelo Polje, Berane, Pljevlja and Bar, which are to be built by then. For the municipalities of Plužine and Šavnik, a construction of a transfer station is planned. Green waste would mainly be disposed of at municipal level or at the inner region level and, if necessary, burned at the plant for thermal waste treatment.

Comparative analysis of the listed options in view of the possible effects/risks to the environment is given in Chapter 6.5.

7.2. ALTERNATIVE SOLUTIONS FOR THE PROJECT

Proposed alternatives for technologies of thermal treatment of municipal waste

Thermal treatment procedures under the Plan, that comply with the BAT technologies are: burning technology (fully oxidizing combustion) i.e. incineration, pyrolysis (thermal degradation of organic materials in the absence of oxygen) and gasification (partial oxidation). Incineration is used for treatment of a very large number of different types of waste. Pyrolysis and gasification are less frequently applied for thermal waste treatment and the number of different types of waste that can be treated by these procedures is smaller.

The technology of thermal waste treatment by incineration involves the exploitation of the resulting energy (WtE - Waste to Energy plant). Both pyrolysis and gasification differ from incineration in that they can be used for using the chemical, leveraging value from waste (instead of their energy values). The obtained chemical products can be used in some cases as a raw material for other processes.

The primary purpose of waste incineration is to reduce the mass of waste by about 75% and the volume by about 90%, as well as the destruction of hazardous organic compounds and pathogens. Incineration system is in the process of continuous technological development. Improvements are focused on obtaining useful energy to the highest extent possible, reducing the price of construction, maintenance and energy yield, as well as maximum possible reduction of emissions and other substances that are products of combustion.

Besides the usual targets of waste incineration (i.e. effective waste treatment), additional objectives of the process of gasification and pyrolysis are: transforming certain waste fractions into process gas (called syngas or synthesis gas) and reducing the need for purification of flue gases by reducing their volume. In some cases, solid residues arising from such processes contain pollutants that are being transferred to gas phase in the system for incineration, and following efficient purification of flue gases, they are later removed together with the rest from the plant for purification of waste gases.

The process of incineration of municipal waste is followed by production of large amounts of flue gases. They contain the residue of incomplete combustion and high level of pollution, occurring in the form of particles and gases such as HCl, HF and SO_2. Given the composition of the waste and the nature of the chemical processes that accompany combustion, the type and concentration of pollutants depend on the composition of the waste and the combustion conditions. In order to prevent these, in fact, harmful substances to get into the atmosphere, flue gases must be purified to the extent permitted by applicable legislative stipulations. Accordingly, the emission limit values represent a limiting factor, and one of the basic conditions for the selection of cleaner technologies.

The thermal waste treatment produces residual waste generated by combustion and waste generated by cleaning flue gases. Waste generated by combustion (clay) can be used as material in road construction (eg. in the production of asphalt). Wastes from cleaning (flying ash) flue gases is additionally treated and stabilized and afterwards deposited to landfills for non-hazardous or hazardous waste respectively.

The analysis of potential impacts/risks to the environment during regular operation of the plant for thermal waste treatment or in emergency situations, is provided in Chapter 6.5.

Proposed alternatives for technologies for processing sludge from a wastewater treatment plant

On the territory of Montenegro, the sludge generated at the plants for waste water treatment is disposed of within the very plants, without any processing.

Within the system of waste management, treatment of sewage sludge contains several possible procedures. Those are the following procedures of sludge processing, also possible in accordance with the applicable regulations:

1. Disposal on agricultural land
2. Treatment on reedy fields
3. Reclamation of landfills and other areas
4. Incineration.

The application of further processing and re-use of sludge depends on its quality.

