The European Union's Programme for Montenegro

# Strengthening the Capacities for Implementation of the Water Framework Directive in Montenegro

Contract No.383-638: EuropeAid/138151/DH/SER/ME

# *Adriatic River Basin Management Plan*

## *Final Version* *(27/03/20)*

This project is funded by The European Union

A project implemented by a consortium led by SAFEGE

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*This report has been produced as part of a project financed by the European Union. The contents of this publication are the sole responsibility of the Consortium Safege and Eptisa and can in no way be taken to reflect the views of the European Union.*

| Version | Date | Quality Control | | Comment |
|---|---|---|---|---|
| Draft-v1 | 24/06/2019 | Prepared by | QA by | Submission to Contracting Authority for comments |
| | | Patrick Reynolds | Dusan Rakic | |
| Final | 27/03/2020 | Prepared by Patrick Reynolds | QA by Dusan Rakic | Adapted following obtained comments |

This project is implemented by **SAFEGE** in Consortium with **Eptisa Servicios de Ingenieria**

# Contents

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AA-EQS | Annual Average Environmental Quality Standard |
| AIA | Administration for Inspection Affairs |
| AQUASTAT | Aquastat water database – FAO, European Environment Agency |
| ARB | Adriatic River Basin in Montenegro |
| ASCI | Areas of Special Conservation Interest at the European Level |
| AWB | Artificial Water Body |
| $BOD_5$ | Biochemical Oxygen Demand 5-day test |
| BQE | Biological Quality Element |
| Ca | Calcium |
| CETI | Centre for Eco-Toxicological Research in Podgorica |
| CIS | Common Implementation Strategy |
| CLC | Corine Land Cover |
| cm | Centimetre |
| COD | Chemical Oxygen Demand |
| CODmn | Chemical Oxygen Demand, using potassium permanganate (KMnO4) as oxidizing agent |
| Corine | Coordinate Information on the Environment |
| DEHP | Di-2-ethylhexyl phthalate is the most common member of the class of phthalates, which are used as plasticizers in polymer products |
| DEM | Digital Elevation Model |
| DIKTAS | Dinaric Karst Transboundary Aquifer System |
| DO | Dissolved Oxygen |
| DrWPAs | Drinking Water Protected Area |
| DWM | Directorate of Water Management (MARD) |
| DWB | Delineated Water Body |
| EC | European Community |
| ECRIN | European Catchments and Rivers Network |
| EEA | European Environment Agency |
| EF | Environmental (or Ecological) Flow |
| EIA | Environmental Impact Assessment |
| EIONET | European Environment Information and Observation Network |
| EMERALD | Area of Special Conservation Interest |
| EN | European Normative |
| EPA | Agency for Nature and Environmental Protection |
| EPIK | Methods for assessment of aquifer vulnerability |
| EQR | Ecological Quality Ratio |
| EQS | Environmental Quality Standard or Ecological Quality Standard |
| EQSD | Environmental Quality Standards Directive |
| EU | European Union |
| EUROSTAT | Statistical Office of the European Communities |
| FA | Fissured aquifer |
| FAO | Food and Agriculture Organization (United Nations) |
| Fe | Iron |
| GDP | Gross Domestic Product |
| GGWB | Group of Groundwater Bodies |
| GIS | Geographical Information System |
| GoM | Government of Montenegro |
| GPS | Global Positioning Satellite |
| GSM | Geological Survey of Montenegro |

| | |
|---|---|
| GW | Groundwater |
| GWB | Groundwater Body |
| GWh | Gigawatt Hour |
| h | Hour |
| $HCO_3$ | Bicarbonate |
| HG | Hydrogeology |
| HMWB | Heavily Modified Water Body |
| HYMO | Hydromorphology |
| l | Litres |
| IBT | Inter-Basin Water Transfer |
| ICI | industrial/ commercial/ institutional Sector |
| IED | Directive 2010/75/EU of the EU Parliament and the Council on industrial emissions |
| IGRAC | International Groundwater Resources Assessment Centre |
| IHMS | Institute of Hydrometeorology and Seismology of Montenegro |
| IHP | United Nations Educational, Scientific and Cultural Organization |
| IMB | Institute for Marine Biology |
| IMPRESS | EU Guidance document on Pressures and Impacts Analysis |
| IntErO | Intensity of Erosion and Outflow |
| IPA | Instrument for Pre-Accession Assistance |
| IPH | Institute for Public Health |
| IPPC | Integrated Pollution Prevention and Control |
| ISO | International Organization for Standardization |
| iU | Index of vulnerability |
| KA | Karstic Aquifer |
| kg | Kilogramme |
| km | Kilometre |
| KTM | Key Type of Measures |
| KWh | Kilowatt Hour |
| Landsat | Land Remote-Sensing Satellite (System) |
| m | Metre |
| MAC | Maximum Allowable Concentration |
| MARD | Ministry of Agriculture and Rural Development |
| m.a.s.l | Metres Above Sea Level |
| MCM | Million Cubic Meters |
| ME | Ministry of Economy |
| mEH | Mini Electric Hydropower |
| MF | Ministry of Finance |
| MH | Ministry of Health |
| mm | Milimetre |
| MNE | Montenegro |
| MONTSTAT | Statistical Office of Montenegro |
| MSDT | Ministry of Sustainable Development and Tourism |
| mQM | Mean Monthly Flow |
| MW | Megawatt |
| MWh | Megawatt Hour |
| N | Nitrogen |
| NATURA 2000 | Network of Nature Protection Areas in the Territory of the European Union |
| NCSSD | National Communication Strategy for Sustainable Development |
| NEAS | National Environmental Approximation Strategy |
| NGO | Non-Governmental Organisation |

| | |
|---|---|
| $NH_4$ | Ammonium ion |
| $NO_2$ | Nitrite |
| $NO_3$ | Nitrate |
| NSBAP | National Biodiversity Strategy with Action Plan |
| NSSD | National Strategy for Sustainable Development |
| NVZ | Nitrate Vulnerable Zone |
| OG | Official Gazette of Montenegro |
| P | Phosphate |
| PAH | Polyaromatic Hydrocarbons |
| PE | Population Equivalent |
| PEW | Regionalni Vodovod Crnogorsko Primorje |
| PO4 | Orthophosphate |
| PoM | Programme of Measures |
| PS | Priority Substances |
| Q | Yield, Flow or Discharge |
| QA | Quality Assurance |
| QC | Quality Control |
| RBD | River Basin Districts |
| RBMP | River Basin Management Plan |
| RBSP | River Basin Specific Pollutants |
| s | Seconds |
| SDG | Sustainable Development Goals |
| SEA | Strategic Environmental Assessment |
| Sec | Second |
| SFRY | Socialist Federal Republic of Yugoslavia |
| SHPP | Small Hydropower Plants |
| SME | Small and Medium Size Enterprise |
| $SO_4$ | Sulphate |
| SODA | Slope, Overlying Strata, Depth and Aquifer parameters for assessing aquifer vulnerability |
| SWB | Surface Water Body |
| TBA | Transboundary Aquifer |
| TDS | Total Dissolved Solids |
| TNMN | Transnational Monitoring Network |
| UMM | Union of Municipalities of Montenegro |
| UNECE | United Nations Economic Commission for Europe |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UWWT | Urban Wastewater Treatment |
| UWWTD | Urban Wastewater Treatment Directive (91/271/EEC) |
| VOC | Volatile Organic Compound |
| WA | Water Administration |
| WATECO | Water and Economics Guidance Working Group |
| WB | Water Body |
| WDES | Water for Dependent Ecosystems |
| WISE | Water Information System for Europe |
| WFD | Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy |
| WMS | Water Management Strategy of Montenegro |
| WMO | World Meteorological Organization |
| WWTP | Wastewater Treatment Plant |

# EXECUTIVE SUMMARY

The River Basin Management Plan (RBMP) for the Adriatic River Basin (ARB) in Montenegro is prepared **to ensure effective water management in the country, taking into the consideration existing practice, available data and resources**. The document has been **developed according to the requirements of the EU Water Framework Directive (WFD, Directive 2000/60/EC) and national legislation in the field of water management and nature protection**, which establishes a legal framework to protect and enhance the status of all waters and protected areas including water dependent ecosystems, prevent their deterioration and ensure long-term optimal (sustainable) use of water resources.

Surface waters and groundwater are vital natural resources and generally are **under significant anthropogenic pressure** and, consequently, a significant proportion of these resources is depredated, or under threat. In addition, beside water use, waters are under the threat due to pollution and hydromorphological degradation. **The protection of waters and improving of their status in the Adriatic River Basin is therefore essential** for the development of the country and region.

**In 2000, the WFD came into force, establishing a legal framework to protect and enhance the status of aquatic ecosystems**, prevent their deterioration, and ensure the long-term use of water resources throughout the EU. The objective of the WFD is to achieve for all inland surface waters, 'good chemical and ecological status (or potential)', and for all groundwater to achieve 'good quality and good quantitative status'.

To meet these ambitious objectives, **careful planning** is essential with proper articulation of all aspects of water management. This is the main objective of this document.

As regards to Montenegrin legislation in water sector, the WFD has been the main driver for the evolution of the **legal framework in the country** regarding water management, providing the frame for the Law on Water and associated amendments (Official Gazette of Montenegro, Nos. 27/07, 32/11, 48/15 and 84/18). The adoption of this legal framework is still ongoing issue. In addition, measures for flood protection and prevention, according to the requirements of the Floods Directive (2007/60/EC) will be integrated into the RBMP as early as 2021.

The **content and structure of the RBMP** for the Adriatic River Basin **follows the general requirements of the Annex VII of the WFD and is in line with national regulation** ("Official Gazette of Montenegro", No. 39/09 of 17 June 2009). This document involves following the main water management items: **characterization of discrete water bodies** in the area of concern, **identification of the main pressures** and **assessment of impacts, risk assessment**, **status assessment, identification of significant and other water management issues**, **the economic analysis of water use**, **the definition of the environmental targets to be achieved, the preparation of programmes of measures (PoMs) and prioritization of measures**.

Initially, **characterization of the surface and groundwater bodies** in the Adriatic River Basin has been carried out together with summary of main natural characteristics of the area – hydrological, climate, geological, relief).

**Characterization of Water Bodies:** The total surface of the Adriatic watershed in Montenegro is 6,650 km$^2$ or 47.8 % of state territory.

**Surface Water Bodies (SWBs**) - The Zeta, Morača and Bojana Rivers, together with Lake Skadar form the main part of the Adriatic River Basin, flowing into the Adriatic Sea. Many smaller rivers are included in the basin, which includes: Orahovštica, Crmnička Rijeka, Sutorina, Sjevernica, Mrtvica, Nožica, Mala Rijeka, Sušica, Gračanica, Ribnica, Matica, Sitnica and the Cijevna. Six artificial lakes are also present in the Adriatic River Basin, namely, Bilećko, Krupac, Liverovici, Grahovsko, Slansko and Vrtac.

**SWBs are grouped** based on partial field analyses on published and other (project results, other relevant sources). For the Adriatic River Basin, seven type groups of running waters have been identified: Type Group 1 – Small and medium sized mountain and mid-altitude watercourses with domination of hard bottom substrate; Type Group 2 - Small and medium sized lowland watercourses with domination of hard and medium sized bottom substrate; Type Group 3 – Large lowland rivers with domination of medium sized bottom substrates; Type Group 4 - Large lowland rivers with domination of fine bottom substrates; Type Group 5 – Source regions of small and medium sized permanent watercourses with domination of hard and medium sized bottom substrate and specific biotic communities in the catchments area; Type Group 6 - lowland lakes and Type Group 8 – Heavily Modified or Artificially Water Bodies. Transitional waters have been classified into 4 Type Groups, while coastal waters (up to 1 nautical mile from the shore) have been classified into two main types.

Based on the criteria described in the EU CIS Guidance Document No 2, 41 inland surface water bodies (rivers and lakes) were delineated for the Adriatic River Basin. The SWBs include 5 heavily modified water bodies (HMWBs), 3 artificial water bodies (AWBs) and 3 natural lakes.

**Groundwater –** Along with karst, the main aquifer systems are intergranular, the richest resources exist in fluvio-glacial and alluvial deposits. Karstic aquifers are thus formed within a very thick (over 3,000 m) complex of Mesozoic limestones and dolomites. The recharge of karst aquifers is from precipitation and waters percolated from sinking rivers. It can be assessed that the average infiltration rate varies between 50% and 80% of precipitation depending on the locality, morphology and karstification properties. As a result of intensive karstification, a network of highly permeable underground channels acts as preferential pathways of intensive groundwater circulation.

It is very difficult to estimate the overall effective porosity (considered also as a storage coefficient) of the karst aquifer because of the anisotropic and heterogeneous character of limestones and dolomites. Most references provide values in the range of 0.5% - 1.5%, while locally it can be significantly higher.

Based on results of tracing tests conducted in various karst aquifer systems it has been concluded that the main erosional base of the External Dinarides is the level of the Adriatic Sea, while the local erosional base for numerous springs are the edges of karstic poljes or the contact of carbonate and non-carbonate rocks. Calculated velocities of used dyes are in range of 0.1-13.8 cm/s which is confirming well developed system of karstic channels and cavities.

Spring zones in the Boka Kotorska Bay (the Orahovačka Ljuta, Spila, Sopot, Morinje Springs, Škurda and Gurdić) annually discharge more than 150 m$^3$/s, on average. Some of these springs even dry out completely during summer, while after intensive rainfall or at the end of winter some of them can discharge over 100 m$^3$/s. The sublacustrian spring Bolje sestre tapped for regional water supply of the Montenegrin coastal area is discharging in minimum 2.3 m$^3$/s. Some other submerged springs along the edge of Skadar Lake - vruljas are discharging even greater amount of water.

Concerning the specific underground yield, Montenegro is in group of the world's countries with greatest values: an average is 40 $l/s/km^2$, while in certain aquifers specific yield is greater than 70 $l/s/km^2$, as in case of Lower Zeta in Skadar basin.

The key aspect of the 'groundwater body' concept is that the groundwater body (GWB) is the management unit under the WFD that is necessary for the subdivision of large geographical areas of aquifer in order for them to be effectively managed. The aim of **groundwater body characterization** is to establish the quantitative and chemical status of each groundwater body i.e. aquifer which supplies more than 50 people and whose abstraction is larger than 10 $m^3$/day.

The following factors have been taken into consideration for **delineation of GWBs** in the Adriatic River Basin: Regulatory framework – EU WFD and national legislation; Experiences of other countries, especially those from SE Europe and the Dinaric region, "Scale effect" – size of the national territory and concerned basins; Hydrogeology (aquifer systems distribution, permeability, water resources); Groundwater use and protection; Current literature and other sources (project results, master and water plans, strategies in the water sector).

**GWBs are grouped**, based on the following criteria: Similarities in hydrogeological function (merging aquifers of the same types), and regional interconnection (even though some outcrops of one aquifer are separated by some impervious rocks or other aquifers, they are considered to belong to one common group).

GWBs and groups of groundwater bodies (GGWBs) also include a part of terrains that are not aquifer itself, but from which there are intensive runoffs toward adjacent aquifers. These allogenic catchments are an important element of the assessment of the water budget and resources of concerned water bodies.

In the Adriatic River Basin, a total of 17 groundwater bodies have been identified, comprised of 4 GWBs and 13 GGWBs. In total, 5 out of the 17 delineated water bodies are of transboundary character. There are no GWBs or GGWBs that are larger than 1000 $km^2$, while 7 GWBs are smaller than 300 $km^2$.

**Identification of significant pressures**: The purpose of the **pressure and impact analysis** is to identify the **significant pressure** that influence SWBs and GWBs. The main purpose of the **risk analysis** is to identify the water bodies that are at risk of not achieving the required environmental (quality) objective.

For **SWBs,** the DSPIR framework (Driving Force, Pressures, State, Impacts and Response) has been applied to the surface waters in the Adriatic River Basin to identify and address the preliminary elements on pressures and provide an analysis of the impacts, which highlight the potential risk that a water body will not achieve the required environmental objectives. The approach undertaken follows the WFD Common Implementation Strategy (CIS) guidance No. 3. The analysis of the pressures on the surface water bodies was carried out at 'river segment' level but the synthesis of the pressure and the assessment of the risk of non-achievement of the environmental objectives was performed at 'water body level' for all 41 delineated SWBs.

Based on comprehensive analysis of all surface water bodies with respect to point and diffuse sources of pollution, as well as pressures caused by hydromorphological degradation and invasive species, the preliminary **assessment of pressures** and **identification of SWBs that are "at risk"** has been performed. For 10 SWBs (out of 41) it was assessed that point pollution is a significant pressure. Further analysis of all pressures (diffuse pollution, abstraction, physical alterations etc.) resulted in a total of 14 out of the 41 waterbodies judged to be ‘at risk’, although with varying degrees of confidence. The risk analysis also identified 3 surface water bodies that are classed as ‘possibly at risk’.

A combination of hydrobiological and chemical methods is required to obtain information on the **ecological and chemical status of the SWBs** according to the WFD. Surface water status is the general expression of the status of a body of surface water, determined by the poorer of its ecological and chemical status. Good surface water status means that its ecological and chemical status is at least “good”. Montenegro is in process of adoption of relevant national regulative for assessment of chemical status of water bodies.

The methodology and Ecological Quality Standards (EQSs) are prescribed in the relevant EU Directive (EQSD 2013/39/EU) and QA/QC Directive (2009/90/EC) to determine chemical status and those documents have been used as tool for indicative **chemical status assessment**. The data on chemical status is limited and in majority of SWBs, the indicative chemical status is assessed taking into the consideration the risk analysis and information on type and intensity of pressures, involving also “expert judgment” as a tool for summarizing information on pressures and relevant impacts to particular water body. Additional data for chemical status assessment were collected in 2018 on a limited number of SWBs.

**Ecological status** is an expression of the quality of the structure and functioning of aquatic ecosystems. Good ecological status is the status of body of surface water classified in accordance with Annex V of the Water Framework Directive (WFD). Good ecological potential is the status of heavily modified or artificial body of water. Since Montenegro is in the process of adoption of the monitoring methodology for the assessment of ecological status, together with other documents that should provide procedures that are compliant with requirements of the WFD, in this document indicative ecological status is assessed based on the procedure described in the Annex.

Based on indicative status assessment, out of 41 assessed SWBs, 18 SWBs failed to achieve good status. Furthermore, two coastal and one transitional SWBs that were assessed also as failed to achieve good status. In respect to interpretation of the data on the status of SWBs presented in this document, it should be underlined that only for four WBs confidence of status assessment are evaluated to be of medium confidence, which is 9.76% of total number of assessed SWBs, or 9.30% of the total length of assessed SWBs if we consider inland waters. Thus, for the complete design of mitigation measures, more information is required.

With respect to **hydromorphological analysis (HYMO)**, out of 41 total surface water bodies delineated in the Adriatic River Basin, 24 are considered to be without significant hydromorphological pressures. For 10 surface water bodies, hydromorphological degradation is assessed as moderate to high. Five surface water bodies are preliminary identified as HMWB, however, according to the EU regulations and requirements, that fact has to be confirmed by biological data in a consequent period. For five WBs there was no enough information to roughly assess HYMO status. In addition, one SWB is considered to be HMWB candidate (Ribnica River), and status has to be confirmed in consequent period. It should be noted that that medium to high confidence HYMO status was assessed only for four SWBs (applying HYMO assessment protocols), while the rest is assessed based on the field notes (2017 and 2018 data), using analyses of satellite images and maps and expert opinion (descriptive, by using normative definitions on HYMO assessment).

For the purpose of the RBMP, the quantitative, qualitative and pressures analyses on each of the delineated **GWBs** and **GGWBs** is provided. It should be emphasized that a limited amount of information of sufficient quality is available in Montenegro to properly fulfil the requirements of WFD regarding pressures and impacts. Many datasets are not standardized, and, in many instances, they are not available in the required digital format. Often, the data do not cover the geographical extent of the Adriatic River Basin. Risk analysis is considered for the design of monitoring programmes. In particular, an operational monitoring network has to be defined in order to identify the status of water bodies at risk of not achieving the environmental objectives of WFD. The purpose of the operational monitoring is to establish the status of waterbodies identified at being at risk of failing to meet their environmental objectives and to assess any changes in the status of such bodies resulting from applied mitigation measures.

In respect to quantitative pressures, based on the comparison of water demands (actual extraction + 20%) and exploitable GW reserves, it was concluded that 1 GWB and 2 GGWBs are at risk. These include the GW body of Ulcinjsko polje and the GGW bodies of the Zeta Valley and Prekornica – Bjelopavlići. However, the GWB of Ulcinjsko polje is at risk clearly from the on continuation of using groundwater sources instead of regional water supply. The Zeta Valley and Prekornica – Bjelopavlići are at risk of groundwater quality since 50% and 18% of the exploitable reserves are currently being used, respectively.