Sludge of A quality can also be used on agricultural land, after the stabilization and drying process or after composting if the sludge meets the conditions prescribed by the *Rulebook on detailed conditions to be fulfilled by municipal sewage sludge, no. 89/09.* Possible adverse effects on the soil and the quality of food given the possible unforeseen risks of intake of metals, inorganic pollutants, pathogens and other chemical compounds (drugs) into the ground. One possible application of sewage sludge is extensive (passive) technology which includes drying the sludge in fields planted with reeds with final production of humus, which can be used in agriculture.[60] This procedure requires data on the quality of the sludge and the content of dry matter as well as the number of required surfaces for drying sludge with planted with reeds and the dimensions of each individual field. Other factors, such as the final application of sludge and local regulations, must also be taken into account. Sizing and operation of the fields for drying sludge with planted reeds need to be adapted to weather conditions and crop requirements. The impact on the ground in this case exists because during the application of this method there would be a loss of agricultural land for food production. Given the quality of soil and sludge, it is possible to improve the situation, or in case of unallowed quantities of heavy metals in the sludge, to improve the situation with soil pollution. Sludge of the lower B quality can be used to improve soil quality in parks and green spaces, stream shores, for construction of wetlands and as a cover of landfills. The effect on the ground would be positive as it would enrich the soil where food is produced. The application of sludge on the surface of the landfill with the purpose of greening affects positively the landfill erosion, restores the natural appearance of the location and its integration into the environment. Sewage sludge of low, C quality, shall be incinerated or there will be reclamation of already polluted land, such as the land around the mines and landfills. The impact of using sludge on the soil would be positive because the soil would be reclaimed.

Currently, the area of Montenegro has 4 plants for wastewater treatment that are in operation (Podgorica, Mojkovac, Budva, Žabljak). According to project solutions, plants for incineration of sewage sludge are to be constructed in Podgorica, while drying of sewage sludge on fields with reeds is to be conducted in Mojkovac. Budva is considering disposal at the landfill Možura and usage of treated sewage sludge for remediation of dumpsites. The Municipality of Žabljak is considering the use of treated sewage sludge for the rehabilitation of urban landfills (*source: MSDT, 2015*).

[60] Strategy for eco-remediation in Montenegro with Action Plan for the period 2014-2020.

The concept of centralized waste management provides for incineration of sewage sludge in the plant for thermal waste treatment. The location of the plant is planned and storeroom broth sewage sludge**.**

The table below shows the (un)affordability of individual operations of sludge treatment with regard to possible impacts on key aspects of the environment:

Procedures / *Aspects*	Disposal on agricultural land	Treatment on reedy fields	Reclamation of polluted areas	Incineration
Air	-	-	-	air emissions
Water	the risk of the introduction of dangerous substances	the risk of the introduction of dangerous substances	-	-
Soil	the risk of the introduction of dangerous substances	loss of soil for other purposes; the risk of the introduction of dangerous substances	enhancement of the existing state of soil pollution	-
Health	the risk of transmission of dangerous substances through food	-	-	the risk of increased air emissions

Legend:

	Very significant impact / risk		Moderate impact / risk
	Significant impact / risk		No impact / risk

Based on the potential impacts on those key environmental aspects of certain operations of sludge treatment, the re-cultivation process of polluted areas is considered to be the best since its impact is positive, while the disposal methods in agricultural areas and the treatment on reed fields can have negative impact on the soil, the water and the inhabitants' health. Possible negative effects of the process of burning depend on the type of the plant, but basically almost all thermal processing techniques result in air emissions.

A comparison of the procedure variants considered for processing of sludge from waste water treatment plants did not take into account other analysis factors, such as economic, energy (e.g. the energy consumption for pretreatment of sludge, etc.), but it was based instead on the potential impacts on key aspects the environment (air, water, soil and the health of the population).

Therefore, as a short-term solution it is recommended to use sludge for reclamation of polluted areas. As a medium-term proposal (after re-cultivation of all landfills), it is recommended to implement treatment with production of biogas (anaerobic digestion) and a system for treatment of residual sludge on reed fields. The long-term solution for sludge treatment may represent a continuation of the previously mentioned treatment options or a part of the centralized concept which involves incineration within the plant for thermal waste treatment (waste to energy plants) provided that the competent inspection ensures transport of the sludge to the final thermal treatment plants in an efficient manner.

8. PLANNED MEASURES TO PREVENT, REDUCE OR ELIMINATE, TO THE HIGHEST EXTENT POSSIBLE, ANY SIGNIFICANT NEGATIVE IMPACT ON HEALTH AND THE ENVIRONMENT CAUSED BY THE IMPLEMENTATION OF THE PLAN

8.1. MEASURES TO PREVENT, REDUCE AND ELIMINATE THE IMPACT ON HUMAN HEALTH AND THE ENVIRONMENT

Measures of protection and reducing the impact on surface and ground waters

1. The choice of a location for the sanitary landfill, as well as the location for the plant for thermal waste treatment is to be harmonized with the documents defining the zones of sanitary protection of water resources.
2. When designing the precipitation drainage system for landfills and other facilities of the municipal waste management system, priority should be given to solutions that include closed drainage systems.
3. It is necessary to ensure that the closing of a landfill takes place simultaneously with the opening of a new one. In the course of rehabilitation, where possible, advantage should be given to methods of biological remediation in a manner that would enable maximum achievement of the original near-natural state, in consultation with the guidelines of the "Strategy for eco-remediation in Montenegro," (Podgorica, 2014). The rehabilitated sites must be fenced off and subjected to regular inspections.

Measures of protection and reducing the impact on biological and landscape diversity and protected areas

1. When choosing locations for landfills and other facilities of the waste management system, it is necessary to use for this purpose existing degraded areas to the biggest extent possible.
2. The sites for sanitary landfills need to be planned primarily outside of protected areas and areas important for biodiversity.
3. During the preparation of the project documentation (environmental studies, etc.) for each landfill, the latest data on habitats (habitat map) and protected areas (border areas, of the future Natura 2000 sites) should be consulted.
4. It is necessary to initiate and sponsor a program of regular cleaning of garbage discarded or spread along the roads and in places under protection (natural and cultural heritage) as well as attractive tourist sites. These activities need to be implemented in cooperation with non-governmental organizations, schools and other stakeholders.

Measures of protection and reducing the impact on the population and public health

1. A priority is to start activities on the rehabilitation of the existing landfill Vasov Do in Berane.
2. It is necessary to proceed with the mapping of locations of illegal dumpsites and to make this information available to the public, in collaboration with NGOs.
3. Develop a program to raise awareness as a support to waste separation at its source.
4. Develop a program of raising awareness in order to prevent waste dumpsites.

Mitigation of climate factors

1. It is necessary to build a gas collection system within the framework of projects for the existing landfills Možura (Municipality of Bar) and Livade (Municipality of Podgorica).

8.2. RECOMMENDATIONS FOR IMPROVEMENTS IN THE COURSE OF THE IMPLEMENTATION OF THE PLAN

1. It is necessary to provide support to the municipalities of the northern region during the design of the planned landfill.
2. During the site selection for sanitary landfills, follow the criteria from the regulation – "*Pravilnik o bližim karakteristikama lokacije, uslovima izgradnje, sanitarno-tehničkim uslovima, načinu rada i zatvaranja deponija ("Sl. list Crne Gore", br. 31/13 od 5.07.2013)"*. Specially consider criteria as follows:
   - The edge of the body of the landfill should be at distance of min 500 m from permanent waterflows and lakes, except the waterflows with low flows,
   - The body of the landfill should be designed and built outside the I, II and III zone of sanitary water protection, in compliance with particular regulations,
   - The body of the landfill should be designed and built in order not to be flooded with underground waters in any hydrological condition,
   - The body of the landfill should be designed and built outside the area with significant flood recorded in the past,
   - The edge of the body of the landfill should be at distance of min 300 m from settlements, recreational zones, public parks, rehabilitation centars and spa-s, and agricultural lands aimed for vegetable farms,
   - The edge of the body of the landfill should be at distance of min 300 m from protected areas of the natural and historical heritage.
3. Develop a cost feasibility study for the purpose of selecting the best possible solution for heat treatment technology of municipal waste in the territory of Montenegro. To ensure that the study adequately analyses key issues related to environmental protection (emission control, systemic implications of the entire waste management system, risks).
4. Develop a study of the possibilities for using the railway for transport of municipal waste in the territory of Montenegro.