**GWB risk assessment for diffuse pollution sources** shows that the category of 'Low Risk' is the most widespread category in entire territory of the Adriatic River Basin (58.18% of the total basin). In addition, for 15.35% it was assessed under 'Very Low Risk', while for 17.07% it was assessed that there is no risk of pollution. The analysis indicates so-called hotspots when it comes to the groundwater Risk – Bar, Danilovgrad, Herceg Novi, Kotor, Nikšić, Podgorica, Tivat and Ulcinj.

With respect to **point source pollution risk assessment on groundwaters**, two GGWBs, Nikšić polje and Zeta Valley, are clearly at risk due to the impact of point pollution sources and while four GGWB, Ulcinjsko polje, Grbalj-Lustica, Orahovštica – Rijeka Crnojevića, and Karuc-Sinjacare potentially at risk. The latter is in this group due to hydraulic contact with adjacent GGWB Zeta Valley.

**Monitoring Programmes**: The document provides a description of the **monitoring programme** for the Adriatic River Basin that is designed according the requirements of the WFD taking into the consideration available state of the art in monitoring practice in Montenegro, as well as financial and expert capacity in the country. In accordance with the requirements of Article 8 of the WFD, it is necessary to establish a network for monitoring surface water, that involve **three types of monitoring** for each river basin management plan: **Surveillance monitoring, Operational monitoring** programs and If necessary, **Investigative monitoring** program.

Monitoring programme should also provide information for the **identification of Montenegro River Basin Specific Pollutants** (RBSPs) with the aim of setting up their EQSs and follow up monitoring to assess the ecological status. Thus, the designed monitoring network should also provide confident data to select RBSP for the Adriatic River Basin.

**Surface Water Monitoring**: The WFD compliant monitoring network for the Adriatic River Basin for inland waters covers 35 sites. A total of 26 sites are identified for surveillance monitoring, 13 for operational (all of them are in the same time are surveillance monitoring sites), while 19 sites are proposed for investigative monitoring (either as reference or near natural site in order to assess reference or best available conditions, or to collect additional data for further characterization). For some sites it is assessed that different types of monitoring should be applied. Beside the information on monitoring type per site. The network that coverts transitional and coastal water covers two coastal and one transitional WB selected for surveillance monitoring. The identification of operational monitoring sites should be completed in consequent period, based on the results of surveillance monitoring.

Sites that are identified as relevant for both, surveillance and operational monitoring are considered as high priority sites – first order sites – 7 sites. Those sites are considered as the frame of the monitoring system and should provide confident information for trend analyses, assessment of cross border pollution, and are the basis for providing the data for international cooperation – e.g. delivery of data for European Environment Information and Observation Network (EIONET). High priority sites should also provide the data for identification of Montenegro River Basin Specific Pollutants (RBSPs; WFD 2000/60/EC). The monitoring determinants and frequency for each monitoring type are identified.

The network identified for investigative monitoring includes the sites that are under minor anthropogenic influence (reference or "near natural" sites) and sites that are needed to be further investigated, since the data is insufficient/missing to be properly characterized. The information from those sites should be used for more accurate identification of reference conditions or "best available" values that should be used for further upgrade of system of ecological status assessment.

Montenegro is in the process of adoption of the water status monitoring methodology that is compliant with requirements of the WFD. Parameters that are characteristic of each relevant quality element must be monitored. **Biological quality elements** have been proposed for all **inland SWBs, transitional and coastal water bodies**. Assessment of data provided by the monitoring program and the achieved degree of reliability and accuracy should be included in water management plan for each water body.

**Groundwater monitoring:** As a first step towards creation of an optimal groundwater monitoring network the body of groundwater designated within a geological formation was delineated and taken as the basis for groundwater monitoring. In accordance to hydrogeology setting of the Adriatic River Basin, all designated groundwater bodies (GWBs) or group of groundwater bodies (GGWBs) have been classified as karstic or karstic-fissured, and intergranular groundwater bodies. In some cases, complex GWB consists of these two types has also been designated.

The second step required characterization and includes the determination/description and quantification of geological and hydrogeological conditions, particularly the geometry of the GWBs and GGWBs, the nature of the aquifer roof and floor, the rate of water exchange, and the dependence of terrestrial ecosystems on infiltrated or discharged groundwater.

The third step, as a part of characterization process was to define qualitative (chemical) and quantitative status of GWBs and GGWBs. The focus is on chemical quality pressures—diffuse and point sources of pollution, as well as quantity pressures—abstraction rates and artificial recharge, if they exist. Once the status of GWBs and GGWBs is determined and if they are at risk (quantitative or qualitative, or both) then adequate monitoring and mitigation measures to protect and save quality of GW can be undertaken. The WFD introduces 'surveillance monitoring' and 'operational monitoring' depending on the nature of groundwater pressures. Operational monitoring requires a higher monitoring frequency and surveying of specific components, critical to water quality.

In terms of quantitative assessment, the distribution of monitoring points was designed to ensure that the spatial and temporal variability of the groundwater surface can be sufficiently well recorded within a groundwater body. The problem with determining the chemical status is that maximum permissible concentrations have not been defined at the level of EU, except for a few parameters. To achieve objectives, if good status cannot be restored or attained, then the chemical status must be at least that which existed before applicable legislation was adopted, or before its implementation began.

The proposed type of monitoring of the quality and quantity for each GWB in the Adriatic River Basin is presented in the document, together with 41 monitoring sites.

**The effect of climate change**: The effect of climate change in the Adriatic River Basin reveals that changes in temperature and in precipitation will inevitably impact on and create changes in the water balance, i.e. a reduction in the amount of precipitation in comparison to the period 1961-1990 would cause a significant decrease in the average annual flow value by the end of the 21st century in comparison to flows observed during the baseline period. Due to an envisaged increase in temperature by 2100 in A1B and A2 climate scenarios, a reduced accumulation of snow would result in a decrease in mean monthly flow values during spring months.

The climate projections were generated by Euro CORDEX with a spatial resolution of 0,11° (near 1.,5 x 12.5 Km) . The climate projections correspond to the Global Climate Model CNRM-CERFACS-CNRM-CM5, scenario RCP 45. (Representative Concentration Path 4,5 $W/m^2$) that is the most probable climate scenario that foresee an average global warming increase of 1.4 °C in the period 2046 - 2055. For all projections, the maximum temperature varies from -1°C (February) to +34°C (August). The minimum temperature varies from -8.6°C (February) to 24.7°C (August).

**Protected Areas**: The WFD and other related legal documents consider separately protected areas because they need extra protection for conservation of habitats and/or species, or they are distinguished as important to be protected based on other reasons covered by the Community legislation (e.g., abstraction of drinking water – the WFD Article 6).

In Montenegro the related national legislation is not fully harmonized with the EU standards. Thus, the modified approach in dealing with protected areas should be used, having in mind the different national standards for the delineation of protected areas and the future introduction of the EMERALD network.

Montenegro has made progress in transposing the international and EU legislation related to protected areas included also in WFD. However, the country is having difficulties in implementing them, which is translated in practice in lack of designation of protected areas and of the register of the protected areas in Adriatic River Basin.

The National Biodiversity Strategy with Action Plan (NSBAP) for the period 2016-2020 has been adopted and it established a strategic framework for the implementation of the Convention on Biodiversity, including the measures and actions to reach Aichi targets in accordance with the Strategic Plan for Conservation of Biodiversity 2011-2020 and the EU 2020 Biodiversity Strategy.

The WFD requires establishing of a register of Protected Areas (PA), including the details on related WBs. According to the Guidance Document No. 1 (2003), the river basin management plan for each river basin district includes the map showing protected areas. The results of the monitoring programmes showing the status of all water bodies and protected areas have not been formally mapped since the actual SWB and GWB operation monitoring programmes has not officially been conducted as yet.

The register of protected areas required by the WFD under Article 6 is included and encompasses: (i) areas designated for the abstraction of water intended for human consumption under Article 7; (ii) areas designated for the protection of economically significant aquatic species; (iii) bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC; (iv) nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC; and (v) areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites designated under Directive 92/43/EEC(1) and Directive 79/409/EEC(2).

**Economic Analysis of Water Use**: The Water Framework Directive promotes the application of sound economic principles, methods and instruments for supporting the achievement of its objectives (good ecological status) in Europe. The WFD is one of the first environmental policy directives of the European Community that explicitly draws on economic considerations for achieving its objectives. In particular, according to the requirements stipulated in Article 5 of the Directive, an economic analysis of water uses has to be carried out on a river basin district scale.

This RBMP provides an analysis of relevant data on the Adriatic River Basin and puts it into the economic context, referring to the details of both abstractive (i.e. agricultural, industrial and domestic) and non-abstractive (e.g. hydropower plants and fish farming) use of water. The analysis provides an estimate of the value of water for both of these categories and performs an estimate of trend projections regarding net water use for the Adriatic River Basin.

There are losses incurred in the water supply system all across the Adriatic River Basin. Current estimates based on the latest report on water sector show that non-revenue water (i.e. the difference between the volume of water supplied and invoiced to the customers) stands at 60.27%. The main reasons for this large gap are deficiencies in the water transport network (technical losses) as well as unregistered and illegal connections to the network, and inaccurate metering of water consumption (administrative losses). Such high level (i.e. European average is in the range between 10% and 25%) puts enormous pressure on local utility companies and represents the main underlying reason for the lack of financial and economic sustainability of the system. Naturally, **both central and local governments are strongly advised to take measures in order bring the share of non-revenue water to a level which will ensure long-term sustainability of the water supply system in the Adriatic River Basin.** These measures are primarily investment related and may require significant financial resources. However, there are measures which require trivial or no financial resources but could contribute considerably to reduction of non-revenue water volumes (e.g. those regarding reduction of illegal connections to the system).

Since 2009, Montenegro started implementing a new price setting framework in the domain of non-abstractive water. The details of this framework are set forth by the Decision on the Amount and Method of Calculating Water Charges and the Criteria and Method of Determining the Degree of Water Pollution. Depending on the specific purpose, total payments depend mainly on the volume of water abstracted. Fees for use of water for electricity generation are based on the quantity of electricity (kWh) generated on the grid. There is also a separate charge rate per kW for the use of water for other energy purposes by power plants. However, provisions of this Decision do not relate to the main source of water use in Montenegro which is for domestic and ICI purposes. Thus, as a key recommendation and concluding point, **there is an urgent need to alter current water and wastewater tariff-setting policy to meet the requirements of the Water Framework Directive**. The present arrangements impose charges to water and sewerage users that do not recover the costs of these services. The financial cost recovery is 94% primarily due to sizeable inflows in the form of subsidies from the budget revenues – either through direct transfers from the local government or indirect subsidies in the infrastructure granted by the central government. On the other hand, when subsidies are factored out and financial flows are adjusted to reflect their economic value, the cost recovery drops to 85.8% which is far below the required full-cost recovery of 100%. It is thus obvious that such pricing policy undermines one of the key principles outlined in the WFD - Article 9 in particular.

**Environmental Objectives**: Taking into consideration of the main environmental objectives outlined in the WFD, a set of management objectives have been developed, which are also based on the objectives outlined in the national water management strategy.

In order to achieve the environmental objectives, it is important that they are clearly measurable and understandable by all sectors of society, i.e. all stakeholders including the public. The environmental (management) objectives, actions include:

- Promotion of the sustainable use of water resources, their fair distribution among users, maximizing economic benefits in respect of environmental conditions and sustainable management principles
- Preservation and achievement of minimal "good" ecological and chemical status for surface water bodies that have "less than good", "poor" or "very poor" status. (rivers, lakes and highly modified water bodies)
- Prevention of pollution in order to avoid a deterioration of groundwater quality and to attain a good chemical status in GWBs
- Reduction of flood risk and losses for life, livelihoods, health, economy, cultural and environmental assets of persons, businesses and communities
- Preservation and/or reduction of the rate of erosion affecting rivers

Based on the quality status of the surface water and groundwater bodies, a further assessment has been carried to determine if there is clear justification for exemption from meeting the required environmental quality objectives.

Out of the 41 surface water bodies, 15 can be considered for exemption but solely based on the need for extended deadlines in order to reach good status.

Only one surface water body, Zeta_2, will not be unable to reach the good ecological potential by 2033 since the river is canalized and used for electricity production. In this case an exemption would be required.

One groundwater body, Zeta Valley, is judged not to be able to meet its objective until 2033 due to point and diffuse source pollution arising from the industrial and agricultural activities.

**Programme of Measures**: The WFD requires that, within a River Basin District, a Programme of Measures is established to address the significant issues identified and to allow the achievement of the objectives established under Article 4. The Directive further specifies that the measures shall include as a minimum ‘basic measures’ and, where necessary to achieve objectives, ‘supplementary measures’.

A total of 25 basic measures are proposed, with the addition of 25 supplementary measures, all of which are grouped according to priority, indicated as either as high (1), medium (2) or low (3). Of the basic measures, 17 measures as high priority, which include but are not limited to, i) WWTP construction and/or rehabilitation and construction of sewerage networks, and ii) solid waste management and waste transfer stations which will alleviate current and future pressures to the river network and groundwaters.

The supplementary measures are proposed in order to clearly define known problems that affect surface waters and groundwaters. Such measures mainly cover the need to define solutions for contaminated sites and discharges from industrial and agricultural point sources.

Information on each measure is provided in a uniform way, and includes, where possible : the location, the water body in question, possible restrictions to be taken into account, i.e. within protected areas or flood areas, a short description of the measure, the relevant project investor, the indicative investment costs, the possible maintenance costs, the necessity for permits, the relevant authorities, the current status of implementation (if any), and the relative impact of the measure.

A further 8 basic and 9 supplementary measures relating directly to the Skadar Sub-Basin measures are included, which are related to the sustainable management of Skadar Lake and attributed water bodies.

In order to clarify the specific actions required for the Adriatic River Basin, a plan of action for all relevant stakeholders is outlined in order to monitor the progress during the first RBMP cycle, which for the Adriatic River Basin would be expected to start in 2022.

**Consultation**: Comments on the RBMP from relevant MNE public institutions and from NGOs are provided as an annex (separate volume) to the RBMP.

# 1 BACKGROUND

## 1.1 Introduction

In 2000, the "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" or, in short, the EU Water Framework Directive (WFD), was adopted. The Directive established the processes and procedures for the regulation and protection of waterbodies in Europe, which for the Adriatic River Basin comprises of rivers, lakes and groundwater. In the broadest sense, the WFD may be summarized as 'an environmental governance framework' that ensures the sustainable use of national water resources.

The purpose of the WFD is to:

- Prevent further deterioration of, protect and enhance the status of water resources;
- Promote sustainable water use based on long-term protection of water resources;
- Aim at enhancing protection and improvement of the aquatic environment through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- Ensure the progressive reduction of pollution of groundwater and prevents its further pollution; and
- Contribute to mitigating the effects of floods and droughts.

The WFD summarizes much of the European experience of pollution, water quality and ecosystem management, and it represents a new and comprehensive way of source-to-sink thinking, where the primary goals are to achieve the desired quality of the water resources, and quantity sufficient to support quality objectives and other varying ecosystem and economic needs. The Directive establishes environmental governance by natural geographical units, known as River Basin Districts (RBDs) to be implemented by the so called 'competent authority'.

The central concept to the Water Framework Directive is the concept of integration that is seen as key to the management of water protection within the river basin district. The concept of integration encompasses the following:

- Integration of environmental objectives, combining quality, ecological and quantity objectives for protecting highly valuable aquatic ecosystems and ensuring a general good status of other waters;
- Integration of all water resources, combining fresh surface water and groundwater bodies at the river basin scale;
- Integration of all water uses, functions and values into a common policy framework, i.e. investigating water for the environment, water for health and human consumption, water for economic sectors, transport, leisure, water as a social good;
- Integration of disciplines, analyses and expertise, combining hydrology, hydraulics, ecology, chemistry, soil sciences, technology engineering and economics to assess current pressures and impacts on water resources and identify measures for achieving the environmental objectives of the Directive in the most cost-effective manner;
- Integration of water legislation into a common and coherent framework;

- Integration of all significant management and ecological aspects relevant to sustainable river basin planning including those which are beyond the scope of the Water Framework Directive such as flood protection and prevention;
- Integration of a wide range of measures, including pricing and economic and financial instruments, in a common management approach for achieving the environmental objectives of the Directive. Programmes of measures are defined in River Basin Management Plans developed for each river basin district;
- Integration of stakeholders and the civil society in decision making, by promoting transparency and information to the public, and by offering a unique opportunity for involving stakeholders in the development of river basin management plans;
- Integration of different decision-making levels that influence water resources and water status, be local, regional or national, for an effective management of all waters; and
- Integration of water management from different Member States, for river basins shared by several countries, existing and/or future Member States of the European Union.

The Directive envisages also public information and consultation. The interested parties will be encouraged to take active involvement of in the implementation of this Directive, in particular in the production, review and updating of the river basin management plans. On request, access will be given to background documents and information used for the development of the draft river basin management plan.

Since 2001, the EU Member States and the European Commission have jointly developed a common strategy for supporting the implementation of the Water Framework Directive, known as the Common Implementation Strategy (CIS). The main aim of this strategy is to allow a coherent and harmonious implementation of this Directive by using common standards, terms and procedures across all components of the WFD.

The relevance of the WFD to Montenegro is that the data collection and information management requirements of developing effective River Basin Management Plans are very considerable, and both the legislative framework and the national environmental monitoring networks must be in a high state of competence (fitness for purpose) in order to deliver all that the WFD requires.

As regards to Montenegrin legislation in water sector, the Water Framework Directive has been the main driver for the evolution of the legal framework in Montenegro regarding water resources management and water services, providing the foundations for the Law on Water and associated amendments (Official Gazette of Montenegro, Nos. 27/07, 32/11, 48/15 and 84/18).

The following is a summary of related Directives, which are taken into account for the development of the Adriatic River Basin Plan.

**Urban Waste Water Treatment Directive**

The Council Directive 91/271/EEC concerning urban waste-water treatment was adopted on 21 May 1991. Its objective is to protect the environment from the adverse effects of urban waste water discharges and discharges from certain industrial sectors and concerns the collection, treatment and discharge of:

- Domestic wastewater
- Mixture of wastewater from the household with industrial wastewater
- Wastewater from certain industrial sectors

Four main principles are laid down in the Directive are: Planning, Regulation, Monitoring, and Information and reporting. Specifically, the Directive requires:

- The Collection and treatment of wastewater in all agglomerations of >2000 population equivalents (PE or p.e.);
- Secondary treatment of all discharges from agglomerations of > 2000 p.e., and more advanced treatment for agglomerations >10 000 population equivalents in designated sensitive areas and their catchments;
- A requirement for pre-authorization of all discharges of urban wastewater, of discharges from the food-processing industry and of industrial discharges into urban wastewater collection systems;
- Monitoring of the performance of treatment plants and receiving waters; and
- Controls of sewage sludge disposal and re-use, and treated wastewater re-use whenever it is appropriate.

The Urban Waste Water Treatment (UWWTD) Directive has been mostly transposed (95%). Agglomerations are defined in the Rulebook on Geographical Boundaries for the number and capacity of agglomerations (this is hereinafter referred to as the Plan). Sensitive areas were determined by the Decision on the designation of sensitive areas (Official Gazette of Montenegro 46/17 of 18 July 2017). In order to protect the waters, Montenegro has chosen not to designate less sensitive areas.

Implementation of the UWWD in the Adriatic River Basin is based on the strategic Master Plans for sewage and waste water treatment was adopted in 2005 for the Central and Northern regions. The NEAS, as well as the Negotiating Position, specifies the year 2035 for the completion of the construction of sewage systems.

### Groundwater Directive

The Groundwater Directive is at a very early stage of legal alignment. The Directive 2006/118/EC on the protection of groundwater against pollution and deterioration establishes a regime which sets groundwater quality standards and introduces measures to prevent or limit inputs of pollutants into groundwater. The directive establishes quality criteria that takes in account local characteristics and allows for further improvements to be made based on monitoring data and new scientific knowledge.

Groundwater is also covered by some components of the Water Framework Directive, covering a number of different steps for achieving good quantitative and chemical status of groundwater. The Groundwater directive thus represents a proportionate and scientifically sound response to the requirements of the Water Framework Directive as it relates to assessments on chemical status of groundwater and the identification and reversal of significant and sustained upward trends in pollutant concentrations.

### Nitrates Directive

The Nitrates Directive 91/676/EEC aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. It forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures. The implementation of the directive encompasses: Identification of water polluted, or at risk of pollution; Designation as "Nitrate Vulnerable Zones"; Establishment of Codes of Good Agricultural Practice to be implemented by farmers on a voluntary basis; Establishment of action programmes to be implemented by farmers within Nitrate Vulnerable Zones on a compulsory basis; and National monitoring and reporting.

Regarding Montenegrin legislation, some elements of the Nitrates Directive are reflected in the Law on Water and the Law on fertilizers (2007). The alignment was continued with further amendments to these two laws during 2020-2021. The Code of Good Agricultural Practice was adopted (in June 2013).

### Floods Directive

The Directive on the assessment and management of flood risks 2007/60/EC was adopted with the aim to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. The Directive required Member States to first carry out a preliminary assessment by 2011 to identify the river basins at risk of flooding. For such zones they would then need to draw up flood risk maps by 2013 and establish flood risk management plans focused on prevention, protection and preparedness by 2015. The Directive applies to waters across the whole territory of the EU.

The Directive was carried out in coordination with the Water Framework Directive, notably by flood risk management plans and river basin management plans being coordinated, and through coordination of the public participation procedures in the preparation of these plans. All assessments, maps and plans prepared will be made available to the public.

The directive is fully transposed through the Water Act and its by-laws. The proposal is not made through the Water Management Financing Act or the Law on Protection and Rescue. Amendments to the Act have been completed and the Rulebook is: Rulebook on the Preliminary Assessment of the Flood Risk Assessment and the Flood Risk Management Plan ("OG of MNE 69/15). The alignment has continued through the amendments to the existing Law on Water and through the adoption of several implementing acts, including the Rulebook on the Methodology for the Classification of Flood Risk Zones. A new Plan for the next 6-year cycle - General plan for protection against harmful effects of water, for waters of importance for Montenegro, for the period 2017-2022 ("Official Gazette of Montenegro", No.17/17 of 17 March 2017). The Operational Plan is not a "successor" of the General, but a special plan that is made every year.

The preliminary flood risk assessment (PFRA) is not prescribed by the Water Law, but its preparation is prescribed by the Water Act. There are data in the Water Law that can be used when designing a PFRA, i.e. past floods, the areas threatened by floods (many rivers), the infrastructure constructed with the purpose of protecting against floods and the proposal for future measures for the improvement of the river basins and defence against floods. The financing of the works and infrastructure for the protection against the harmful effects of water is prescribed in the Law on Water Management Financing (2008). Montenegro stated that it intends to coordinate preparation of flood risk management plans for the river basin management plans required by the WFD. Measures for flood protection and prevention, according to the requirements of the Floods Directive (2007/60/EC) will be integrated into the RBMPs as early as 2021.

### Drinking Water Directive

The Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption (Drinking Water Directive) concerns the quality of water intended for human consumption. Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.

The Drinking Water Directive applies to:

- all distribution systems serving more than 50 people or supplying more than 10 cubic meter per day, but also distribution systems serving less than 50 people/supplying less than 10 $m^3$ per day if the water is supplied as part of an economic activity;
- drinking water from tankers;

- drinking water in bottles or containers;
- water used in the food-processing industry, unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form.

Montenegro indicated that it has been partially transposed by the Rulebook on drinking water safety (OGM, 24/2012), the Law on food safety (2007) and the Law on Waters (2007), and the Rulebook on Methods for control/testing of Drinking Water Safety. The competent authorities are in place: The Ministry of Health is responsible for the control and monitoring of the drinking water safety, while MARD is responsible for the protection of the water sources and the determination of the sanitary protected areas; the Inspection Directorate through the Sanitary Inspection is responsible for the water safety control, and through the Water Inspection is responsible for the monitoring and implementation of the Law on Waters. The monitoring is performed by 4 national accredited laboratories in Montenegro.

### Directive on Water Quality Standards

The Directive 2008/105/EC on Water Quality Standards sets out environmental quality standards (EQS) concerning the presence in surface water of certain substances or groups of substances identified as priority pollutants on account of the substantial risk they pose to or via the aquatic environment. The priority substances are defined by the Water Framework Directive, by Decision 2455/2001/EC, and by amended Directive 2013/39/EU. These substances include the metals cadmium, lead, mercury and nickel, and their compounds, benzene, polyaromatic hydrocarbons (PAH) and several pesticides. 21 priority substances are classed as hazardous.

The environmental quality standards are limits on the concentration of the priority substances and eight other pollutants in water (or biota), i.e. thresholds which must not be exceeded if good chemical status is to be met. The quality standards are differentiated for inland surface waters (rivers and lakes) and other surface waters. For some substances, biota EQS are set, meaning that the specified concentration of the relevant substance in biota (generally fish) must not be exceeded.

Montenegro is in process of adoption of relevant national regulative for assessment of chemical status of water bodies. The methodology and Ecological Quality Standards (EQSs) are prescribed in the relevant EU Directive (EQSD 2013/39/EU) and QA/QC Directive (2009/90/EC) to determine chemical status and those documents have been used as tool for indicative chemical status assessment.

**Bathing Water Quality Directive**

The Bathing Water Directive 2007/6/EC (as amended by Regulation (EC) No 596/2009) applies to surface waters that can be used for bathing except for swimming pools and spa pools, confined waters subject to treatment or used for therapeutic purposes and confined waters artificially separated from surface water and groundwater. The Directive is intended to:

- Be based on scientific knowledge on protecting health and the environment, as well as environmental management experience;
- Provide better and earlier information of citizens about quality of their bathing waters, including logos;
- Move from simple sampling and monitoring of bathing waters to bathing quality management, and,
- Be integrated into all other EU measures protecting the quality of all our waters (rivers, lakes, groundwaters and coastal waters) through the Water Framework Directive.

Two main parameters for analysis (intestinal enterococci and Escherichia coli) are defined, instead of nineteen in the previous Directive. These parameters will be used to monitor and assess the quality of bathing waters and to classify them. Other parameters could be taken into account, such as the presence of cyanobacteria or microalgae.

In Montenegro, the definition of bathing waters from the Bathing Water Directive has been transposed into the Law on Waters (Article 74d) and applies to all surface waters. The program of systematic testing of water quality at water intakes (zones of sanitary protection) and public bathing areas ("Official Gazette of the Republic of Montenegro" No. 13/00), which defines freshwater and sea bathing areas, is also in force.

Although currently not fully in compliance with the EU WFD requirements for bathing waters, Montenegro does have existing legal documents related to the Bathing Water Directive, which also includes:

- The Decree on Classification and categorization of surface and groundwaters (OG 02/07), which (i) defines waters that can be used for bathing and (ii) uses a two-tier classifications (Class K1 – 'excellent' and Class K2 – 'satisfactory') for the measurement of intestinal enterococci and *Eschericia coli*.[1]
- Rulebook on the manner and deadlines for implementing measures to ensure the conservation, protection and improvement of the quality of bathing water (OG 28/19).

**Marine Framework Strategy Directive**

Directive 2008/56/EC on establishing a framework for community action in the field of marine environmental policy - known as the Marine Strategy Framework Directive (MSFD), was formally adopted by the European Union in July 2008. The aim of the European Union's ambitious Marine Strategy Framework Directive is to protect more effectively the marine environment across Europe.

The MSFD outlines a transparent, legislative framework for an ecosystem-based approach to the management of human activities which supports the sustainable use of marine goods and services. The overarching goal of the Directive is to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment.

The Law on Marine Environment Protection was adopted by the Parliament of Montenegro on 23rd December 2019 ("Official Gazette of Montenegro", 073/19). This law partially transposes MSFD into Montenegrin legislation and only after the adoption of the by-laws it will be possible to consider MSFD from 2008 and its amendments from 2017 together with related Decision fully transposed. The full transposition of this directive is one of Montenegro's most important obligations defined in the Chapter 27: Environment and Climate Change in the framework of the EU integration process.

[1] The Regulation terminating Regulation 2/07 "passed" the Government and sent for signature and publication. In order to comply with the WFD, the Regulation was replaced by: the Rulebook on the manner and deadlines for determining the status of surface waters ("Official Gazette of Montenegro", No. 25/19) and the Rulebook on the manner and deadlines for determining the status of groundwater ("Official Gazette of Montenegro", No. 52/19). The Regulation transposing WFD was adopted in May last year - Rulebook on the manner and deadlines for implementation of measures to ensure preservation, protection and improvement of the quality of bathing water (Official Gazette of Montenegro, No. 28/19).

## 1.2 Structure of the Adriatic River Basin Plan

The following sections below have been detailed in the RBMP, which are arranged according to the general requirements Annex VII of the EU Water Framework Directive (2000/60/EC) and in line with the Montenegro Regulation on the content and way of preparing the water management plan in the aquatic area of water or its part "Official Gazette of Montenegro", No. 39/09 of 17 June 2009.

| | Contents of the EU WFD Adriatic River Basin Management Plan |
|---|---|
| **Section 2** | **Legal and institutional framework for water management** |
| **Section 3** | **A general description of the characteristics of the river basin district required under Article 5 and Annex II, which includes:** |
| | Description of the surface waters |
| | Mapping of the eco-regions & surface water body types within river basin |
| | Delineation of surface waters |
| | Description of the groundwaters |
| | Delineation of groundwaters |
| | Characterization of groundwater bodies |
| **Section 4** | **A summary of significant pressures and impact of human activity on the status of surface water and groundwater, which includes:** |
| | Estimation of point source pollution |
| | Estimation of diffuse source pollution |
| | A summary of land use |
| | Estimation of pressures on the quantitative status of water, including abstractions |
| | Analysis of other impacts of human activity on the status of water |
| **Section 5** | **Identification and mapping of protected areas as required by Article 6 and Annex IV, which includes:** |
| | Areas designated for the abstraction of water intended for human consumption under Article 7 |
| | Areas designated for the protection of economically significant aquatic species |
| | Nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EE |
| | Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites. |
| **Section 6** | **Monitoring networks established for the purposes of Article 8 and Annex V:** |
| | Surface water (ecological and chemical) |

| | **Contents of the EU WFD Adriatic River Basin Management Plan** |
|---|---|
| | Groundwater (chemical and quantitative) |
| | Protected areas (provided in Section 5) |
| **Section 7** | **Status of surface water bodies and groundwater bodies** |
| **Section 8** | **A summary of the economic analysis of water use as required by Article 5 and Annex III** |
| **Section 9** | **A list of the environmental objectives established under Article 4 for surface waters, groundwaters and protected area**s |
| **Section 10** | **A summary of the measures required to implement Community legislation for the protection of water** |
| **Section 11** | **National strategic objectives for water and linkage to the Adriatic River Basin Management Plan** |
| | The key principles in relation to the main results to be achieved, the means of verification, the responsible authorities involved and recommendations for the RBMP |
| | 6-Year plan of action (2021-2027) |
| **Annexes** | **1. Groundwater bodies: Characterization, status and references used (separate volume)** |
| | **2. Proposal for a system of ecological status assessment** |
| | **3. Comments Received by the Consultant on the draft RBMP (separate volume)** |

# 2 LEGAL AND INSTITUTIONAL FRAMEWORK FOR WATER MANAGEMENT

## 2.1 Introduction

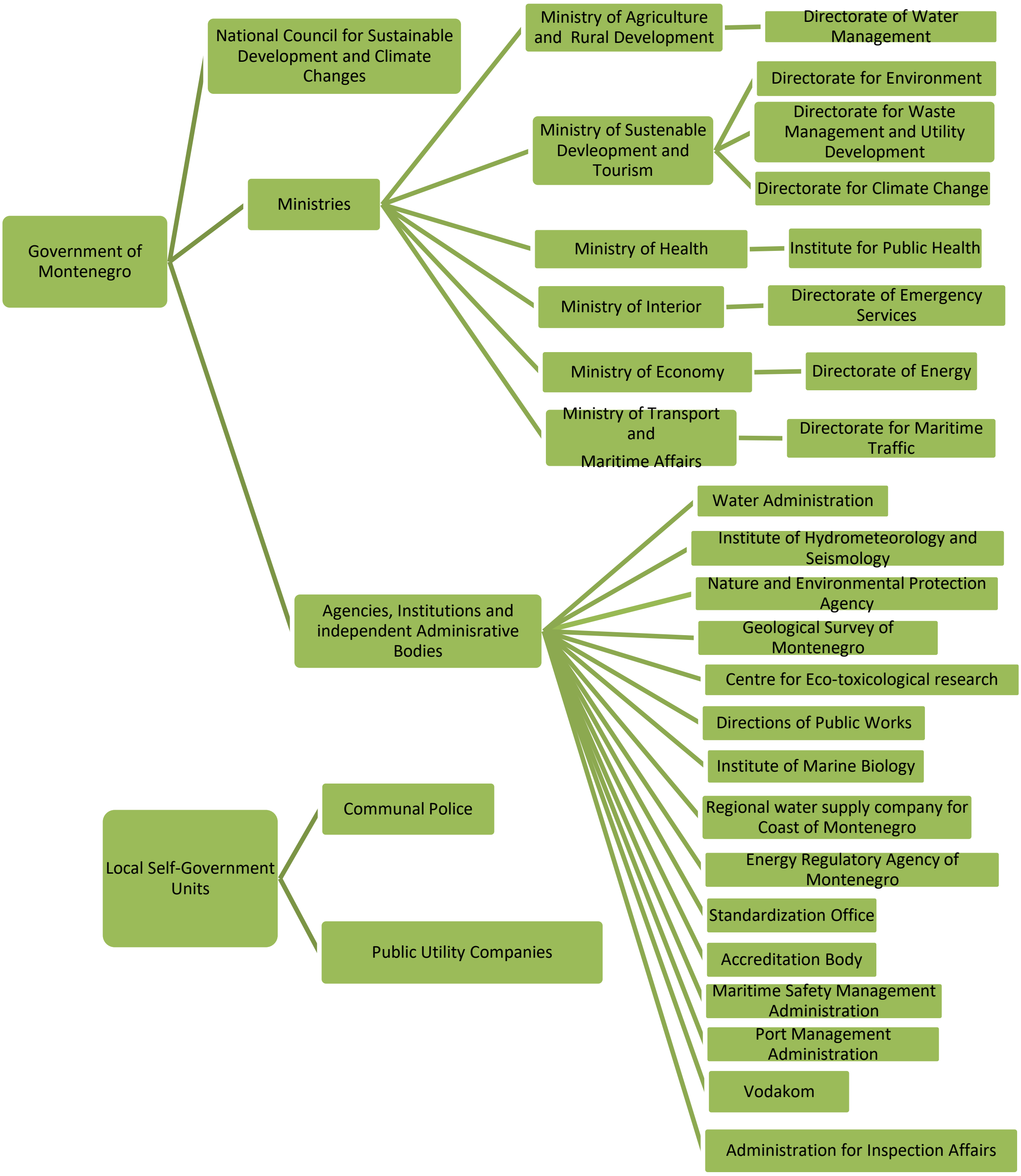
The **Government** is the supreme executive body of the country. It is responsible for adoption and endorsement of documents and acts submitted by respective ministries and take some high-level executive state decisions in water management. It has the power to adopt the strategic and planning documents on the national level – the Water Management Strategy of Montenegro (WMS) and the River Basin Management Plans (RBMP). In terms of water management, the Government is involved in the following decisions: determination of environmental objectives, award of concessions, adoption of the criteria for monitoring network, adoption of state monitoring network for surface and groundwater bodies, adoption of contents of reports, manners and procedures, adoption of early warning plans, adoption plan for water management for use of water funds, adoption of method of calculation of total charge and price of services.

The responsibility, organization and capacities of the public administration institutions are regulated by legal provisions and by the needs associated with economic and social transition to the ultimate goal of joining the EU. The public administration institutions are grouped as follows:

1. Institutions directly responsible for water management and environmental protection;
2. Institutions responsible for activities from the sphere of energy;
3. Institutions in other areas of water resource management;
4. Institutions responsible for harmonization of the national regulations with EU regulations;
5. Local government.

The overall **institutional set up for the water management in Montenegro** is represented in Figure 2.1.

## Figure 2.1 Organization of the Water Sector in Montenegro



The most important public administration institutions in charge of water resource management in Montenegro are as follows:

**Group 1 - Water resources management and environmental protection**:

- Ministry of Agriculture and Rural Development:
    - Directorate of Water Management
- Water Administration
- Ministry of Sustainable Development and Tourism:
    - Environmental Directorate;
    - Waste Management and Communal Development Directorate;
    - Climate Change Directorate;
    - Department for Sustainable Development and Integrated Management of the Marine and Coastal Zone.

  Authorities within the MSDT are as follows:
    - Agency for Nature and Environmental Protection;
    - Institute of Hydro-Meteorology and Seismology of Montenegro; o Directions of Public Works
    - Regional Water Supply Company for Coast of Montenegro
    - Vodacom
    - Centre for Eco-toxicological research
- Ministry of Health:
    - Public Health Institute
- Ministry of Interior:
    - Directorate of Emergency Services
- Ministry of Transportation and Maritime Affairs:
    - Maritime Safety Management Authority
    - Port Management Authority
- Administration for Inspection Affairs

**Group 2- Energy:**

- Ministry of Economy:
    - Directorate of Energy;
    - Energy Regulatory Agency of Montenegro

The Ministry supervises the legality and expediency of the work of the following Administration Body:

- Geological Survey of Montenegro

**Group 3 - Institutions in other areas relevant to the water resources management:**

- Ministry of Finance (Department of Property);
- Ministry of Foreign Affairs
- Statistics Office (MONSTAT)
- Standardization Office (Ministry of Economy);
- Accreditation Body of Montenegro (Ministry of Economy);

- Scientific institutions, etc.

**Group 4 - Harmonization of the National Regulations with EU Regulations:**

- Ministry of Foreign Affairs
- Ministries (MARD, MSDT, MH, MTMA, etc.)
- Other authorities and services of the Montenegrin Government (including Legislation Secretariat)
- Certain Parliament bodies, etc.

**Group 5 - Local Self Government Units**:

Local Self Government Units:

- Ministry of Interior (Segment related to local government)
- Communal Police
- Public Utility Companies
- Union of Municipalities of Montenegro

### 2.1.1 Ministerial level and specialised structures under the ministries

According to the WL the **Ministry of Agriculture and Rural Development (MARD),** through **Directorate of Water Management (DWM),** has the leading role in water management legislation, with obligations and a coordination role in all aspects of water management covered by the Water Law, which includes overall supervision of the implementation of the Water Law. DWM is in charge of proposing and implementing policies in the water sector, including adoption of planning documents and normative acts within its competence and administrative control, inspection and surveillance.

**Water Administration (WA)** is an administrative body responsible for implementation of water management strategy and plants (participates in the preparation of plans, submits water management plans to the European Commission, ensures the participation of the public and interested persons in the process of preparation and adoption of the plan, monitors the implementation of the program of measures). Also, WA carries out works related to water protection, protection from water and water use. These include provisions and implementation of measures and works of water and waterway development, protection against adverse water effects and protection against water pollution; providing use of water, waterway materials, water land and state owned water faculties, through concessions, lease and similar; water facility management for the purpose of protection against adverse water effects; issuing water documents; setting water charges; creating and operating water information system, water cadaster, water registry; setting the boundaries of the water assets and setting the status of the public water asset; cooperation with relevant international organizations and institutions in line with relevant responsibilities.

**Ministry of Sustainable Development and Tourism (MSDT)** is the umbrella institution for coordination of activities within Chapter 27-Environment and Climate Change (C27). This Ministry carries out tasks related to development and strategic policy making in the area of the Environment and Climate change, harmonization of national regulations with the EU acquis in this area, implementation and administrative supervision of implementation of certain regulations in this area, as well as other tasks related to the strategic planning in the area of Environment and Climate change.

The MSDT exercises activities, among other, related to sustainable development and environmental protection, some of which are: implementation of sustainable development programs and projects; provision of technical, organizational and administrative support to the National Sustainable Development Council; spatial and environmental strategic planning; system of integrated environmental protection and sustainable utilization of natural resources; integrated pollution prevention and control; **wastewater management; coordination of the regional water supply systems**; developing environmental protection standards; monitoring environmental conditions; cooperation with the international financial institutions and EU funds in implementation of environmental protection and utility services projects; cooperation with NGOs; harmonization of regulations under the Ministry's jurisdiction with EU acquis; and other activities under the Ministry's jurisdiction.

MSDT is responsible for the activities relating to inter alia the system of utility operations and coordination of regional water supply systems. The transposition and implementation of EU legislation regulating, collection and treatment of urban wastewaters (Directive 91/271/EEC), is in responsibility of MARD with assistance of MSDT in some areas (definition of agglomeration, required quality of discharged wastewater).

MSDT is responsible for the activities relating to transposition of the Directive 2008/56/EC (Marine Strategy Framework Directive) and Directive 2014/89/EU (Maritime Spatial Planning) as well as the implementation and monitoring of implementation of relevant national regulations on these issues.

MSDT exercises control over the work of the following institutions: Environmental Protection Agency, Institute of Hydrometeorology and Seismology of Montenegro, Directions of Public Works, Centre for Eco-toxicological research, Regional Water Supply Company for Coast of Montenegro, Vodacom and Procon.

The management and monitoring of the marine waters and coastal area is within the competence of the MSDT in line with the national legislation (Law on Environment[5], Law on Coastal Zone Management[6]), the legislation governing the organization and operations of state administration and international obligations undertaken until now (e.g. Barcelona Convention) which regulates the protection and sustainable management of marine ecosystems and coastal area. Under this and other relevant national legislation (Law on the Sea, Law on Preventing Pollution of the Sea from Vessels, Law on Ports, etc. ), issues relating to preventing sea water pollution from vessels was entrusted to the MTMA, its Maritime Safety Department and the Port Master's Office. The Law on Utility Activities[7] has the provisions placing the maintenance and cleaning of open beaches within the competence of municipalities[8], which is in line with the Law on Local Self-Government[9].