9. OVERVIEW OF POSSIBLE SIGNIFICANT CROSS-BORDER ENVIRONMENTAL IMPACTS

As signatory to the Espoo Convention and member of the Kiev Protocol, Montenegro has committed to inform the other states of any projects that may have impacts across its international borders. In relation to the possible trans-boundary impacts resulting from the activities of the Plan, the strategic assessment considered the following activities and waste management system facilities:

- Plant for thermal waste treatment in the area of Nikšić

  In case of accidents at the plant for thermal waste treatment, potentially significant air pollution can occur, which in adverse weather conditions (wind speed and direction) can expand to a wider area, which could potentially affect neighboring countries (Bosnia and Herzegovina, Croatia). Therefore, it is recommended to carry out cross-border consultations in accordance with the requirements of the Espoo Convention, with Bosnia and Herzegovina and Croatia, when developing environmental impact assessment for the project, which will be created if there is a more detailed design of such facilities.

- Sanitary landfill in Bijelo Polje (sub-option Goja and Kumanica)

The sites Goja and Kumanica are located near the Montenegrin border with Serbia. Both locations are on visually exposed positions. Since there are other infrastructural facilities in the vicinity (roads, railway) there will be additional disruption of the quality of the landscape of the wider area, which in cross-border context can be significant given the proximity of the route which in the future can expect a significant influx of tourists due to planned greater development of tourism in the northern part of the country. Also, the sites are located near an area of the ecological network of the River Lim valley that extends along the border area. The proximity of the location of the sanitary landfill is a potential risk to the aquatic ecosystem of the river Lim. For these and other reasons, it is not recommended that these locations are considered as priorities for the accommodation of a sanitary landfill. If however, there is a further consideration of these locations, it is suggested to undertake at least basic cross-border consultations within the framework of project impact assessment on the environment in both locations.

10. ENVIRONMENTAL MONITORING PROGRAM DESCRIPTION, INCLUDING HEALTH, DURING REALIZATION OF THE PLAN (MONITORING)

It is recommended to monitor the following priority issues:

- Significantly strengthen and improve the monitoring of waste quantities disposed of in sanitary landfills.
- To continue to monitor the situation and the number of illegal dumpsites, as it has been so far done by the non-governmental organizations, and to provide public access to this data.
- To monitor the work of inspection services (number and amount of penalties).

11. CONCLUSIONS OBTAINED DURING THE DRAFTING OF THE REPORT ON STRATEGIC ASSESSMENT, PRESENTED IN A MANNER UNDERSTANDABLE TO THE PUBLIC

Key findings related to certain facilities / plants

The sanitary landfill sites in Ramčina and Zaton (Bijelo Polje) and Budoš (Nikšić) are emphasized as at least potentially problematic objects of the waste management system. These sites are characterized by a greater distance from the village, relatively good accessibility in terms of transport of waste (as compared to other landfills), stable geological conditions, lower risk of possible pollution of surrounding watercourses and low environmental sensitivity of the local area.

Sites which are also acceptable in terms of environmental protection are the remaining alternative locations Goja and Kumanica (Bijelo Polje). These locations are potentially risky due to the vicinity of surface water courses and ecological network areas and their visual exposure. However, these risks can be reduced to an acceptable level by applying protection and mitigation measures provided in the project's environmental impact studies and by applying good environmental management during the operation of landfills.

A risky facility of the waste management system is the location of the sanitary landfill Duboki Do (Herceg Novi). This site is risky because of its complex geological structure, the distance of areas with an extremely large amount of precipitation in the wider Mediterranean region and the immediate proximity of the future national park and UNESCO's World Heritage area of the Kotor - Risan bay. This location is also characteristic because of the risk of possible pollution of the water wells in the area in case of an accident (leakage or spillage from the landfill during extreme rainfall). Given the need for safe disposal of waste generated in the area of Herceg Novi, a landfill on the proposed location Duboki Do represents a less risky solution than a transport of waste from Herceg Novi, the Kotor Bay to another landfill.

A very risky option is the current proposal for facilities for thermal waste treatment (waste to energy plant) in Nikšić. This proposal is at an early stage of initial design idea hence any further parameters of this facility remain unknown. From what can be inferred about the possible project[61], this option could face several significant risks both during its regular operation, and during accidents. Most significant questions are those of the possible impacts and risks to the quality of air, soil and water, and consequently human health.

Finally, the location of the sanitary landfill in Berane (Vasov Do) and Bijelo Polje (Čelinska Kosa 1 and 2) do not represent a favorable option because they represent a potential risk to the environment. The site Vasov Do is located along a watercourse and causes the existing water pollution; the site Čelinska Kosa 1 is on an intermittent watercourse in the vicinity of an ecological network, while the site Čelinska Kosa 2 is located within the ecological network.

Key findings related to the options proposed for waste management system

[61] Despite the contacts that were established with representatives of the municipality of Nikšić on several occasions, the SEA team was unable to get material with design data and the features of such a plant. Suggestions on the SEA report were obtained from the municipality of Nikšić on 26 May and they stated as follows: "Bring the Report on SEA in line with Article 15 of the Act on Strategic Environmental Assessment", which specifies the content of the strategic assessment report. The part that describes the impact of the landfill must take into account that this is a technology that significantly affects all segments of the environment during the operation of the landfill. The environmental impact will remain great even after closing down the landfill, which implies decade-long monitoring. We believe that it is necessary to find a solution in the modern technologies that are applied in the EU countries (Germany, Sweden, etc.) in order to protect the environment."

When comparing environmental impacts of the four options for waste management system in Montenegro - the initial proposal (2014) and three options proposed in the revised draft NWMP, the strategic assessment reached the following conclusions:

- The least risky alternative proposal is Option 1 which includes two not very problematic proposals for sanitary landfills (Bijelo Polje and Nikšić) and one potentially problematic proposal for a sanitary landfill (Duboki Do). This system is characterized by transport of waste on a relatively short distance. The option includes the possibility of a limited risk of accidents both on-site and in the context of transport. The only problematic proposal, the location of Duboki Do - to be implemented as the last possibility within this option - and only after clarification of all uncertainties related to a possible conflict situation involving the sanitary protection zones in the area. If possible serious risks of pollution of the water supply system of the Morinje springs are confirmed, it will be necessary to look for alternative locations for the sanitary landfill area of Herceg Novi.
- More risky proposal is the alternative Option 2, which includes many of the same features as Option 1 but does not include the location of the sanitary landfill Budoš (Nikšić) which is not considered problematic. This option involves greater transport requirements that are associated with higher risks during waste transport. Therefore, the strategic assessment ranked this option as second favorable.
- The most risky proposal is Option 3, which includes a centralized facility for thermal waste treatment (waste to energy plant) in Nikšić. Given that more detailed information on this project is missing, this option may, at best, be characterized as moderately significant in terms of quality of air, soil and water as well as significant for risks associated with the transport of waste. This plant is very sensitive when it comes to mistakes in managing the object and can easily become the cause of an accident with serious consequences. Option 3 may have an adverse effect due to a number of possible accidents (during operation of the plant, during disposal of residual waste after the heat treatment and the transport of waste over long distances). Moreover, a centralized solution will make the whole waste management system of Montenegro reliant on continuous and uninterrupted operation of one single thermal waste treatment plant (waste -to- energy plant). It is impossible to predict what will happen with the system of waste management in case of shutdown of the plant for thermal waste treatment for the purpose of conducting routine maintenance, or as a result of possible accidents, or due to other factors (such as economic, legal, etc.). Taking into account all the risks, it is recommended to address the implementation of this option with extreme caution.