The Ministry of Sustainable Development and Tourism has a very good cooperation with civil society, especially with environmental NGOs. They are involved in cooperation with public authorities in different ways starting from participation in drafting of legal and strategic documents (on the basis of the Regulation on cooperation with NGOs), through Cooperation Protocols that the Ministry signed with NGO Networks (BELS, NATURA 2000, NKEI, etc.).

**Agency for Nature and Environmental Protection (EPA)** is the main executive administrative body in charge of implementation of regulations in the area of Environment and Climate change. It is competent for organization, planning and participation in environmental monitoring, including making proposals of the national list of environmental indicators, as well as for updating the data on all environmental segments and reporting at the national and the European levels, including reporting to the European Environment Agency (EIONET).

Based on the new Law on Environment, adopted by the Parliament in July 2016, EPA is organizing and implementing the monitoring of all segments of environment, except for water quality, which is under the responsibility of MARD.

The mandate of the EPA includes implementation of strategies, programmes, laws and regulations in the field of environment, implementation of international treaties within its jurisdiction, environmental permitting, EIA, SEA, IPPC licensing, environmental monitoring, keeping relevant registers (including the Central Register of Protected Areas and Areas under Preventive Protection )and databases, and reporting and coordination of reporting on the state of the environment. The EPA is also responsible for the provision of information to national and international organizations and to the public.

**Institute of Hydrometeorology and Seismology of Montenegro (IHMS)** as the public administration authority has been established to exercise technical and associated administrative activities by means of applying scientific methods and knowledge, in charge of all physical and chemical processes in the atmosphere and hydrosphere, i.e. hydrological and meteorological activities in the broadest sense. Analytical data on environmental conditions is published in the Annual Reports, archived and delivered in suitable form to the line Ministry and other interested users.

The Water law in Article 83, paragraph 5 prescribes following: ‘Monitoring of surface and groundwater and protected areas is carried out by the body responsible for hydrometeorological affairs.”(see Table 2.1).

The IHMS reports to the MSDT. According to the Law on Hydrometeorological Services, the IHMS has a mandate for the following activities:

- Observation and analysing of meteorological, hydrological, ecological, agrometeorological, hydrographic and seismic parameters; analysing, processing and storage of measured and observed parameters
- Production of studies, analysis and information about climate, state of the ground, air, surface and underground waters and coastal sea
- Forecasting and dissemination of data from the fields of meteorology, hydrology, hydrography, ecology, agro-meteorology and seismology
- Control and estimation of quality of surface and ground waters, precipitation and air quality, based on analysis of physic-chemical, biochemical and microbiological parameters
- Providing data, information and reports for the necessity of maritime, air and road traffic, electro power industry, water management, agriculture, engineering, tourism, protection of life and goods, public and others
- Informing and alerting responsible Agencies during emergency situations
- Execution of international obligations in the areas of meteorology, hydrology, hydrography, seismology, water and air quality.

IHMS cooperates with i) the national meteorological, hydro-meteorological and seismological services of other countries and international organizations in the sphere of meteorology, ii) Hydrology, seismology and environment control, hydro-meteorological services from the regions, and iii) with relevant public authorities and organization in Montenegro.

**Ministry of Health (MH)** has a major role to play in implementing the Drinking Water Directive Directive (98/83/EC). The responsible institutions for the implementation of Council Directive 98/83/EC are the Ministry of Health and the Institute of Public Health of Montenegro. The collaboration of MARD and MH provides a link between water management and human health protection. Through the Directorate for Public Health and Programmatic Health Care, MH is responsible for the health safety of water for human consumption and for providing opinions on its safety. He is involved in the field of water protection to create the above link between the Institute of Public Health and, in the area of enforcement, the State Sanitary and Health Inspectorate.

**Institute for Public Health (IPH)** responsible for physical and chemical analysis of water and microbiological testing of drinking water is responsible for control and monitoring of water safety (Directive 98/83/EC). The Law on providing healthy water for human consumption defines that monitoring of water for human use is carried out by the IPH. Also, the role of the IPH is highly specialized health care institution of the tertiary health care focused on preserving and improving citizens’ health. Exercising the activities, the Institute, among other, conducts the following: recommends and implements hygienic control measures related to drinking water, surface and waste waters; monitors, analyses and evaluates environment quality impacts (air, soil and noise) on population health; participates in preventive supervision of designing and construction of civil engineering and other facilities and in designing of spatial and urban plans from the perspective of protection and improvement of environment, working environment and citizens health; prepares and issues the "Statistical Yearbook", newsletters and other publications.

The Law on Records in Health Care has prescribed the “Records of the Conditions and Measures of Human Environment Protection and Improvement” and “Records of Health Safety of Provisions and Objects of General Use”. Aforementioned records include data on the sources of pollution, cause and place of pollution, type and quantity of noxious substances, level of pollution, consequences of pollution and protection measures undertaken against individual sources of pollution.

**The Ministry of Transport and Maritime Affairs** performs administrative tasks related to maritime traffic and safety, for instance the protection of merchant ships and ports, the prevention of and emergency in the event of sea pollution, and the control of dangerous goods transportation in maritime and inland navigation. Organizational units of Ministry -– Directorate for applying standards to protect the sea from pollution, which includes responsibly for protection of sea from pollution from ships, protection of human life at sea, as well as a security protection vessels.

**Directorate for Maritime Transport** includes: Port Administration Bar and Port Administration Kotor which are also competent for implementation of Directive 1999/32/EC relating to the Sulphur content in marine fuels, amending Directive 93/12/EC, through the control of use of marine fuels and equipment for prevention of emission of pollutants into the air, i.e. through controls of ship logs and technical documentation. Maritime Safety Department Bar, is also responsible for implementation of Directive 1999/32/EC relating to the Sulphur content in marine fuels, amending Directive 93/12/EC.

**Ministry of the Interior** (Directorate for Emergency Services) is responsible for risk management and emergency situations response, including in the event of floods. The MI is competent for transposition of EU regulations on civil protection and implementation of corresponding national regulations, risk management, protection and rescue management in emergency situations and management of remediation following emergency situations (earthquake, fire and other natural and technical-technological disasters). Also, MI is competent for implementation of obligations stemming from the Decision 1313/2013 (establishment of the Union Civil Protection Mechanism) and the Commission Decision 2014/762/EU laying down rules for the implementation of Decision No 1313/2013/EU on a Union Civil Protection Mechanism.

One of the competencies of MI is assistance in transposition and implementation of Directive 2007/60/EC to the MARD as primary competent institutions.

**Ministry of Economy (ME)** exercises activities, among other, related to: industrial production in the following sectors and subsectors: electric power generation and gas production, rock and ore mining (harnessing energy resources, harnessing other resources and materials); energy policy; implementation of policy and coordination of project implementation in the sphere of energy efficiency, exercising technical and administrative activities in the sphere of energy efficiency, setting the directions and dynamics of energy development; preparation of the energy balance of Montenegro; concession system and concession awarding in line with the ministry's responsibilities; geological research, etc. ME has been organized in nine directorates. Energy Directorate and Energy Efficiency Directorate exercise activities of energy and energy efficiency.

**Institute of Marine Biology (IMB)**, as the organizational unit of the University of Montenegro, carries out expert researches, which are, among other things, relevant for: the status of particular species, their biology and conditions, management of habitats and establishment of criteria for species and habitat preservation, potential participation in definition of the list of special protection areas and development of indicators. However, the way scientific and research activities are organized does not allow for a continuous involvement in policy implementation in this area. In that relation, scientific activity of IMB will contribute to implementation of some EU regulations for Chapter 27, above all the Marine Framework Strategy Directive 2008/56/EC

**Centre of Ecotoxicological Research of Montenegro (CETR)** exercises Ecotoxicological research of all segments of environment, including surface and subsurface waters and sea water, wastewaters, drinking water, soil, sediments, sea, noise and vibration research in working environment and living environment, waste categorization, etc. CETR are also in charge, beside other tasks (work organization, laboratory analyses, data interpretation), of field measurements, laboratory analyses, data verification and validation, as well as for implementation of quality assurance programmes for the data from measuring points (QA/QC). The work of the CETI is supervised by the Ministry of Sustainable Development and Tourism.

**Geological Survey of Montenegro** and more specifically its Department of Hydrogeology, Engineering Geology and Water Concessions, performs hydrogeological research for the purpose of water supply, protection of groundwater and construction of hydro-power plants and in this respect, it develops related maps as well as studies and reports; it also prepares documentation for the purpose of granting water concessions.

### 2.1.2 Enforcement level - Inspection

The **Administration for Inspection Affairs (AIA)** is the body competent for enforcement of national legislation aligned with EU regulations on Environment and Climate change. AIA should be organized and reinforced with personnel in accordance with the Recommendation 2001/331/EC of the European Parliament and of the Council on minimum criteria for environmental inspection in EU member states. AIA carries out tasks related to supervision of implementation of laws and other regulations and general acts related to Chapter 27 and it undertakes administrative and other measures and actions to eliminate established irregularities and ensure a correct implementation of regulations, including launching of procedures before competent bodies. Inspection supervision is carried out according to the work plan, upon orders of the chief inspector and initiatives that are conferred to him, after which supervision data are accurately entered into the database, with submitted reports on performance and the report on controls executed upon orders, as well as information about the status and identified events in the field in the area of supervision implemented by the responsible organizational unit. In

AIA there are three organizational units whose competences include issues related to the EU acquis for C27:

- Sector of Environmental and Spatial Protection;
- Sector of Protection and Safety of Human, Animal, Plant and Forest Health, and
- Sector of Protection of Market and Economy, Games of Chance and Public Procurement.

Sector of Environment and Spatial Protection consists of three organized units whose jurisdiction is in terms of the EU acquis for Chapter 27: Department for Environmental Inspection, Department for Water Management Inspection and Department for Mining, Geology and Hydrocarbon Inspection.

Department for Environmental Inspection is responsible for inspection control in terms of Chapter 27, including eight subareas: Horizontal legislation, Air quality, Waste management, Nature protection, Industrial pollution, Chemicals, Noise and Climate changes.

Department for Water Management Inspection is responsible for enforcement on implementation of law, secondary legislation and other regulations in the field of the water supply (subarea: Water quality).

Department for Mining, Geology and Hydrocarbon Inspection is competent for inspection control regarding the laws, secondary legislation and other regulations in the field of geology, mining and exploring and production of hydrocarbon, including control over implementation the Law on Waste Management - waste management from mining.

### 2.1.3 Consultative bodies

The Consultative body at the national level which, among other things, deals with issues related to water management is the National Council for Sustainable Development, Climate Change and Integrated Coastal Area Management.

The **National Council for Sustainable Development** was established in 2002 on the eve of the World Summit on Sustainable Development in Johannesburg as an advisory body to the Government of Montenegro with a mission to influence government policy in the field of sustainable development. In the meantime, it has undergone several changes in the composition and scope of work, and today it is called the National Council for Sustainable Development, Climate Changes and Integrated Coastal Area Management.

The Council consists of 26 members, consisting of ministers of sustainable development, economics, labor, agriculture, transport and culture, director of the Institute of Hydrometeorology and Seismology, director of the Public Enterprise for Maritime Management, presidents of three municipalities, representatives of the Chamber of Commerce, academy of science, business sector, non-governmental organizations and independent persons / experts in the field of sustainable development.

In Montenegro, the Water Act does propose the establishment of an inter-ministerial water body (Articles 151a and 151b) In order to make proposals for deciding on professional issues and for providing professional assistance in the decision-making process in the field of water, a Water Council is established.

The **Water Council** provides advice, in particular, to make proposals of importance for the improvement of the water situation; Provides expert assistance in developing strategies, national programs and water management plans; give expert opinions at a public hearing for water management planning documents; monitor the implementation of the national water management program and plans; make proposals for improving public participation in the planning, decision making and control of their implementation; make expert proposals for educating the public on the importance of water as a natural public good, on the need to rationalize water consumption, protect water and the role of water bodies in providing services.

The Water Council is formed by the Government. The Water Council has a president and ten members, who are appointed by the Government at the proposal of the Ministry. The members of the Water Council shall be appointed for a term of four years. The members of the Water Council are appointed from: prominent scientific and expert persons in the field of water and environmental protection, public health, economy and finances, local self-government units, non-governmental organizations in the field of water and environmental protection, as well as scientific and professional institutions from of importance for the sustainable management of water resources and of companies engaged in water supply and wastewater treatment activities.

The Consultative body at the local level which, among other things, deals with issues related to water management is **Union of Municipalities of Montenegro (UMM**). UMM is the national association of local communities (municipalities, administrative capital and capital city) of MNE. Some of the activities of the Community are as follows: improvement and development of utility services (including water management) , economic and non-economic activities and other areas under jurisdiction of local government; improving education of local government servants; cooperation with international local government organizations, other international organizations and local communities from other countries and the region, etc.

Strengthening the **involvement of NGOs and other stakeholders** and creating a system for their effective participation in policy- and decision-making has been the focus of specific efforts by the Government in the last few years.

Apart from the Law on Non-Governmental Organizations, the Regulation on the procedure and manner of conducting public debate in preparing laws and Regulation on the procedure and manner of developing cooperation between public administration bodies and nongovernmental organizations have been adopted to guide public authorities. Procedures for public participation exist in other legal acts, including the laws on EIA, SEA and IPPC.

The network of Aarhus centers opened through the joint efforts of MSDT, the EPA and the Organization for Security and Cooperation in Europe (OSCE) Mission to Montenegro includes three centers: Podgorica, Nikšić and Berane.

### 2.1.4 Policy and Legal Framework in Montenegro

#### National Strategy for Sustainable Development

The 2007 National Strategy for Sustainable Development (NSSD), accompanied by the Action Plan for the period 2007–2012, set the following general objectives: accelerate economic growth and development and reduce regional development disparities; reduce poverty and provide equal access to services and resources; ensure effective control and reduction of pollution, and sustainable management of natural resources; improve governance and public participation in environmental matters; and preserve cultural diversity.

Based on the NSSD provisions, the NSSD Action Plan was revised in 2011. A working group of the National Council for Sustainable Development and Climate Change is working on the development of a revised NSSD for the period 2014–2020. The revised strategy is envisaged to be more horizontal, in line with the Rio+20 outcomes and Europe 2020 (the EU's 10-year growth strategy), with clear targets and indicators.

The 2010 National Communication Strategy for Sustainable Development (NCSSD) includes recommendations and guidelines for the promotion of sustainable development to be applied by various governmental authorities. The first and only annual report on the implementation of the NCSSD was adopted in December 2011. The NCSSD suffers from lack of resources and currently its systematic implementation is not ensured. Water is one of the most important segments that this strategy applies to.

### National Environmental Approximation Strategy

Main objective of the National Environmental Approximation Strategy (NEAS) is to provide strategic planning framework for achieving full compliance of the national legal and institutional framework with requirements of the EU in order to improve state of the environment, respond to climate change challenges and sustainably manage natural resources. NEAS is adopted in order to enable gradual, complete transposition of the entire EU acquis into the legal system of Montenegro. It also provides for a framework for fulfilment of the obligations assumed by ratification of numerous international treaties in the areas of environment, climate change and sustainable development. The NEAS also lays down obligations in the context of continuous coordination of activities undertaken by state bodies and local government bodies competent for environmental protection in the process of harmonizing national legislation with the EU acquis.

This document also confirms political will of Montenegro to implement the Stabilization and Association Agreement. The progress made in the process of approximation of the environment and climate change sector within the scope identified by the NEAS creates opportunities for adequate development and necessary adjustment of administrative and technical capacities of Montenegro for environmental management which is compliant with the EU standards.

### Strategy for water management by 2035

The Water Management Strategy for 2035 was adopted in July 2017. This document should be a long-term planning document that sets out the vision, goals and objectives of national policy in water management and in the development of the water sector. Strategic decisions, commitments and guidelines in all segments of the economy and society depend on this document, since the water sector is most closely linked to all other components of the state's development policy. In accordance with the Law on Water, the Strategy in particular contains: an assessment of the current situation in the field of water management; water management goals and guidelines; measures to achieve the identified water management objectives and project the development of water management.

### The Law on Water

The Law on Water (Official Gazette of Montenegro, Nos. 27/07, 32/11, 48/15 and 84/18), replacing the 1998 Law on Water Regime, stipulates the principles of water management. The basic units of water management are two river basin districts. The Law on Water is the main instrument transposing WFD. In 2015, Law on Water was amended in order to further align with requirements of WFD. The Law envisages the development of a water master plan for the whole country and of water management plans for each river basin district or for parts of a river basin district. Following the adoption of the water management plans, the Government should adopt a programme of measures for each river basin district.

The law prescribes the main goals for sustainable water protection and management, as well as the terms and conditions for implementation of water management activities. The Law declares as main principles of water management the prevention of deterioration of aquatic ecosystems; ensuring the good status of waters; progressive reduction of pollution of groundwater; sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use; public participation in decision-making related to waters; and mitigation of the effects of floods and droughts.

Among other issues, the Law on Water points to an integrated management based on river basin approach and regulates ownership on water, water management planning, water regulation and use, water infrastructure, water monitoring, protection against floods and erosion. However, implementation is still in progress despite the step forward given by the Law.

The Law regulates concessions for various water uses, organization of water use permitting and designation of zones and strips of sanitary protection at water intakes. Data about water quality status, categories and classes of surface water and groundwater bodies, water documentation, legislative, organizational, strategic and planning measures in the field of water management will be included in the water information system. The Law stipulates that local self-government authorities are responsible for supplying drinking water for all settlements exceeding 200 inhabitants or with average annual water demand exceeding 100 $m^3$/day. Water supply in settlements that do not meet these criteria should be regulated by local self-government authorities. In practice, water supply and sewerage activities are carried out by public utility companies.

In terms of implementation, the water information system demanded by the Law still has to be established. The water management plans, which are envisaged by the Law to be ready in 2016, still have to be developed. There is a need for improvement of water monitoring system, and in general water protection issues, as well as strategic and planning documents. The main implementation challenges are related to development of River Basin Management Plans and significant investments needed for implementation of Urban Waste Water Treatment Directive.

Further information regarding the primary and secondary legislation of the Water Law is provided below in Sections 2.2 and 2.3.

### The Law on Environment

The 2008 Law on Environment, replacing the 1996 Law on Environment, is a key legal act on the management and protection of the environment. It establishes principles, mechanisms and the institutional framework for environmental protection in line with the requirements stemming from Montenegro’s international commitments.

The Law describes such principles as an integrated approach to environmental protection, cooperation among governmental authorities at different levels and between governmental authorities and stakeholders, access to information and public participation, and the ‘polluter pays’ and ‘user pays’ principles. It delineates the roles of national and local self-government authorities in planning, implementation, monitoring and reporting, and also defines the sources of financing for environmental protection.

The Law sets the framework and responsibilities for environmental monitoring. It also regulates the responsibilities of legal and natural persons on environmental protection. In addition, it stipulates the size of fines for legal and natural persons for selected categories of offences, mostly connected to failures to participate in monitoring, provision of information and prevention of accidents.

This Law designates the EPA as the state authority responsible for monitoring activities, authorizes the Agency to engage other legal or natural persons in implementation of the monitoring activities, and obliges it to elaborate the national list of environmental indicators and publish the collected and assessed information on the environment.

In addition, the Law on Environment obliges legal persons and entrepreneurs managing facilities that pollute the environment to organize self-monitoring and report data collected through the self-monitoring to respective local self-government authorities and the Agency. Further, it sets the requirement for establishing a cadaster of environmental polluters to be managed by local self-government authorities (local cadaster) and the Agency (national cadaster). The Law on Environment sets out a good basis for conducting environmental monitoring and assessment as well as for providing the public with environmental information.

While in some areas, such as the establishment of the EPA or the system for environmental monitoring, the Law on Environment fostered progress, a number of its provisions have not been implemented. For example, the environmental protection fund, to be established in accordance with the Law, has not become a reality. The four-year national environmental protection programme, envisaged by the Law as a main strategic document to define the objectives and priorities on environmental protection and to serve as a basis for local environmental protection plans, has not been developed.

#### The Law on Environmental Impact Assessment

The 2005 Law on Environmental Impact Assessment (EIA), applicable since 2008, enabled the decentralization of the EIA procedure. Its delayed application was rooted in the need to create sufficient capacity at the central, but especially the local, level. Five implementing regulations, including the Regulation on projects requiring environmental impact assessment (OG 20/07, 47/13), were enacted in 2007.

The Law further elaborated the scope and content of the EIA procedure, including from a transboundary perspective, and significantly strengthened public participation. The scope of EIA was harmonized with the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and EIA Guidelines have been issued.

Concerning the criteria for projects requiring an EIA, for some activities (e.g. poultry and livestock farms) Montenegro has chosen to apply stricter thresholds as compared with the EU mandatory list of EIA installations. Furthermore, the Law on Nature Protection takes into consideration the need for an “appropriate assessment” that is required for projects that could have significant effect on the conservation and integrity of ecologically significant areas, i.e. the future Natura 2000 sites. For projects that need both an EIA and appropriate assessment, the latter should be done as part of the EIA procedure. If an EIA is not necessary but appropriate assessment is needed, it is to be done by the EPA as a separate procedure.

The EIA procedure is implemented at the early stage of project planning, being a prerequisite for obtaining a permit for construction. This procedure results in a formal decision by the competent authority on the approval of the EIA study. The decision may prescribe additional environmental protection measures. These requirements become an integral part of the project’s technical documentation. EIAs are carried out at both central and local levels. The competent authority for the implementation of the EIA procedure is a state authority responsible for environmental protection, for projects for which approvals, permits and licenses are issued by other state authorities; or a local authority responsible for environmental protection, for projects for which approvals, permits and licenses are issued by other local authorities.

Since 2008, when the Law on EIA came into force, most EIA procedures have been carried out at the local level. Most EIAs concern infrastructure projects (petrol stations, mobile telephone base stations, tourism infrastructure, WWTPs), mining, and small HPP installations.

Montenegrin legislation does not include the requirement permitting only authorized physical or legal persons to participate in the EIA study elaboration. On the one hand, this excludes a formal barrier preventing the involvement of different experts in the EIA process; on the other hand, this implicitly means that the EIA commission bears the full responsibility for evaluation of the quality of the EIA study.

### The Law on Strategic Environmental Assessment

The 2005 Law on Strategic Environmental Assessment (SEA), applicable since 2008, sets down the conditions and procedures for SEA of plans and programmes. At the national level, the authority responsible for preparing a plan or programme has to carry out the SEA procedure. The local administration body responsible for preparing a plan or programme carries out SEA of plans and programmes envisaged for adoption at local level.

The Law defines its scope of application to include "plans, programmes and documents" prepared and/or adopted at national or local level. The SEA is mandatory for plans, programmes and documents in areas specified by the Law that lay down the framework for future development of projects that are subject to environmental impact assessment (EIA). SEA is also mandatory for plans and programmes that may have an impact on protected areas, natural habitats, and wild flora and fauna. SEA is not obligatory but may be required when minor amendments are introduced in the plans and programmes under the above categories. The decision on preparing or not preparing an SEA (so-called screening) has to be taken by the authority responsible for preparing a plan or programme, taking into account the comments of the EPA (for national plans and programmes) or the local environmental protection authority (for local plans and programmes), health authorities, other authorities concerned and the public concerned, who are given 15 days to provide their opinion. The decision on preparing a SEA will be taken simultaneously with the decision to prepare a plan or programme.

The SEA report is prepared by a local or foreign company chosen by the authority responsible for preparing a plan or programme, on the basis of a tender. The evaluation and approval of a SEA report is done by the EPA (for national plans and programmes) or local environmental protection authority (for local plans and programmes).

### The Law on Nature Protection

The 2008 Law on Nature Protection (OG 51/08, 21/09, 40/11, 62/13, 6/14), replacing the 1977 Law, aims to align the nature protection system with obligations resulting from Montenegro's international commitments and relevant EU directives. The Law describes the classification of protected natural assets. These include: (i) protected areas – strict and special nature reserves, natural parks, nature monuments, protected habitats and landscapes with outstanding features; (ii) protected species of plants, animals and fungi – strictly protected wild species and protected wild species; and (iii) protected geological and paleontological sites.

According to the Law, red lists of endangered wild species of plants, animals and fungi should have been finalized by 2011. The Government should identify the ecological network Natura 2000 sites at the latest by accession of Montenegro to the EU. According to the Law, each protected natural asset should have a management plan adopted for the period of five years and an annual management programme. However, management plans and annual management programmes have been adopted for national parks only.

In December 2013, parliament amended the law on nature protection, mainly as regards the evaluation of plans, programmes, projects, actions and activities that may have a significant impact on the maintenance and integrity of the ecological network and ecologically significant sites, together with compensatory measures. It still misses out essential articles of the Habitat and Birds Directive.

#### The Law on Water Management Financing

The 2008 Law on Water Management Financing (OG 65/08, 074/10, 040/11) provides for the responsibility of the Government to take part in the financing of works on water supply facilities in rural areas.. The use of the funds provided for in this Law shall be made in accordance with the programs, water management plans and programs of measures provided for by the law.

The Law specifies the sources for the financing of water management, the method of calculation and payment of taxes for water protection and use, as well as other questions relevant for gathering and use of the funds. The Law acknowledges that the water has its economic value which is determined according to the analysis of expenses necessary to provide its availability and protection. The funds generated by the taxes paid in accordance with this law can be irrevocably assigned to providers of communal services in order to foster the construction of installations necessary for water use or protection from pollution.

#### The Law on Hydro-Meteorological Services

The Law on Hydro-Meteorological Services (OG 30/12) aims to provide science-based warnings, forecasts and information on weather and climate, the state of the atmosphere and the water status in order to protect the natural and man-made material goods and sustainable development. Hydro-meteorological services include a set of activities on systematic monitoring, research and weather forecasting and climate, the state of the sea, air and water quality. Carrying out hydro-meteorological activities is based on:

- The principle of integrity
- The principle of continuity
- The principle of prevention
- The principle of public information
- The principle of validity
- The principle of standardization.

In order to achieve gradual and complete transposition and implementation of the entire EU acquis for Chapter 27 - Environment and Climate Change, Montenegro adopted in 2016 the National Strategy with Action Plan for transposition, implementation and enforcement of the EU acquis on Environment and Climate Change (the Strategy with AP) 2016-2020. Nevertheless, the necessary capacity for implementation of the EU legislation which is needed in order to comply with the EU directives remains to be significantly strengthened.

## 2.2 Primary Legislation

Water resources management is regulated through the Water Law of 2007, as subsequently amended (Official Gazette of Montenegro, Nos. 27/07, 32/11, 48/15 and 84/18). The Law provides for integrated water resources management and regulates water uses, as well as activities that may have a negative impact on the status of water. Furthermore, it provides for the protection of water against pollution and for the protection from the harmful effects of water. The Law applies to surface water, groundwater, transitional waters, mineral and thermal waters (except for the purpose of obtaining mineral raw materials or geothermal energy), the water estate (water domain), drinking water sources in the territorial sea and coastal waters as far as their pollution from land-based sources is concerned. Under Article 3, the general water management principles – or, rather, objectives - are:

- The prevention of deterioration, protection and enhancement the status of aquatic ecosystems and of the terrestrial and wetland ecosystems directly depending therefrom;
- To ensure the good status of waters;
- To encourage economic and social development;
- To enhance the protection and improvement of the aquatic environment in its entirety through measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of priority hazardous substances;
- To promote sustainable water use based on the long-term protection of water resources;
- To ensure the progressive reduction of groundwater pollution and prevent further pollution;
- To contribute to the mitigation of the effects of floods and droughts;
- To contribute to the provision of sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use, to a significant reduction of groundwater pollution, to the protection of territorial and coastal waters and to the achievement of the objectives set out in the relevant international agreements, including those aiming to prevent and eliminate pollution of the marine environment;
- To ensure conditions for public participation in decision-making;
- To enable the fulfilment of international legal obligations concerning water;
- To prevent and resolve conflicts on water use and protection.

Article 5 defines the terms employed in the text, in line with the definitions offered by the EU Water Framework Directive, while the provisions of Chapter II define the legal (ownership) status of water, the water estate (water domain) and the manner in which rights to the use of the public water estate may be acquired (general use, ministerio legis; special use, through a concession, permit or authorization issued by a competent authority), and the status of riparian land, among other things. Article 8 draws a distinction between waters of state significance, to be designated by the Government, and waters of local significance.

Chapter III of the Law is devoted to water management and water objects. After defining the main concepts and principles in its first part, it indicates the territorial scope of water management (Part 2). In particular, Article 21 assigns the country's water resources in part to the Adriatic basin district as a part of the international basin district of the Adriatic Sea, which includes the following river basins: Zeta, Morača, Skadar Lake, Bojana, Trebisnjica and the watercourses of the Montenegrin coast flowing directly into the Adriatic Sea, with associated groundwater and coastal waters.

In line with the Water Framework Directive, Article 21a stipulates that sub-basins and small river basins may be combined together to form a river basin district; groundwaters which do not follow a given river basin are assigned to the nearest or most appropriate river basin district; coastal waters, also, are assigned to the nearest or most appropriate river basin district. The Ministry in charge of water affairs is to determine the boundaries of sub-basins and small basins.

Part 3 of Chapter III is devoted to water management planning. While Article 23 sets out the content of the water management strategy, Article 24 is about the river basin management plans, the content of which reflects the directions provided for by the Water Framework Directive. These plans are to be prepared by the competent authority and are approved by the Government. They are subject to review every six years (Article 25). Article 24a deals specifically with river basin management plans for international river basin districts, while Article 26 covers the event of review before the expiry of the six-year period due to unforeseeable changes in the circumstances under which a plan was initially adopted. Article 28 enables the Government to adopt special plans for certain categories of watercourses, or when specific water management issues so require. Under Article 29, both the strategy and the plans are subject to strategic environmental impact assessment. Articles 30 and 31 set out the duty of the competent authority to promote the participation of interested parties in the planning process and outline the main requirements for this participation, including the public information requirement, in accordance with the Water Framework Directive.

Article 32 mandates the Government to adopt a programme of measures for each river basin district with a view to the achievement of the environmental objectives detailed in Article 73, consisting of basic measures and, when the implementation of a plan so requires, supplementary measures. When water resources monitoring results show that the objectives are not likely to be attained, the Government is empowered to examine the causes of this failure, to review the licenses issued under the Law and to establish the additional measures needed to remedy the situation, including the setting of more stringent water quality standards. If these causes are the result of force majeure, such as in the case of floods or prolonged drought, and could not have been reasonably foreseen, the Government may determine that the additional measures shall not be implemented. In implementing the programme of measures, steps are to be taken in order to prevent an increase in the pollution of marine waters. The implementation of the programme of measures must not lead to an increase in the pollution of surface water and the environment in general.

The economic aspects of water resources management are dealt with in a separate Law on the Financing of Water Management, which was enacted in 2008 and was amended in 2010 and 2011 (Official Gazette of Montenegro, Nos. 65/08, 74/10 and 40/11). Among other things, this law sets out financing sources, methods of calculation, payment modalities and fees. The basic principle underlying the Law is that funds for the financing of water management are to be obtained from the fees paid by water users and polluters in accordance with the “user pays” and “polluter pays” principles, including fees for the extraction of river deposits (sand and gravel), water rights processing fees, fees for the leasing of state-owned water bodies and hydraulic infrastructure, donations and other sources. They are to be used for financing activities such as water resources planning and the implementation of programmes of measures, the regulation of water use, the protection of water from pollution, the protection against the harmful effects of water, water resources monitoring and the maintenance of the water resources information system. Thirty per cent of the revenue from fees is allocated to the national budget; 70% to the budget of the local self-government units.

## 2.3 Subsidiary Legislation (by-laws)

The subsidiary legislation adopted in order to implement the Water Law includes:

- Decree on the classification and categorization of surface and underground water (Official Gazette of Montenegro, No. 2/07 of 29 October 2007).
- Decree on the content and management of the water information system (Official Gazette of Montenegro, No. 33/08 of 27 May 2008).
- Decree on the content and methods of preparation of water management plans for water areas of river basins or for their related sections (Official Gazette of Montenegro, No. 39/09 of 17 June 2009).
- Decree on the method of classification and categories of water facilities and their management and maintenance (Official Gazette of Montenegro, No.15/8 of 5 March 2008).
- Decision on the determination of the waters of importance to Montenegro (Official Gazette of Montenegro, No. 9/08 of 8 February 2008 and No. 28/09).

- Decision on the determination of the sources intended for regional and public water supply (public water supply) and determination of their boundaries (Official Gazette of Montenegro, No. 36/08 of 10 July 2008).
- Decision on the amount and method of calculating water charges and the criteria and method of determining the degree of water pollution (Official Gazette of Montenegro, No. 29/09 of 24 April, 2009).
- Decision on the determination of sensitive areas in the aquatic area of the Adriatic River Basin (Official Gazette of Montenegro, No. 46/17 of 18 July 2017).
- Rulebook on the content of the request and documentation for the issuance of water acts, methods and requirements for mandatory announcement in determining water conditions and the content of water acts (Official Gazette of Montenegro, No. 7/08 of 1 February 2008)
- Rulebook on the form, detailed content and method for keeping the water book (Official Gazette of Montenegro, No. 81/08 of 26 December 2008).
- Rulebook on the content of the water management strategy and the report on the implementation of the strategy (Official Gazette of Montenegro, No. 17/16 of 2016).
- Rulebook on the delimitation of sub-basin and small basin areas (Official Gazette of Montenegro, No. 15/16 of 2016).
- Rulebook on the determination and maintenance of zones and belts of sanitary protection of springs and restrictions in these zones (Official Gazette of Montenegro, No. 66/09 of 2 October 2009).
- Rulebook on the quality and sanitary-technical conditions for wastewater discharge into receiving water bodies and the public sewerage system, on the method and procedure for testing the quality of wastewater, the minimum number of tests and the content of the report on the determined wastewater quality (Official Gazette of Montenegro, Nos. 45/08 of 31 July 2008, 9/10 of 19 February 2010, 26/12 of 24 May 2012, 52/12 of 12 October 2012 and 59/13 of 26 December 2013).
- Rulebook on the content and management of the water cadaster (Official Gazette of Montenegro, No. 81/08 of 26 December 2008).
- Rulebook on the method and conditions for measuring the quantities of wastewater discharged into the receiver (Official Gazette of Montenegro, No. 24/10 of 30 April 2010).
- Rulebook on the procedures for measuring the amount of water at the water intake. (Official Gazette of Montenegro, No. 24/10 of 30 April 2010).
- Rulebook on the method for determining the boundaries of water lands, 12 April 2012.
- Rulebook on the content of operational instructions for the management of reservoirs for protection against floods Official Gazette of Montenegro, No. 3/18 of 19 January 2018).
- Rulebook on the method and scope of water quality testing, 2 December 2015.
- Rulebook on closer conditions to be fulfilled by legal entities performing water quality tests (Official Gazette of Montenegro, No. 66/12, of 31 December 2012).
- Rulebook on the method for determining the ecologically acceptable flow of surface water (Official Gazette of Montenegro, No. 2/16 of 14 January 2016 and 23/16).
- Rulebook on the methodology for the declaration of erosion areas (Official Gazette of Montenegro, No.72/15 of 21 December 2015).

- Rulebook on the detailed content of the preliminary assessment of flood risks and flood risk management plan (Official Gazette of Montenegro, No. 69/15 of 14 December 2015).
- Rulebook on criteria for the determination of vulnerable and sensitive areas for the purpose of protection of water from pollution (Official Gazette of Montenegro, No. 32/16 of 20 May 2016)
- Rulebook on the detailed composition and content of water infrastructure (Official Gazette of Montenegro, No. 11/11 of 18 February 2011).
- Rulebook on detailed conditions to be fulfilled by a commercial company for the exploitation of river deposits (Official Gazette of Montenegro, No. 51/10 of 9 October 2012, Updated December 2018).
- General plan for protection of waters from harmful effects for waters of importance to Montenegro, for the period 2010-2016, 28 October 2010.

Montenegro has made significant progress towards the transposition of the EU acquis into its legal system, which was completed through the amendments to the Water Law of 2015 and 2018 and the adoption of a large number of bylaws. Only a few gaps remain to be addressed. Among other things, water quality standards remain to be determined and monitoring programmes are not in place yet. The same applies to the list of priority substances. However, a rulebook on the determination of the status of water quality and water quality standards for surface water, groundwater and bathing waters is in progress. Based on this rulebook, water resources monitoring programmes in line with the requirements set out by the Water Framework Directive are planned to be adopted by the end of 2019. These programmes will cover surface water, groundwater and all resource monitoring aspects, including hydromorphology. A governmental decision on the determination of nitrate-sensitive areas is also planned to be issued.

## 2.4 Roles and Responsibilites for Monitoring of Waters

The procedure for the monitoring of surface water status, groundwater status and protected areas is established by the EU Water Framework Directive. These requirements are not transposed solely in the Water Law and deriving bylaws but also in the set of accompanying acts including the Law on Hydro- meteorological Affairs, the Law on Coastal Area, the Energy Law, the Draft Law on Water Safe for Human consumption etc. These acts provide competencies to a wide network of institutions from various fields of work, making a coordination of the overall water monitoring a challenging task.

Monitoring of the use of water is required for following purposes: drinking water, waste water discharges, bathing water, use of waters in protected areas, irrigation/drainage and electricity production.

## Table 2.1 Roles and Responsibilities for Monitoring

| Issues | Tasks | Responsibilities | Legal reference | |
|---|---|---|---|---|
| | | | MNE | EU |
| **Preparation and Adoption of the Monitoring Network** | | | | |
| Setting the criteria for the performance of monitoring | Prescribe and propose conditions, manners and procedures monitoring of each river basin district | IHMS | WL Art. 83 | WFD Art. 8 |
| Monitoring of surface water | To provide and include information on volume and level or rate of flow of surface water in national monitoring program | IHMS | WL Art. 83 | WFD Art. 8 |
| Monitoring of groundwater | To provide and include information on chemical and quantitative status of groundwater in national monitoring program | IHMS | WL Art. 83 | WFD Art. 8 |
| **Monitoring of Drinking Waters** | | | | |
| Definition of criteria for monitoring drinking water | Definition of methodology, detailed requirements for facilities, equipment and staff, procedure for monitoring DW | IHMS (overall monitoring of water quality)<br><br>MH /IPH (responsibilities to be taken over upon adoption of the Law on water for human consumption)[2] | Law on Hydro-meteorological Affairs Art.5-<br><br>Draft Law on water for human consumption (approved by the Government on 28th September, yet to be passed on to the Parliament for full adoption) | DWD |
| Water abstractions | Obligation for facilities that use 10m$^3$ per day water abstractions or supply water to more than 50 people to be monitored for the quality and quantity of water | IHMS | WL Art.49 in relation to Art. 83 | DWD |
| Inspection | Analysis requested by inspectors for drinking and bathing waters shall be performed | Inspection administration | WL. Art 161 and 162 | DWD |
| Reporting | Obligation to report about condition of drinking water every 3 year | MH (responsibilities to be taken over upon adoption of the Law on water for human consumption) | Draft Law on water for human consumption (approved by the Government on 28th September, yet to be passed on to the Parliament for full adoption) | DWD |

[2] The law defines the obligation to carry out water monitoring for human consumption and defines that the Institute of Public Health conducts monitoring of water for human use. The law also defines the obligation to inform the public about the quality of water both after the results have been obtained and in the sense of drafting annual reports.