12. SOURCE OF DATA

1. Demografski trendovi u Crnoj Gori od sredine 20. vijeka i perspektive do 2050. godine
2. „EIA study for the construction of the regional sanitary landfill in the municipality of Bijelo Polje“ (2008.)
3. „EIA study on the construction of regional sanitary landfill in municipality Berane“ (2009.)
4. Elaborat o određivanju i održavanju zona sanitarne zaštite i ograničenjima u tim zonama za Morinjska izvorišta „Svrčak“, „Palić“, „Donja voda“, „Zminac“ i „Vrba“ (NIK STONE d.o.o. Nikšić, 2015.)
5. Elaborat o procjeni uticaja na životnu sredinu regionalne sanitarne deponije u Nikšiću, 2012.
6. Elaborat procjene uticaja na životnu sredinu za sanitarnu deponiju “Duboki do”
7. European Environment Agency Report, No 7/2014
8. Informacija o stanju životne sredine u Crnoj Gori za 2013. Godinu (Agencija za zaštitu životne sredine, 2014.)
9. Izvještaj o higijenskoj ispravnosti vode za piće za 2013. godinu, Institut za javno zdravlje Podgorica, 2014.
10. Izvještaj, program kontrole kvaliteta vazduha Crne Gore 2008 – 2013 (CETI)
11. Izvještaj o ispitivanju, program monitoringa buke u životnoj sredini za 2013. (CETI, 2014.)
12. Izvještaj o izvršenoj tehničkoj kontroli (reviziji) Elaborata o određivanju i održavanju zona sanitarne zaštite i ograničenjima u tim zonama za Morinjska izvorišta „Svrčak“, „Palić“, „Donja voda“, „Zminac“ i „Vrba“ (Podgorica, 2015.)
13. Katalog tipova staništa Crne Gore značajnih za Evropsku uniju (2012.)
14. Nacrt Državnog plana upravljanja otpadom 2014 – 2020 (Ministarstvo održivog razvoja i turizma, 2014.)
15. Nacrt Državnog plana upravljanja otpadom u Crnoj Gori 2014 – 2020 (Ministarstvo održivog razvoja i turizma, 2015.)
16. Popis stanovništva 2003., Zavod za statistiku Crne Gore (Monstat)
17. Popis stanovništva, domaćinstva u stanova 2011., Zavod za statistiku Crne Gore (Monstat)
18. Projekcije stanovništva Crne Gore do 2060. godine sa strukturnom analizom stanovništva Crne Gore, Zavod za statistiku Crne Gore (Monstat), 2014.
19. Prostorni plan Crne Gore do 2020. godine, 2008. (Službeni list 24/08)
20. Spisak divljih deponija po opštinama (OZON, 2015.)
21. Technical guidance report – Municipal Solid Waste Incineration (World Bank, 1999)
22. Vodoprivredna osnova Republike Crne Gore (Ministarstvo poljoprivrede, šumarstav i vodoprivrede 2001.)
23. World Heritage List – The Kotor natural, cultural and historical region (UNESCO, 1979)