<table>
<tr><th rowspan="2">Issues</th><th rowspan="2">Tasks</th><th rowspan="2">Responsibilities</th><th colspan="2">Legal reference</th></tr>
<tr><th>M<br>NE</th><th>EU</th></tr>
<tr><td colspan="5">Monitoring of Waste Water Discharges</td></tr>
<tr><td rowspan="3">Definition of criteria to monitor waste waters</td><td rowspan="3">Methodology, reference measures, methods and parameters shall be defined</td><td>Companies and other legal entities which discharge waste water</td><td>WL Art. 84,</td><td rowspan="3">UWWTD</td></tr>
<tr><td>MARD</td><td>Rulebook on the method and conditions of measuring the amount of waste water that is discharged into the receiver</td></tr>
<tr><td>MARD</td><td>Rulebook on the method and conditions of measuring the amount of waste water that is discharged into the receiver</td></tr>
<tr><td>Collecting systems</td><td>Collecting systems to be in line with technical requirements set by EU</td><td>MARD, determines the rules and procedures, higher instance for appeals<br>WA, municipalities – issue water acts</td><td>WL Art. 112-126</td><td>UWWTD</td></tr>
<tr><td>Reporting</td><td>Conditions of WW discharges shall be announce every 2 years</td><td>MARD</td><td>Rulebook on quality of wastewaters</td><td>UWWTD</td></tr>
<tr><td colspan="5">Monitoring of Bathing Waters</td></tr>
<tr><td rowspan="3">Reference Conditions</td><td rowspan="3">Methodology, reference methods, requirements, manners and procedure for monitoring, and parameters shall be defined</td><td>MARD</td><td>WL Art 75</td><td rowspan="3">BWD</td></tr>
<tr><td>Public Company for management of the Costal Area</td><td>Decision on categorization and qualification of surface and underground water</td></tr>
<tr><td>IHMS</td><td>Law on Hydro-meteorological Affairs Art. 18</td></tr>
<tr><td>Implementation of the monitoring plan</td><td>Monitoring activities shall be performed and data provided</td><td>IHMS (overall examination and monitoring of water quality in the country)</td><td>Law on Hydro-meteorological Affairs Art. 18</td><td>BWD</td></tr>
</table>

| Issues | Tasks | Responsibilities | Legal reference | |
|---|---|---|---|---|
| | | | M<br>NE | EU |
| | | Public Company for management of the Costal Area in cooperation with Institute of Marine Biology (water quality monitoring solely for costal area) | Decision on categorization and qualification of surface and underground water, Law on Costal Area Art. 5 | |
| Informing the public | Modalities and procedures for informing public about the status of BW shall be defined | MARD | WL Art 158-160 | BWD |
| | | Public Company for management of the Costal Area in cooperation with Institute of Marine Biology (solely for costal area) | Law on Costal Area Art. 5 | |
| Identification of bathing waters | List of waters suitable for bathing to be provided | MARD | WL Art. 74d | BWD |
| **Monitoring of Protected Areas** | | | | |
| Definition of technical requirements | Technical requirements for monitoring waters in protected areas shall be established | IHMS | WL Art. 83 | WFD Art. 6 |
| Implementation of the monitoring plan | To provide and include information relevant for preservation of water in protected areas in national monitoring program | IHMS | WL Art. 83 | WFD Art.6 |
| **Submission of Monitoring Information** | | | | |
| Drinking water and bathing water information | Data submitted to MARD and to the state authority responsible for food safety | MARD | WL Art. 51 and 52 | DWD, BWD |
| | | MH | Draft Law on safe water for human consumption (approved by the Government on 28th September, yet to be passed on to the Parliament for full adoption) | |
| Local monitoring network data | Data coming from local monitoring network shall be collected and submitted to IHMS | IHMS | Law on Hydro-meteorological Affairs Art. 21 and 22 | DWD, BWD |
| Collect, process and store information | Information/data received from the monitoring activities shall be collected, processed and stored. | WA | WL. 159 paragraph 2 | DWD, BWD |
| Public Access to monitoring data | Data and results received from the monitoring of water bodies and waters intended for human consumption and bathing water shall be made public | IHMS | WL Art. 83 | DWD, BWD |

| Issues | Tasks | Responsibilities | Legal reference | |
|---|---|---|---|---|
| | | | M<br>NE | EU |
| Water management database | The data and information received from the measurement that are gathered, processed and verified shall constitute an official database for water resource management, | WA<br><br>IHMS | WL Art. 159, Regulation on the content and management of the water system | DWD, BWD |
| Notifications in case of emergency | Bodies in charge of monitoring activities shall inform IHMS in case of emergency | Companies and other legal entities using storage and retention basins | WL Art. 101 | DWD, BWD |
| **Information Systems** | | | | |
| Informing the public | Obligation to inform the public about the implementation of the WL and about the monitoring activities. Obligation to report about the status of international waters | MARD, WA, municipalities, Competent authorities, companies and other legal entities that perform activities of public interest | WL Art. 158-160 | WFD Art. 14 |

## 2.5 International Agreements Relevant for Montenegro

Montenegro is a party to a number of international legal instruments relating to the management of transboundary water resources. These instruments include conventions of global and regional application and agreements concerning transboundary water resources shared between Montenegro and neighboring countries. Global and regional conventions include:

- The Convention on the Law of Non-Navigational Uses of International Watercourses (UN Watercourses Convention), New York, 21 May 1997, ratified by Montenegro in 2013 (global) (Official Gazette of Montenegro – International Agreements, No. 6/13 of 24 July 2013).
- The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention), Helsinki, 17 March 1992, ratified in 2014 (global following the entry into force of the 2003 amendments) (Official Gazette of Montenegro – International Agreements, No. 1/14 of 15 January 2014).
- The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), Espoo, 25 February 1992, ratified (through accession) by Montenegro in 2009.
- The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention), Aarhus, 25 June 1998, ratified (through accession) by Montenegro in 2009.
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Ramsar, 2 February 1971, ratified (by way of succession) by Montenegro in 2006.
- The Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention), Barcelona, 16 February 1976.

The UN Watercourses Convention defines “watercourse” as “a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole” (Article 2). Therefore, it considers all components of the system, whether surface or underground, this entailing recognition of the impact of activities within the territory of a watercourse state on other watercourse states.

The UNECE Water Convention covers water use, water pollution and emergency situations deriving from water, including floods. It applies to surface water and groundwater and aims at promoting the prevention, control and reduction of any transboundary impact. The term “transboundary impact” refers to “any significant adverse effect on the environment resulting from a change in the conditions of transboundary waters caused by a human activity, the physical origin of which is situated wholly or in part within an area under the jurisdiction of a Party, within an area under the jurisdiction of another Party” (Article 1). The Convention sets out obligations for all parties and for riparian parties, i.e., the parties bordering the same transboundary waters. The overarching obligation for all parties is that to prevent, control and reduce any transboundary impact. In particular, the parties shall take measures to prevent, control and reduce water pollution, ensure that their transboundary waters are managed in an ecologically sound and rational manner and are used reasonably and equitably, and ensure the conservation and, if necessary, restoration of ecosystems. The parties are to be guided by the precautionary principle, the “polluter-pays” principle and the intergenerational equity principle. Article 3 requires the parties to adopt, implement and harmonize legal, administrative, economic, financial and technical measures to prevent, control and reduce water pollution, and provides an indicative list of these measures, including the licensing of wastewater discharges, the setting of effluent treatment requirements, the conduct of environmental impact assessments, the adoption of the ecosystem approach and contingency planning. The parties are to establish water resources monitoring programmes and exchange information.

Specific obligations for riparian parties relate to the establishment and implementation of joint programmes for monitoring the conditions of transboundary waters, including floods and ice drifts and transboundary impacts, and to the conduct of joint or coordinated assessments. A corollary of this duty is the harmonization of rules for the setting up and operation of monitoring and assessment programmes. Assessment results are to be disclosed to the public. Under Article 13, the riparian parties are under a duty to exchange reasonably available data and information on the environmental conditions of transboundary waters, experiences as to the application of best available technologies, emissions and monitoring results, measures taken or planned to be taken to prevent, control and reduce transboundary impact and wastewater discharge permits. Article 14 deals with critical situations and requires the riparian parties to set up and operate, where appropriate, joint or coordinated warning and alarm systems to facilitate the prompt exchange of data. These systems are to function on the basis of compatible data transmission and processing procedures to be agreed upon. Article 15 deals with critical situations and requires the riparian parties to provide each other mutual assistance upon request, following specified procedures. Article 16 is about public information.

Article 9 of the UNECE Water Convention introduces a duty to enter into bilateral or multilateral agreements or other arrangements, or to adapt the existing ones to the principles of the Convention. Among others, these agreements or arrangements are expected to cover joint monitoring and assessment and must provide for the establishment of joint bodies, of which Article 9 specifies the main functions.

The Espoo Convention requires the parties to assess the environmental impact of certain activities at an early stage of planning, and to notify and consult each other on all major projects under consideration that are likely to have a significant adverse transboundary environmental impact. The Aarhus Convention establishes the right of the public to receive environmental information held by public authorities, to participate in decision-making on environmental matters and to review procedures to challenge public decisions that have been made in violation of these two rights.

Under the Ramsar Convention, the parties have the duty to designate at least one wetland within their respective territories for inclusion in the List of Wetlands of International Importance. The wetlands to be included in the list are those of international significance in terms of ecology, botany, zoology, limnology or hydrological features. The inclusion of a wetland triggers the obligation of the party or parties concerned to formulate and implement their plans in such a manner as to promote its wise use and conservation, including the establishment of natural reserves. When a wetland is transboundary or is part of a transboundary water system, the states concerned must consult each other on all matters relating to its conservation and make efforts to coordinate their policies and regulations in such respect. Montenegro has designated two Ramsar sites, namely Skadar Lake and the Tivat Saline.

The Barcelona Convention obligates the state parties to take all appropriate measures to prevent, abate and combat pollution of the Mediterranean Sea caused by discharges from rivers, coastal establishments or outfalls, or emanating from any other land-based sources within their territories. The parties are to cooperate in dealing with pollution emergencies and in taking damage reduction or abatement measures. A duty of states to notify each other of these emergencies is also provided for, together with a duty to implement programmes to monitor pollution in the Sea and to endeavor to establish a monitoring system. To this end, they must designate the competent authorities for monitoring sea pollution within their respective territories, and, as far as practicable, participate in arrangements for participating in such monitoring beyond their territorial jurisdictions. Cooperation under the Convention extends to the formulation and adoption of procedures for the determination of liability and compensation for damage resulting from the pollution of the marine environment due to violations of the provisions of the Convention.

### Table 2.2 Roles and Responsibilities for the Management of International River Basins

| Issues | Tasks | Responsibility | Legal Reference | |
|---|---|---|---|---|
| | | | MNE | EU |
| **International River Basins Water Management Plan** | | | | |
| **Preparation of the Water Management Plan for International River Basin** | International river basin is managed based on the management plan set by states on whose territory the basin is located. In absence of such a plan, the basin shall be managed by River Basins Water Management Plan. | GoM, MARD/WA | WL Art. 24a, 157 | WFD Art. 3 and Art. 13 |
| **Cooperation and exchange of information** | | | | |
| **Transboundary cooperation and information sharing in management of international river basins** | Harmonization of the programs of measures pertaining to international river basin districts, Exchange of relevant information for the purposes of water information system. | MARD/WA | WL Art. 32 157, 159 | WFD Art. 3 and Art. 13 |
| **Cooperation in Preliminary Assessment of Flood Risk** | | | | |
| **Cooperation and adoption of strategic documents in preliminary assessment** | Exchange of information with the countries with which water area is shared; Determining areas of significant flood endangered aquatic | GM, MARD/WA, IHMS | WL Art 95b, 95c, 95d, 95e; 157 | WFD Art. 3 and Art. 13 |

| Issues | Tasks | Responsibility | Legal Reference | |
|---|---|---|---|---|
| | | | MNE | EU |
| **of flood risk relating to international river basins** | area that is part of the international river basin; Development of hazard and flood risk maps including areas of neighbouring countries; Adopting a joint plan for flood risk management with neighbouring countries. | | | |

### 2.5.1 Adriatic River Basin District

As far as cooperation in the management of water resources in the international Adriatic River Basin District is concerned, Montenegro and Albania have signed a number of international legal instruments. On 30 January 2003, the two countries signed the Protocol on Cooperation in the Field of Water Management, which concerns scientific research on the regulation of the water regime of the Skadar Lake and the Drin and Bojana Rivers (to be conducted by the Academies of Sciences and Arts of the two countries). Through the Memorandum of Understanding (MOU) on Cooperation in the Field of Implementation of Environmental Protection and Sustainable Development, signed by the ministers responsible for environment protection at Podgorica on 9 May 2003, the two countries committed themselves to conserve the natural resources of Lake Skadar in a coordinated and integrated manner and to improve their national-level legal and institutional capacities. Montenegro has also reported to the Secretariat of the UNECE Water Convention on the Agreement with Albania on the Protection and Sustainable Development of the Skadar/Shkodra Lake (2008), which calls for the establishment of an advisory commission, and on the MOU for the management of the Extended Drini Basin - The Drini Strategic Shared Vision (Tirana, 25 November 2011), both mentioned in the report on the implementation of the Convention for 2018. The latter MOU was signed by Montenegro, Albania, Greece, The Northern Macedonia and Kosovo.

On 3 July, 2018, at Shkodra, Montenegro and Albania signed the Framework Agreement between on Mutual Relations in Transboundary Water Resources Management, which covers all water resources of common interest. The focus of this Agreement is on water use, water protection and flood management. Except for a requirement to exchange hydrogeological data, groundwater falls outside its scope, although it is included in the definition of "transboundary waters". According to its provisions, the parties undertake to cooperate based on the principles of sovereign equality, territorial integrity, reciprocity, mutual benefits and good faith and, in particular, to:

- Regularly exchange data and information on the status of their transboundary water resources;
- Implement the principles of prevention, precaution, "polluter pays", sustainable development and reasonable and equitable use of water;
- Implement legal, organizational, institutional, technical, economic and other measures, as necessary;
- Use their transboundary waters in a reasonable, equitable and sustainable manner, based on the water balance, coordinated plans and programmes, existing water permits (water acts) and other relevant criteria. The parties shall define factors for the determination of reasonable, equitable and sustainable utilization, methods for settling disputes on water use, the methodology for the preparation of water balances and methods for flow measurements and determining the quantity of water available.

- Prevent water quality deterioration and seek to improve the status of their common waters; regularly monitor and assess water quality based on the Water Framework Directive and, based on results, jointly assess trends in changes in the water status; take measures to prevent and eliminate the effects of accidental pollution and hazardous substances and components and use the list of hazardous substances under the Water Framework Directive; consult each other on the granting of water permits and other acts relating to the construction or reconstruction of hydraulic infrastructure in their respective territories; promote the application of best available technologies for wastewater treatment so as to comply with jointly adopted emission limit values and water quality standards; comply with the limit values of water quality standards defined in the Water Framework Directive; take measures to reduce and monitor transboundary impacts caused by pollution from diffuse sources; conduct risk assessments for priority hazardous substances; as soon as possible, notify each other of pollution accidents that may result in a transboundary impact and, upon request, cooperate in impact reduction and elimination; if necessary, intervene in affected areas in order to reduce the consequences of accidental pollution from oil products or other floating products.
- Take protection measures against the harmful effects of water and refrain from carrying out works or implementing measures which may produce transboundary harmful effects;
- Maintain infrastructure, installations, riverbeds and canals in good conditions and comply with operation rules for hydraulic infrastructure;
- Monitor and assess the quantity, quality and status of their common waters, and determine modalities for, and the extent of, the exchange of information on hydrogeology, water abstractions and discharges, the conditions and operating regime of hydraulic infrastructure and all other information needed to prevent, assess and eliminate transboundary impacts;
- Implement joint or coordinated planned measures for monitoring water flows and status, which will be used for warning in case of dangerous occurrence;
- Promote stakeholder involvement in the implementation of the Agreement, and in particular in the preparation, review and updating of water resources plans and projects.
- Endeavor to cooperate with other neighboring countries.

The construction or alteration of works and the implementation of measures that may have an adverse transboundary impact are subject to mutual agreement and to prior authorization (water acts) by the state in the territory of which they are planned. In line with the UN Watercourses Convention, each party is under an obligation to prevent the causing of significant harm to the other party as a result of water utilization within its territory. If significant harm nevertheless occurs, the party having caused the harm is to take all appropriate measures, in consultation with the affected party, to eliminate or reduce such harm and, if necessary, discuss the issue of compensation. The parties shall establish principles and procedures for defining the damage from transboundary impacts in the absence of specific agreement, and for determining the relevant liability and the amount of compensation.

The Agreement provides for the establishment of a bilateral Water Management Commission consisting of 20 members, that is, 10 for each party. The scope of work, functions and powers of the Commission are to be determined by the Rules of Procedure. The Commission may establish sub-committees and expert groups and may hire individual experts to deal with specific issues. The Commission takes its decisions by consensus. The parties may enter into special agreements to deal with specific issues.

Montenegro shares one transboundary aquifer of the Dinaric Karst Aquifer System with Albania. A number of pressures on the aquifer system were identified during the implementation of the GEF DIKTAS (Protection and Sustainable Use of the Dinaric Karst Aquifer System) project (2010-2014), including over-extraction and pollution, and lack of understanding of its characteristics and boundaries. Recommendations offered on that occasion included the negotiation of an agreement providing for an institutional mechanism for consultation and exchange of information as a first step towards systematic commitment to joint aquifer management.

An agreement between the Government of Montenegro and the Government of Croatia on mutual relations in the area of water management was signed at Zagreb on 4 September, 2007 (Official Gazette of Montenegro, No. 1/08 of 10 January 2008). The agreement covers all water resources of common interest, whether surface or underground. According to its provisions, the parties undertake to cooperate on the basis of sovereign equality, territorial integrity, reciprocity, mutual benefits and good faith in a similar frame to all aspects of the agreement with Albania listed above.

# 3 CHARACTERISTICS OF THE ADRIATIC RIVER BASIN

## 3.1 General description of the main (or major) surface waters

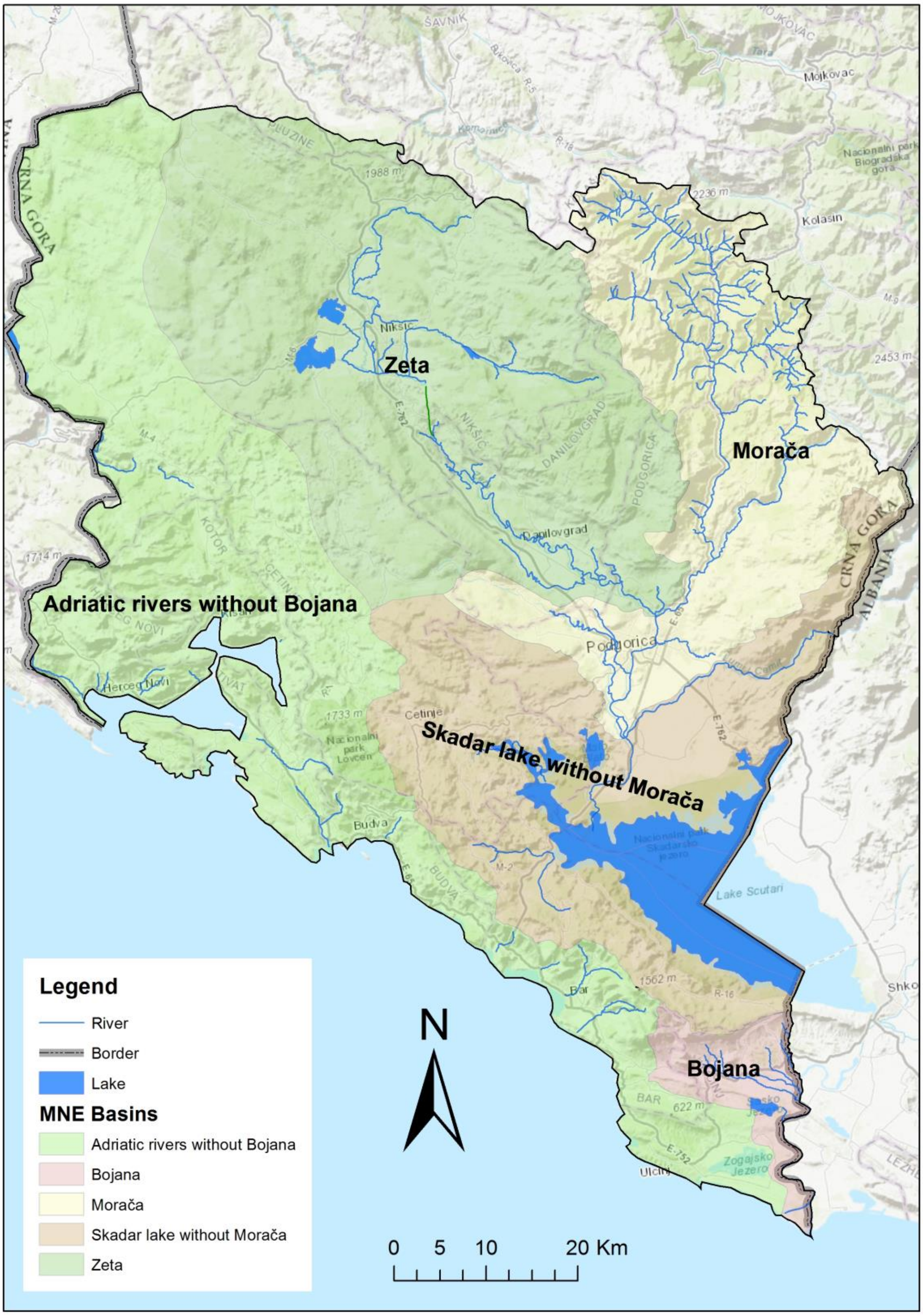
**The Zeta River** originates in upper area of the river Sušica and Rastovac. Zeta generally flows south to the village Zavrh where losing part of the existing water, the water appears in the accumulation Krupac. From here Zeta turns east toward Glibavcu, then still turns to the southeast and east of compensations to the pool, where the water tunnel and pipeline leading to HE "Perućica" at Glava Zete spring. Before the construction of the hydropower system and the regulation of the riverbed Zeta, this aquifer is assembled southern rim Nikšić field (Budoške ponds and Slivlje) to a few kilometres of water appeared on the hot heads Zetas. Since this spring, and spring Perućica and Oboštice, resulting watercourse Lower Zeta, which flows into the river Morača. The total length of the river Zeta is 85 km.

**The Morača River** originates in northern Montenegro, under Rzača mountain, at the height of 975 meters. The Morača River has a river canyon which separates the Moracke Planine range from Sinjajevina Mountain range. In the Kolašin region, the Morača's tributaries are the Koštanica, Sjevernica, Trnovačka Rijeka /River/, Javorski Potok /Brook/, and the Slatina, on the Mrtvica, Ibrištica, Ratnja, and the Slatina, on the left, and the Mrtvica, Ibrištica, Ratnja and the Požanjski Potok on the right. Apart from the Morača's Platije Canyon, its right-hand tributary the Mrtvica also flows, for the most part of its length, through a lesser known high canyon. The region of the Morača River Canyon features the steep slopes of the terrain intersected with deep gorges and canyons. Morača River generally flows southwards some 113 km before emptying into Skadar Lake. In its northern part, the Morača River is a fast, mountainous river, and has cut a canyon north of Podgorica. After merging with its largest tributary, Zeta River, just north of Podgorica, the Morača River enters the Zeta plain and flows through this flat area of Montenegro until it empties into the Skadar Lake. The Morača River is the biggest tributary of Skadar Lake.

**The Bojana River** arises from Lake Skadar in Shkodra (Skadar), Albania. It is 44 km long, and by its water amount brought into the sea it is the third river on the Mediterranean. Bojana is a border river between Montenegro and Albania. It is 41 km long and runs in large curves with an average drop of 0.6%. It is a natural habitat for various plants and animals. In some places along the Bojana the bottom of the riverbed is between two and five metres under the sea level before it plunges into the sea. However, the most distinctive feature of the river Bojana is that the bottom of its riverbed is 36 km under the sea level, but in its upper part! Although it has got that big flow, sea water rushes deeply upwards through its riverbed. Thus, the first peculiar duality is created. In its riverbed there is both salty sea water and fresh water. Sea water as being heavier, flows along the bottom of the riverbed towards St. George. The second duality of the river emerges in its underground flow. Namely, the former riverbed of the Bojana used to be about 40 metres above the present level of the basic rock at Fraskanjel. The river covered its former bed with gravel. Above the gravel layers of clayish impervious sediments have piled, into which the present riverbed of the Bojana was carved. Thus, today there are two river flows with the same direction, aiming towards the sea, one above the other, the surface waterflow and some 10 to 15 metres below the underground water flow.

**Skadar Lake** is one of the most important aquatic waters of Montenegro in hydrological, economic, water management and tourist terms. Therefore, when solving any hydropower and water management activities in its entire basin, it is necessary to take into account the implications of these solutions to water balance and Skadar Lake regimes. Skadar Lake covers an area of less than 400 km$^2$ at minimum water levels, up to 525 km$^2$ at the highest registered water levels. It is primarily filled with the river Morača, and it is built on the River Crnojevića, Orahovštica and the river Kiri in Albania. It flows out to the river Bojana.

### Figure 3.1 Sub-Basin in river network the Adriatic River Basin



## 3.2 Surface water body delineation

One of the first steps in the EU WFD implementation is identification of the surface water categories. “The surface water bodies within the river basin district shall be identified as falling within either one of the following surface water categories – rivers, lakes, transitional waters or coastal waters – or as artificial surface water bodies or heavily modified surface water bodies.” (WFD, Annex II 1.1(i)).

To ensure that water bodies do not cross the boundaries of surface water categories, the suggested first step in delineating surface water bodies involved identifying the boundaries of the ***surface water categories.*** To ensure that water bodies do not cross the boundaries of surface water types, the second step in delineating surface water bodies was to identify the boundaries of the ***surface water types*** in the river basin district[3].

This section describes the typology and delineation of the surface water bodies for the Adriatic River Basin (ARB) based on the ecoregions and types.

For inland waters (rivers and lakes), the ABR is located within one ecoregion: Ecoregion # 5 Dinaric Western Balkans[4]. For transitional and coastal waters, the ecoregion is classified as the Mediterranean Sea.

The typology was determined for each category of the surface water, i.e. rivers, lakes, transitional waters and coastal waters.

For typology of rivers and lakes in the Adriatic River Basin, System A was applied with the descriptors according to the EU Water Framework Directive (Annex II), as shown in Table 3.1.

For transitional waters[5], an alternative characterisation of system B was applied as shown in Table 3.2. System B was used in place of System A since the latter requires an obligatory descriptor of the “mean tidal range”, which is not relevant for the Adriatic Sea since the range is <2m.

For the typology of coastal water bodies[6], System A was applied according to the EU Water Framework Directive, Annex II, 1.2.4 (Table 3.3). The selection of the descriptors and thresholds took into account the coastal water body typology developed in Croatia, which recognises the following:

- 36% or less salinity is distinctive of coastal waters that are under freshwater impact throughout the whole year. Water masses with over 36% salinity are not regarded to be impacted by freshwater input. This is important to consider since the reference conditions threshold values are different, especially for nutrients and phytoplankton;
- *Posidona oceanica*, a seagrass species that is endemic to the Mediterranean Sea, is found at depths between 1 and 40 m, the latter being the boundary for a coastal water descriptor.

[3] CIS Guidance Document No. 2: http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm
[4] https://www.eea.europa.eu/data-and-maps/figures/ecoregions-for-rivers-and-lakes
[5] Transitional water body is a body of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influences by freshwater flows.
[6] ‘Coastal water’ means surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters.

This analysis resulted in a total of 7 types of river water bodies, 4 types of lake water bodies, 4 types of transitional waters and 2 types of coastal water in the ARB (Table 3.4).

### Table 3.1 Descriptors Applied for Rivers and Lakes – System A

<table>
<tr><th>River Descriptors</th><th colspan="2">Lake Descriptors</th></tr>
<tr><td colspan="3">Altitude:<br>High: > 800 m<br>Mid-altitude: 200 to 800 m<br>Lowland: < 200 m</td></tr>
<tr><td>Size of catchment area:<br>Small: 10 to 100 km$^2$<br>Medium: > 100 to 1000 km$^2$<br>Large: > 1000 to 10 000 km$^2$<br>Very large: > 10 000 km$^2$</td><td>Surface area:<br>Small: <0.5 to 1 km$^2$<br>Medium: 1 to 10 km$^2$<br>Medium/Large: 10 to 100 km$^2$<br>Large: > 100 km$^2$</td><td>Mean depth:<br>Shallow: <3m<br>Medium: 3 to 15 m<br>Deep: > 15 m</td></tr>
<tr><td colspan="3">Geology:<br>Calcareous, Siliceous, Organic</td></tr>
</table>

### Table 3.2 Descriptors Applied for Transitional Waters (System B)

| Characterisation | Transitional Water Descriptors |
|---|---|
| Mean annual salinity | Polyhaline: 18 to < 30 %<br>Euhaline: 30 to 40 % |
| Mean substratum composition | Silty-clay<br>Clayey-silt<br>Sand |

### Table 3.3 Descriptors Applied for Coastal Waters (System A)

| Characterisation | Coastal Water Descriptors |
|---|---|
| Mean annual salinity | Polyhaline: < 36%<br>Euhaline: > 36% |
| Mean depth | < 40 m<br>> 40 m |

### Table 3.4 Types of River, Lake, Transitional and Coastal Water Bodies in Montenegro and in the Adriatic River Basin (ARB)

| # | River Type name | ARB |
|---|---|---|
| **R1** | Dinaric Western Balkans small mountain calcareous | ✓ |
| **R2** | Dinaric Western Balkans small mid-altitude calcareous | ✓ |
| **R3** | Dinaric Western Balkans small lowland calcareous | ✓ |
| **R4** | Dinaric Western Balkans medium mountain calcareous | |
| **R5** | Dinaric Western Balkans medium mid-altitude calcareous | ✓ |
| **R6** | Dinaric Western Balkans medium lowland calcareous | ✓ |
| **R7** | Dinaric Western Balkans large mid-altitude calcareous | |
| **R8** | Dinaric Western Balkans large lowland calcareous | ✓ |
| **R9** | Dinaric Western Balkans large lowland mixed | ✓ |
| | **Lake Type Name** | |
| **L1** | Dinaric Western Balkans small, deep, mountain calcareous | |
| **L2** | Dinaric Western Balkans small, medium depth, lowland calcareous | |
| **L3** | Dinaric Western Balkans medium, medium depth, lowland mixed | ✓ |
| **L4** | Dinaric Western Balkans medium/large, shallow, lowland calcareous | ✓ |
| **L5** | Dinaric Western Balkans large, shallow, lowland calcareous | ✓ |
| **L6** | Dinaric Western Balkans large, medium depth, lowland calcareous | ✓ |
| | **Transitional Waters Type Name** | |
| **T1** | Polyhaline bay silty clay | ✓ |
| **T2** | Euhaline bay silty clay | ✓ |
| **T3** | Euhaline bay clayey silt | ✓ |
| **T4** | Euhaline estuary sand | ✓ |
| | **Coastal Waters Type Name** | |
| **C1** | Polyhaline shallow sea | ✓ |
| **C2** | Euhaline deep sea | ✓ |

For rivers, all catchments were considered in the analysis. For lakes, all depths and surface areas were considered. Water bodies were allocated as either:

- **Heavily modified water body** (HMWB), which is a body of surface water which as a result of physical alterations by human activity is substantially changed in character.
- **Artificial water body** (AWB), which is a body of surface water created by human activity.
- **Natural water body** (Natural), which is a body of surface water that is not changed as a result of alterations by human activity or either created by human activity.

Based on the EU Guidelines[7], 41 separate inland surface water bodies (rivers and lakes) were delineated in the Adriatic River Basin, excluding transitional and coastal waters. The inland surface water bodies in the ARB include 5 heavily modified water bodies (HMWBs), 3 artificial water bodies (AWBs) and 3 natural lakes (Table 3.5).

For transitional water, 5 distinct water bodies were identified as shown in Table 3.6. For coastal waters, a total of 5 water bodies that lie within the 1 nautical mile boundary were identified (Table 3.7).

The designation surface water within individual or municipality has been used in order to provide a clear focus for the Programme of Measures, which are outlined in Section 10. In total, 11 municipalities are present in the Adriatic River Basin, which may contain one or more surface water bodies (Table 3.5).

The typology of the surface waters is presented in Figure 3.2. The surface water bodies are illustrated in Figure 3.3. The delineated water bodies in Skadar Lake[8] are illustrated in Figure 3.4. The delineated transitional and coastal water bodies are shown below in Figure 3.5.

## Table 3.5 Delineated Surface Water Bodies in the Adriatic River Basin

| Sub-Basin | Surface Water Body | Type | Status | Length or Area | Map No.[9] | Municipalities |
|---|---|---|---|---|---|---|
| Bojana | Bojana | R9 | Natural | 28.77 km | 1 | Bar<br>Ulcinj |
| Skadar | Orahovštica | R3 | Natural | 10.32 km | 2 | Bar |
| Skadar | Crmnička rijeka | R3 | Natural | 7.91 km | 3 | Bar |
| Adriatic | Sutorina_1 | R3 | Natural | 3.88 km | 4 | Herceg Novi |
| Adriatic | Sutorina_2[10] | R3 | HMWB | 3.15 km | 5 | Herceg Novi |
| Adriatic | Bilećko Lake | N/A | AWB | | 6 | Nikšić |
| Morača | Morača_1 | R1 | Natural | 5.34 km | 7 | Kolasin |
| Morača | Morača_2 | R2 | Natural | 15.08 km | 8 | Kolasin |
| Morača | Morača_3 | R5 | Natural | 14.52 km | 9 | Kolasin |
| Morača | Sjevernica_1 | R1 | Natural | 4.87 km | 10 | Kolasin |
| Morača | Sjevernica_2 | R2 | Natural | 5.44 km | 11 | Kolasin |
| Morača | Mrtvica_1 | R1 | Natural | 5.41 km | 12 | Kolasin |

[7] CIS Guidance Document No. 2: http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

[8] GIZ report

[9] Map numbers refer to the position of the surface water bodies shown in Figure 3.1

[10] River bed in concrete

| Sub-Basin | Surface Water Body | Type | Status | Length or Area | Map No.[9] | Municipalities |
|---|---|---|---|---|---|---|
| Morača | Mrtvica_2 | R2 | Natural | 9.51 km | 13 | Kolasin |
| Morača | Morača_4 | R6 | Natural | 31.95 km | 14 | Podgorica |
| Morača | Nožica | R1 | Natural | 14.44 km | 15 | Podgorica |
| Morača | Mala Rijeka_1 | R2 | Natural | 12.72 km | 16 | Podgorica |
| Morača | Mala Rijeka_2 | R3 | Natural | 5.66 km | 17 | Podgorica |
| Morača | Morača_5 | R8 | Natural | 9.99 km | 18 | Podgorica |
| Zeta | Sušica | R2 | Natural | 6.47 km | 19 | Nikšić |
| Zeta | Zeta_1 | R5 | Natural | 9.13 km | 20 | Nikšić |
| Zeta | Zeta_2[11] | R5 | HMWB | 11.09 km | 21 | Nikšić |
| Zeta | Gračanica_1 | R2 | Natural | 12.66 km | 22 | Nikšić |
| Zeta | Liverovići[12] | R2 | HMWB | | 23 | Nikšić |
| Zeta | Gračanica_2[13] | R2 | HMWB | 13.05 km | 24 | Nikšić |
| Zeta | Krupac Lake | N/A | AWB | 9 km$^2$ | 25 | Nikšić |
| Zeta | Slansko Lake | N/A | AWB | | 26 | Nikšić |
| Zeta | Zeta_3 | R6 | Natural | 10.15 km | 27 | Nikšić Danilovgrad |
| Zeta | Zeta_4 | R8 | Natural | 36.70 km | 28 | Danilovgrad |
| Morača | Ribnica | R6 | Natural | 8.09 km | 29 | Podgorica Tuzi |
| Skadar | Morača_6[14] | R8 | HMWB | 16.82 km | 30 | Podgorica |
| Morača | Matica_1 | R3 | Natural | 2.73 km | 31 | Danilovgrad Podgorica |
| Morača | Matica_2 | R6 | Natural | 6.14 km | 32 | Podgorica |
| Morača | Sitnica | R3 | Natural | 9.29 km | 33 | Podgorica |
| Skadar | Cijevna | R6 | Natural | 31.77 km | 34 | Tuzi Podgorica |
| Skadar | Morača_7 | R8 | Natural | 9.17 km | 35 | Podgorica |

[11] River connectivity lost due to hydropower plant “Salp Zete“

[12] Reservoir

[13] River substantially altered by gravel extraction

[14] River substantially altered by gravel extraction

| Sub-Basin | Surface Water Body | Type | Status | Length or Area | Map No.[9] | Municipalities |
|---|---|---|---|---|---|---|
| Skadar | WB1_Vucko blato | L4 | Natural | | 36 | Cetinje<br>Bar |
| Skadar | WB 2_North | L5 | Natural | | 37 | Tuzi<br>Podgorica |
| Skadar | W3_South west | L5 | Natural | | 38 | Bar<br>Cetinje |
| Skadar | W4_Pelagic zone | L6 | Natural | | 39 | - |
| Bojana | Saško Lake | L4 | Natural | | 40 | Ulcinj |
| Skadar | Malo Blato Lake | L3 | Natural | | 41 | Cetinje<br>Podgorica |

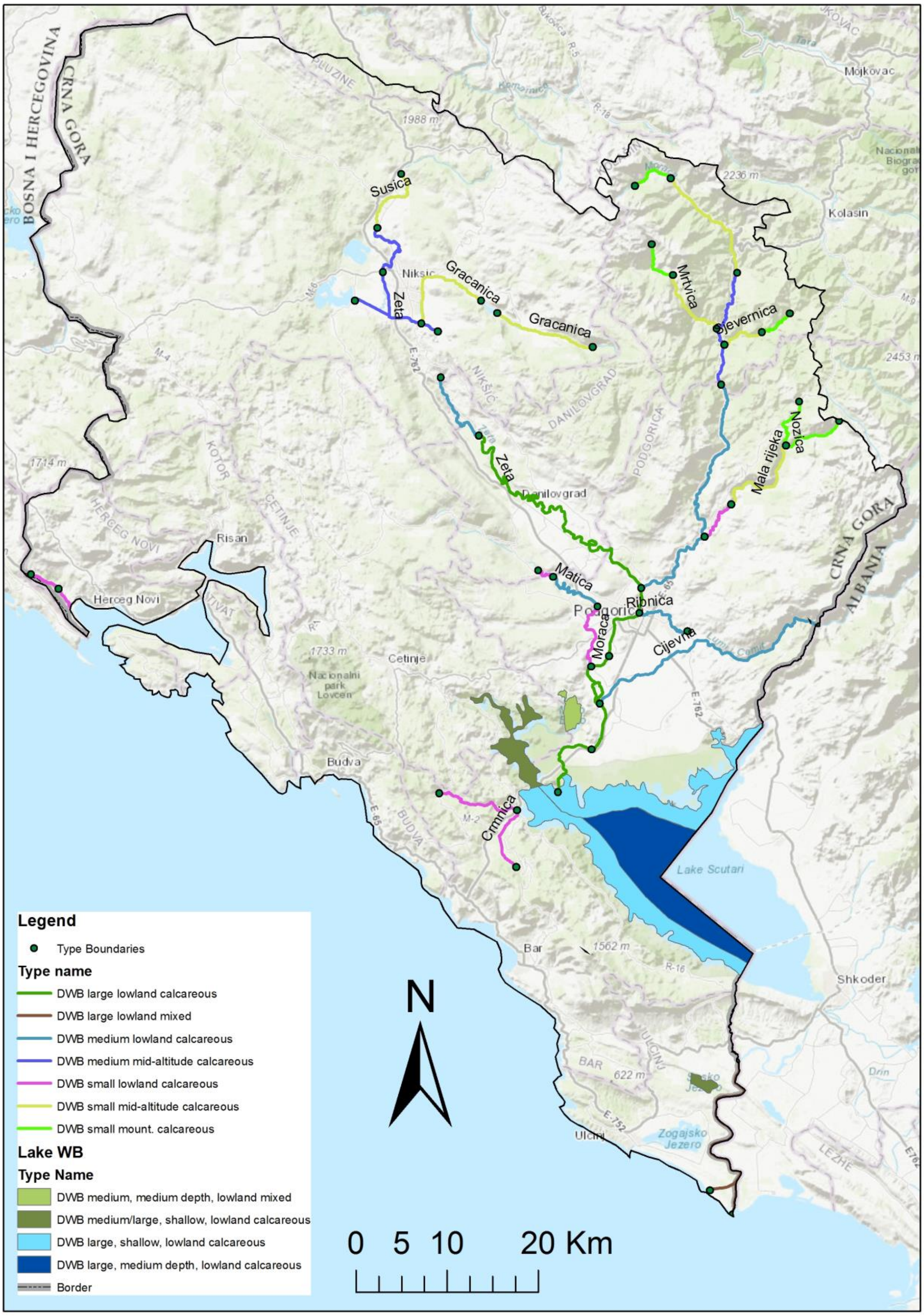
### Table 3.6 Transitional Water Bodies (TWBs) in the Adriatic River Basin

| No. | TWB | Type No. | Area ($Km^2$) | Geographical Coordinates | | | |
|---|---|---|---|---|---|---|---|
| | | | | Latitude (Min) | Latitude (Max) | Longitude (Min) | Longitude (Max) |
| **1.** | TW_1_Kotorski | T1 | 16.3 | 42,432 | 42,492 | 18,702 | 18,773 |
| **2.** | TW_2_Risanski | T1 | 8.0 | 42,484 | 42,513 | 18,670 | 18,704 |
| **3.** | TW_3_Tivatski | T2 | 39.6 | 42,407 | 42,480 | 18,603 | 18,727 |
| **4.** | TW_4_Hercegnovski | T3 | 32.7 | 42,421 | 42,451 | 18,524 | 18,602 |
| **5.** | TW_5_Bojana | T4 | 32.5 | 41,849 | 41,884 | 19,264 | 19,335 |