13. LIST OF LEGISLATION

1. Nacionalna strategija biodiverziteta za period od 2010-2015.g.
2. Strategija regionalnog razvoja Crne Gore za period 2010-2014. godine
3. Nacionalna strategija održivog razvoja Crne Gore (2007.)
4. Nacionalna strategija upravljanja kvalitetom vazduha sa Akcionim planom za period 2013-2016. (2013.)
5. Strategija i master plan za upravljanje otpadom na republičkom nivou (Prijedlog)
6. Procjena tehnoloških potreba za ublažavanje klimatskih promjena i prilagođavanje za Crnu Goru – Nacionalna strategija s Akcionim planom (2012.)
7. Strategija ekoremedijacije u Crnoj Gori sa akcionim planom za period 2014-2020. (2014.)
8. Akcioni plan za borbu protiv degradacije zemljišta i ublažavanja posljedica suše Crne Gore (2014.)
9. Nacionalna šumarska strategija 2014 – 2023. (Prijedlog)
10. Nacionalna strategija biodiverziteta s akcionim planom 2010-2015. (2010.)
11. Strategija razvoja energetike Crne Gore do 2030. (2012.)
12. Strategija razvoja saobraćaja Crne Gore
13. Strategija razvoja zdravstva Crne Gore do 2020. (2003.)
14. Strategija razvoja turizma u Crnoj Gori do 2020. (2008.)
15. Nacionalna strategija za zapošljavanje i razvoj ljudskih resursa 2012-2015. (2012.)
16. Zakon o životnoj sredini („Sl. list CG", br. 48/08 od 11.08.2008)
17. Zakon o strateškoj procjeni uticaja na životnu sredinu („Sl. list CG" 80/05 od 28.12.2005, 73/10 od 10.12.2010, 40/11 od 08.08.2011)
18. Zakon o upravljanju otpadom („Sl. list CG" br. 64/11 od 29.12.2011)
19. Zakon o zaštiti prirode (Sl. list CG", br. 51/08 od 22.08.2008, 21/09 od 20.03.2009, 40/11 od 08.08.2011, 62/13 od 31.12.2013.)
20. Zakon o zaštiti vazduha ("Sl. list CG", br. 25/10 od 05.05.2010, 40/11 od 08.08.2011)
21. Zakon o vodama ("Sl. list CG", br. 27/07 od 17.05.2007, 32/11, 47/11)
22. Zakon o nacionalnim parkovima ("Sl. list CG", br. 56/09 od 14.08.2009, 40/11 od 08.08.2011)
23. Zakon o energetici ("Sl. list CG", br. 28/10, 40/11, 42/11, 06/13)
24. Zakon o šumama („Sl. list CG", br. 55/00)
25. Zakon o zaštiti kulturnih dobara ("Sl. list CG", br. 49/10 od 13.08.2010.)
26. Zakon o zaštiti stanovništva od zaraznih bolesti („Sl. list RCG", br. 32/05 od 27.5.2005.)
27. Zakon o zdravstvenoj zaštiti („Sl. list CG", br. 39/04 od 09.04.2004, 14/10 od 17.03.2010)
28. Zakon o zaštiti od buke u životnoj sredini („Sl. list CG", br. 28/11, 28/12, 01/14)
29. Zakon o potvrđivanju Konvencije o biološkoj raznovrsnosti („Sl. list SRJ Međunarodni ugovori, br.11/01-28")
30. Zakon o potvrđivanju Konvencije o zaštiti evropskih divljači i prirodnih staništa (Bernska Konvencija) ("Sl. list CG" br.7)
31. Zakon o potvrđivanju Konvencije o vlažnim područjima (Ramsar Konvencija) ("Sl. list SFRJ",br.09/77-675)
32. Zakon o potvrđivanju Konvencije o zaštiti svjetske kulturne i prirodne baštine ("Sl. list SFRJ", br.56/74-1771)
33. Zakon o potvrđivanju evropske Konvencije o predjelima ("Sl. list CG", br. 006/08-135)
34. Zakon o potvrđivanju Okvirne Konvencije UN o promjeni klime ("Sl. list SRJ", br.02/97-71)
35. Zakon o potvrđivanju Kjoto protokola uz okvirnu Konvenciju UN o promjeni klime ("Sl. list CG", br.17/07 od 27.03.2007)
36. Zakon o potvrđivanju Konvencije o procjeni uticaja na životnu sredinu u prekograničnom kontekstu (ESPOO Konvencija) ("Sl. list CG" br. 08/08-27)

37. Zakon o potvrđivanju Protokola o strateškoj procjeni uticaja na životnu sredinu u prekograničnom kontekstu ("Sl. list CG" – Međunarodni ugovori, br. 2/2009-19)
    Strateški Master plan za upravljanje čvrstim otpadom na teritoriji Crne Gore (2005.)
38. Pravilnik o određivanju i održavanju zona i pojaseva sanitarne zaštite izvorišta i ograničenjima u tim zonama („Službeni list Crne Gore", br. 66/09 od 2. oktobra 2009.)
    Pravilnik o bližim karakteristikama lokacije, uslovima izgradnje, sanitarno-tehničkim uslovima, načinu rada i zatvaranja deponija ("Sl. list Crne Gore", br. 31/13 od 5.07.2013)

14. ANNEX LIST

Maps of the Environmental Baseline

1. Spatial layout of surface watercourses with basin recharges
2. Forest cover
3. Protected areas
4. Areas of ecological network (Emerald)
5. Biological corridors

Maps of the Waste Management System

1. Existing landfills and facilities for waste separation
2. Planned sites of waste management system – Option with 5 regions
3. Planned sites of waste management system – Option with 3 regions
4. Planned sites of waste management system – centralyzed Option