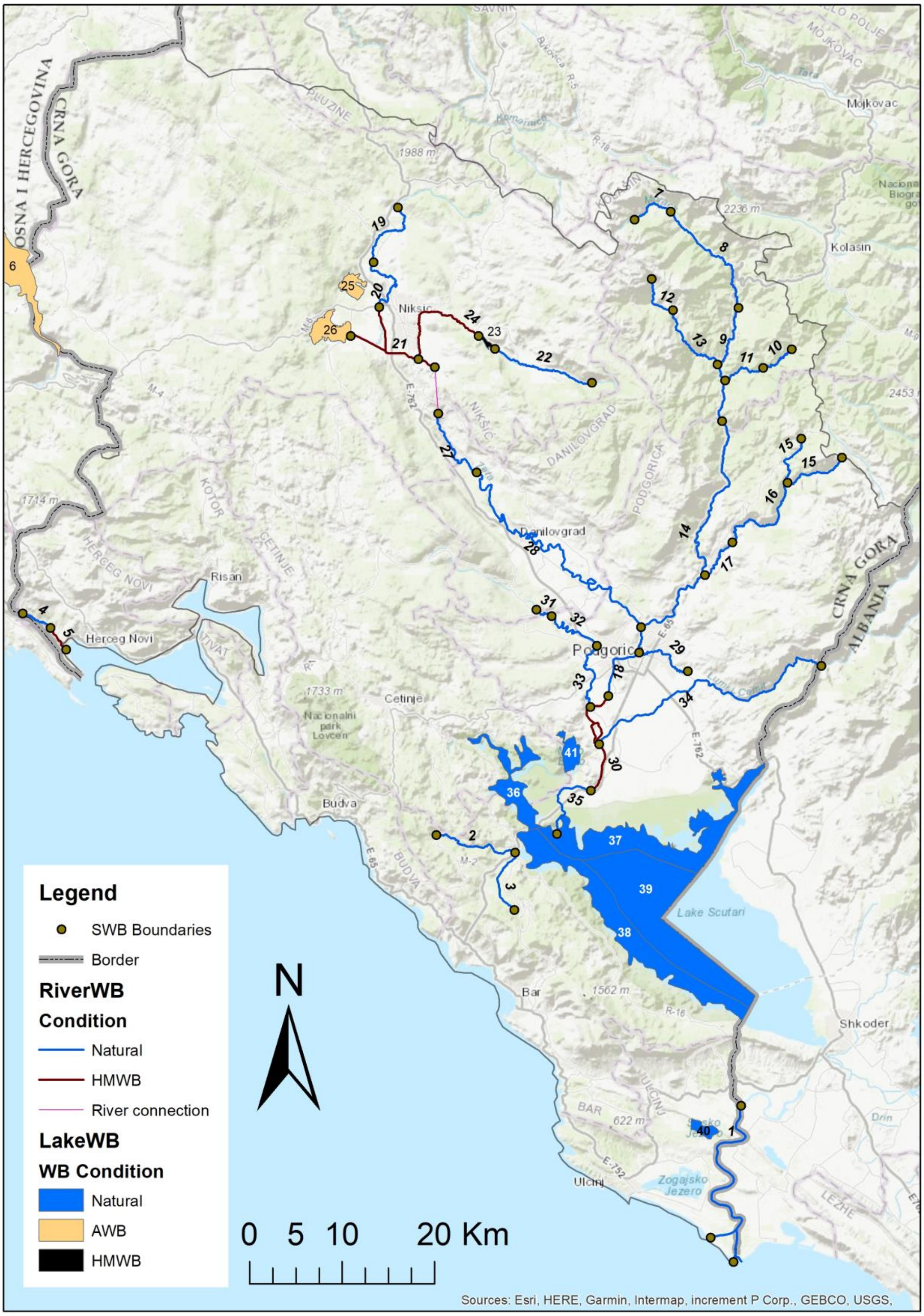
### Table 3.7 Coastal Water Bodies in the Adriatic River Basin

| No. | TWB | Type No. | Area (Km$^2$) | Geographical Coordinates | | | |
|---|---|---|---|---|---|---|---|
| | | | | Latitude (Min) | Latitude (Max) | Longitude (Min) | Longitude (Max) |
| **1.** | MNE_CW1 | C1 | 8.1 | 42,399 | 42,453 | 18,525 | 18,584 |
| **2.** | MNE_CW2 (Traste Bay) | C1 | 17.5 | 42,326 | 42,387 | 18,639 | 18,723 |
| **3.** | MNE_CW3 (Budva Bay) | C1 | 26.2 | 42,224 | 42,281 | 18,801 | 18,907 |
| **4.** | MNE_CW4 | C2 | 34.1 | 42,966 | 42,403 | 18,542 | 19,163 |
| **5.** | MNE_CW5 | C1 | 331.1 | 41,863 | 41,989 | 19,109 | 19,293 |

**Figure 3.2 Typology of the surface water in the Adriatic River Basin**

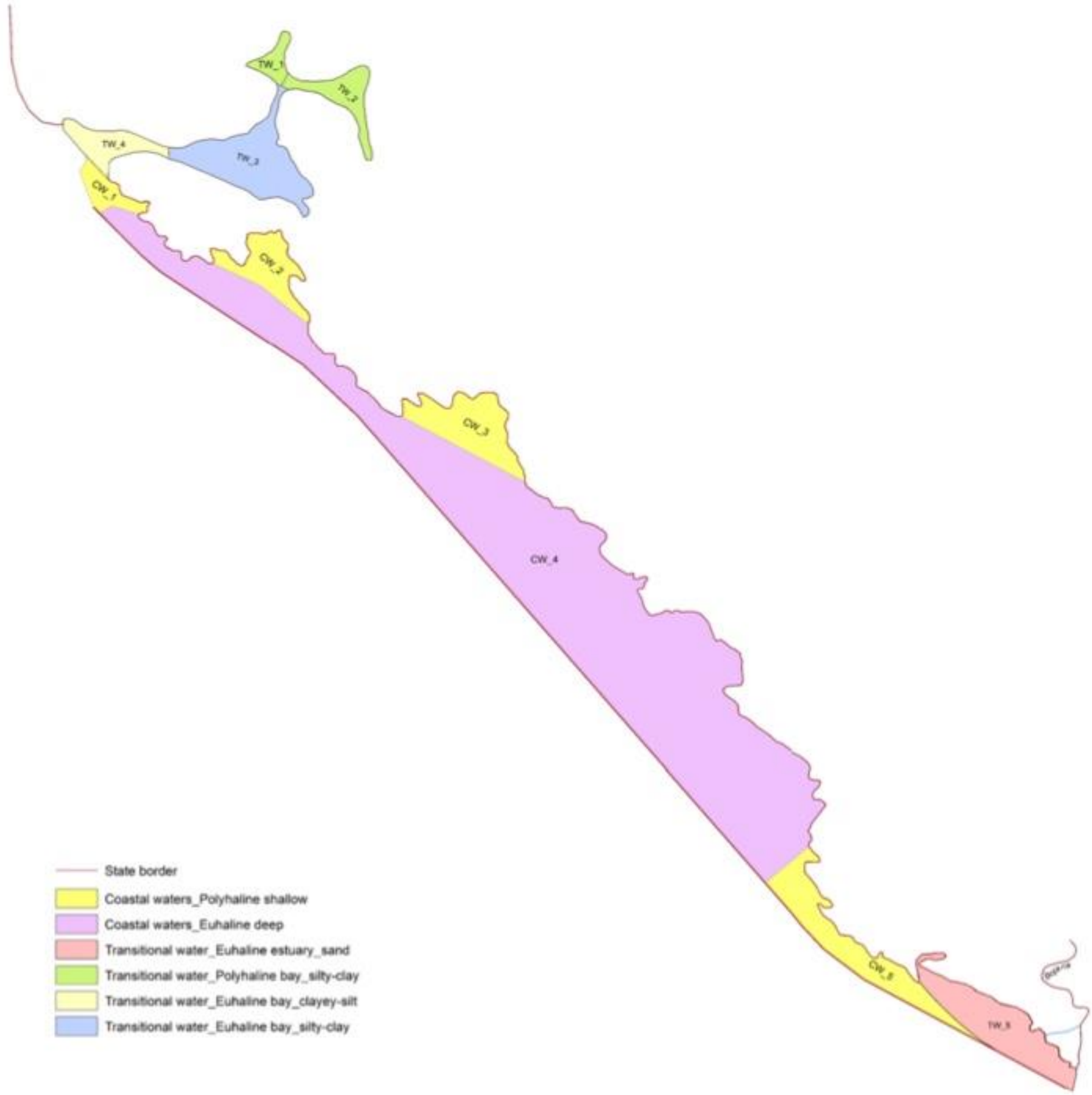


## Figure 3.3 Surface Water Bodies in the Adriatic River Basin



### Figure 3.4 Delineated Water Bodies in Skadar Lake

## Figure 3.5 Delineated Transitional and Coastal Water Bodies



## 3.3 Description of the groundwaters

The whole territory of Montenegro belongs to just one large geostructural unit – Dinarides. The Dinaric system (Dinarides) represents a geologically heterogeneous, south European orogenic belt of the Alpine mountain chain (Alpides). The main orientation of the system is NW-SE, parallel to the Adriatic Sea. It is a long, mostly mountainous structure with numerous intermountain depressions, large karst poljes or valleys created by numerous perennial or sinking streams[15,16]

### 3.3.1 Geo-structural units and stratigraphy

Throughout its early geologic history, the Dinaric region was part of the Mediterranean geosyncline (Tethys). It was not until the Late Paleozoic that carbonate sediments were deposited in quantities favourable for karstification. The first sedimentation cycle represents the interval between Upper Devonian and Middle Jurassic. In most of the internal Dinarides, marine sedimentation started in Upper Permian and lasted until the end of Lower Jurassic. In the External Dinarides this cycle extended until Upper Cretaceous.

The following geotectonic subunits are present in the External Dinarides of Montenegro:

- In the *Adriatic folds* (part of the Adriatic-Ionian fold system) the carbonate and flysch facies prevail. The carbonate facies consist of limestone, dolomite-limestone and sporadically of dolomite of the Upper Cretaceous and Eocene, while flysch facies consist of clay, marl, sandstone, breccia and conglomerates of the Eocene age.
- Terrains of the *Budva - Cukali zone* (or Pindus - Cukali zone) are composed of several stratigraphic-lithologic members, starting with Permian-Triassic up to the end of the Eocene: flysch-clastic facies of the Lower and Middle Triassic; sedimentary-volcanic facies of the Middle Triassic; carbonate facies of the Triassic, Jura, Cretaceous and Paleogene, and flysch facies of the Paleogene.
- The major part of the territory of Montenegro belongs to *the High karst zone*. Its geology is very complex: Mesozoic limestone and dolomite prevail, but there are also spread-out non-karstic rocks such as Lower Paleozoic schist-argillaceous marl layers; Lower and Middle Triassic marl, sandstone and conglomerates as well as Middle Triassic porphyrite, quartz-porphyrite, dacite and andesite. In addition to the above, in two narrow zones across the entire territory of Montenegro from the southwest towards the southeast, there appear Upper Cretaceous – Paleogene sediments of flysch, represented by marl, argillite, limestone, sandstone, breccias and conglomerates.
- *Inner Dinarides* in Montenegro are represented by large Durmitor nappe which extend over ca. 5000 km$^2$. Thick limestones and dolomites complex are mostly Triassic and Jurassic ages and is intersected by volcanic rocks or ophiolite impervious rocks. This is an area with highest mountains in Montenegro.

As part of the Dinaric system, Montenegro is a classical karst country. Dinaric carbonate rock complex is the result of the Alpine orogenic phase with the most intensive tectonic movements during the Tertiary. Tectonic events resulted in a complex system of faults and fractures as privileged

[15] Radulović M., 2000: Karst hydrogeology of Montenegro. Sep. issue of Geological Bulletin, vol. XVIII, Spec. ed. Geol. Survey of Montenegro, Podgorica, 271 p

[16] Stevanović Z., Kukurić, N., Pekaš, Ž., Jolović B., Pambuku A., Radojević D., 2016: Dinaric Karst Aquifer – One of the world's largest transboundary systems and an ideal location for applying innovative and integrated water management. In: Karst Without Boundaries, Stevanović Z., Kresic N., Kukuric N. (eds.), CRC Press/Balkema, Taylor & Francis Group, London, 3-25

subterranean water paths. Moreover, climatic conditions, particularly the successions of wet and warm periods, significantly contributed to karstification.

### 3.3.2 Aquifer systems

The Adriatic River Basin comprises 47.8% of the national territory. Morača with its tributaries Zeta, Cijevna, Rijeka Crnojevića and Orahovštica discharge into Skadar Lake and these waters together with the Bojana River are further flowing into the Adriatic Sea. Considering fact that most of Montenegro territory is covered by karstic rocks with specific hydrogeological setting, the surface dividing lines very often do not correspond with underground ones and such statement is supported by results of many conducted tracing experiments. Generally, the watershed and attributed aquifer systems are rich with water, even compared to worldwide standards. However, in high mountains of Montenegro even along the coast, which is made of karstified rocks, there is shortage of waters due to very deep groundwater table and fast water circulation and drainage.

Along with karst, the main aquifer systems are intergranular, the richest resources exist in fluvio-glacial and alluvial deposits.

### 3.3.3 Karstic aquifers

Karstic aquifers are formed within a very thick (over 3,000 m) complex of Mesozoic limestones and dolomites. The recharge of karst aquifers is from precipitation and waters percolated from sinking rivers. It can be assessed that the average infiltration rate varies between 50% and 80% of precipitation depending on the locality, morphology and karstification properties[17].

As a result of intensive karstification, a network of highly permeable underground channels acts as preferential pathways of intensive groundwater circulation. It is very difficult to estimate the overall effective porosity (considered also as a storage coefficient) of the karst aquifer because of the anisotropic and heterogeneous character of limestones and dolomites. Most references provide values in the range of 0.5% - 1.5%, while locally it can be significantly higher.

Based on results of tracing tests conducted in various karst aquifer systems[18] it has been concluded that the main erosional base of the External Dinarides is the level of the Adriatic Sea, while the local erosional base for numerous springs are the edges of karstic poljes or the contact of carbonate and non-carbonate rocks. Calculated velocities of used dyes are in range of 0.1-13.8 cm/s which is confirming well developed system of karstic channels and cavities.

Spring zones in the Boka Kotorska Bay (the Orahovačka Ljuta, Spila, Sopot, Morinje Springs, Škurda and Gurdić) annually discharge more than 150 $m^3$/s, on average. Some of these springs even dry out completely during summer (e.g. the Sopot, Spila), while after intensive rainfall or at the end of winter some of them can discharge over 100 $m^3$/s. The sublacustrian spring Bolje sestre tapped for regional water supply of the Montenegrin coastal area is discharging in minimum 2,3 $m^3$/s. Some other submerged springs along the edge of Skadar Lake - vruljas are discharging even greater amount of water.

[17] Radulović M., 2000: Karst hydrogeology of Montenegro. Sep. issue of Geological Bulletin, vol. XVIII, Spec. ed. Geol. Survey of Montenegro, Podgorica, 271 p

[18] Radulović M., 2000: Karst hydrogeology of Montenegro. Sep. issue of Geological Bulletin, vol. XVIII, Spec. ed. Geol. Survey of Montenegro, Podgorica, 271 p

Concerning the specific underground yield Montenegro is in group of the world's countries with greatest values: an average is 40 $l/s/km^2$, while in certain aquifers specific yield is greater than 70 $l/s/km^2$, as in case of Lower Zeta in Skadar basin.

### 3.3.4 Intergranular aquifers - recharge, discharge and groundwater flow

In general, the three types of intergranular aquifers can be distinguished:

1. Aquifers in Neogene deposits;
2. Aquifers in Pleistocene fluvio-glacial deposits and karstic poljes;
3. Alluvial aquifers.

Classification is based on sediments age but could also be interrelated to sediments permeability and groundwater availability.

1. The Neogene sediments of marine and lacustrine origins are generally characterized by low permeability and small groundwater reserves. In the edge of Nikšić polje (Brezansko) the sediments thickness is over 40m.

2. By far the richest intergranular aquifer is in Skadar basin – Lower Zeta with Tuško polje. This is typical fluvio-glacial material consists of well permeable conglomerates, gravels, sands, but also presence of clay layers and lenses. This aquifer system extends over 200 $km^2$ and covers the karst aquifer in paleo relief. The thickness of fluvio-glacial sediments very much varies, between 30-100m. The average values of hydraulic conductivity ($5 \times 10^{-3}$ m/s) and transmissivity ($1.8 \times 10^{-2}$ $m^2/s$) result with very large discharge in drilled wells, e.g. two wells have been identified with productivities of 413 l/s and 764 l/s per meter of drawdown, respectively. This aquifer with total dynamic groundwater reserves of ca. 15 $m^3/s$ has also been evaluated as an option for regional water supply of coastal zone.

Some glacial and fluvial material is also deposited along the southern shoreline of Skadar Lake. Orahovsko polje, a small gulf of the Skadar Lake, is periodically flooded. The thickness of the sediments is 15 - 40m, while 7 wells tap groundwater for the city of Bar have an average total discharge of 150 - 180 l/s.

Nikšić polje, the largest karstic polje in the country (66 $km^2$) is filled with lacustrine, glacial and alluvial sediments. Their thickness in certain areas is larger than 100m, but in average is 30-40m. Some sequences are well permeable (alluvium of Zeta), while others are of lower permeability. Several wells tap this groundwater for the Nikšić brewery, while the city and industry are using groundwater from karstic springs or well field Poklonci.

Grahovsko karstic polje is also holding a relatively permeable aquifer. Its thickness is more than 20m in the centre of polje.

The permeability and groundwater availability of alluviums very much depends on river size and flows. Bojana River alluvium is most important: the Lisna-Bori is the largest source of this kind of aquifer in Montenegro and is supplying the city of Ulcinj (total discharge over 200 l/s). It is due to relatively thick and well productive aquifer hydraulically connected with the river water.

Some other alluviums are also supplying potable water but mostly to smaller settlements (villages).

## 3.4 Groundwater body delineation

### 3.4.1 Methodology for classification and delineation of groundwater bodies

The key aspect of the 'groundwater body' concept is that GWB is the management unit under the WFD that is necessary for the subdivision of large geographical areas of aquifer in order for them to be effectively managed. This concept considers:

- Groundwater that can provide for the abstraction of significant quantities of water (i.e. the groundwater that can and should be managed to ensure sustainable, balanced and equitable water use); and
- Groundwater that is in continuity with ecosystems and can place them at risk, either through the transmission of pollution or by unsustainable abstraction that reduces baseflows (i.e. the groundwater that can and should be managed to prevent environmental impacts on surface ecosystems).

The aim of groundwater body characterization is to establish the quantitative and chemical status of each groundwater body i.e. aquifer which supplies more than 50 people and whose abstraction is larger than 10 $m^3$/day. Groundwater characterization is based on the analysis of the available environmental data - geological, hydrological, chemical, impact of human activity, etc. The exception from delineation and characterization of GWB could occur in the following cases:

- They do not have any impact on terrestrial eco systems,
- Deep groundwater that is not utilised,
- Groundwater quality is inappropriate and cannot be used as potable water source, or extraction is economically unjustifiable,
- There are some risks of water extraction.

The following factors have been taken into consideration for delineation criteria at the level of Adriatic River Basin:

- Regulatory framework – EU WFD and national legislation
- Experiences of other countries, especially those from SE Europe and the Dinaric region
- "Scale effect" – size of the national territory and concerned basins
- Hydrogeology (aquifer systems distribution, permeability, water resources)
- Groundwater use and protection
- Current literature and projects, master and water plans, strategies in the water sector

Classification and definition of dividing lines between GWBs have been generated with the knowledge of the following characteristics in mind:

- Surface water bodies delineation
- Geological setting and geo-structural units
- Hydrogeology and aquifer systems classification
- Results of conducted tracing tests
- Estimated catchments of major springs and evaluated inconsistencies between hydrogeological and orographic divides
- Contact and relation between porous and impervious rocks
- Zones of active recharge and aquifers' drainage
- Experts' opinions

For grouping of GWBs the two criteria are applied:

- Similarities in hydrogeological function (merging aquifers of the same types),

- Regional interconnection (even though some outcrops of one aquifer are separated by some impervious rocks or other aquifers, they are considered to belong to one common group).

GWBs and GGWBs also include a part of terrains that are not aquifer itself, but from which there are intensive runoffs toward adjacent aquifers. These *allogenic catchments* are an important element of the assessment of the water budget and resources of concerned WBs. In contrast, some zones where there is no groundwater (impervious rocks) or they exist but in minimal concentration (aquifuges) and not connected to adjacent aquifers, they are not mapped (blank areas) and attributed to GWBs or GGWBs.

### 3.4.2 Delineation of groundwater bodies

In the Adriatic River Basin there are 17 groundwater bodies, comprised of 4 GWBs and 13 GGWBs (Figure 3.6). The groups of ground water bodies are shown separately in Figure 3.7. In total, 5 out of the 17 delineated water bodies are of transboundary character. There are no GWBs or GGWBs that are larger than 1000 km$^2$, while 7 GWBs are smaller than 300 km$^2$. Table 3.8 shows the correlation of population and minimal extracted groundwater in the municipalities of the Adriatic River Basin.

**Table 3.8 Comparison of population and the minimum amount of groundwater exploited within municipalities in the Adriatic River Basin[19]**

| Municipality | Population | $Q_{min}$ (l/s) |
|---|---|---|
| **Nikšić** | 78 443 | 480 |
| **Kolašin** | 8 380 | 78 |
| **Podgorica** | 185 937 | 4 915 |
| **Bar** | 42 048 | 351 |
| **Ulcinj** | 19 921 | 302 |
| **Budva** | 19 218 | 209 |
| **Cetinje** | 16 657 | 1 242 |
| **Danilovgrad** | 18 472 | 375 |
| **Kotor** | 14 031 | 75 |
| **Tivat** | 22 601 | 860 |
| **Herceg Novi** | 30 854 | 77 |

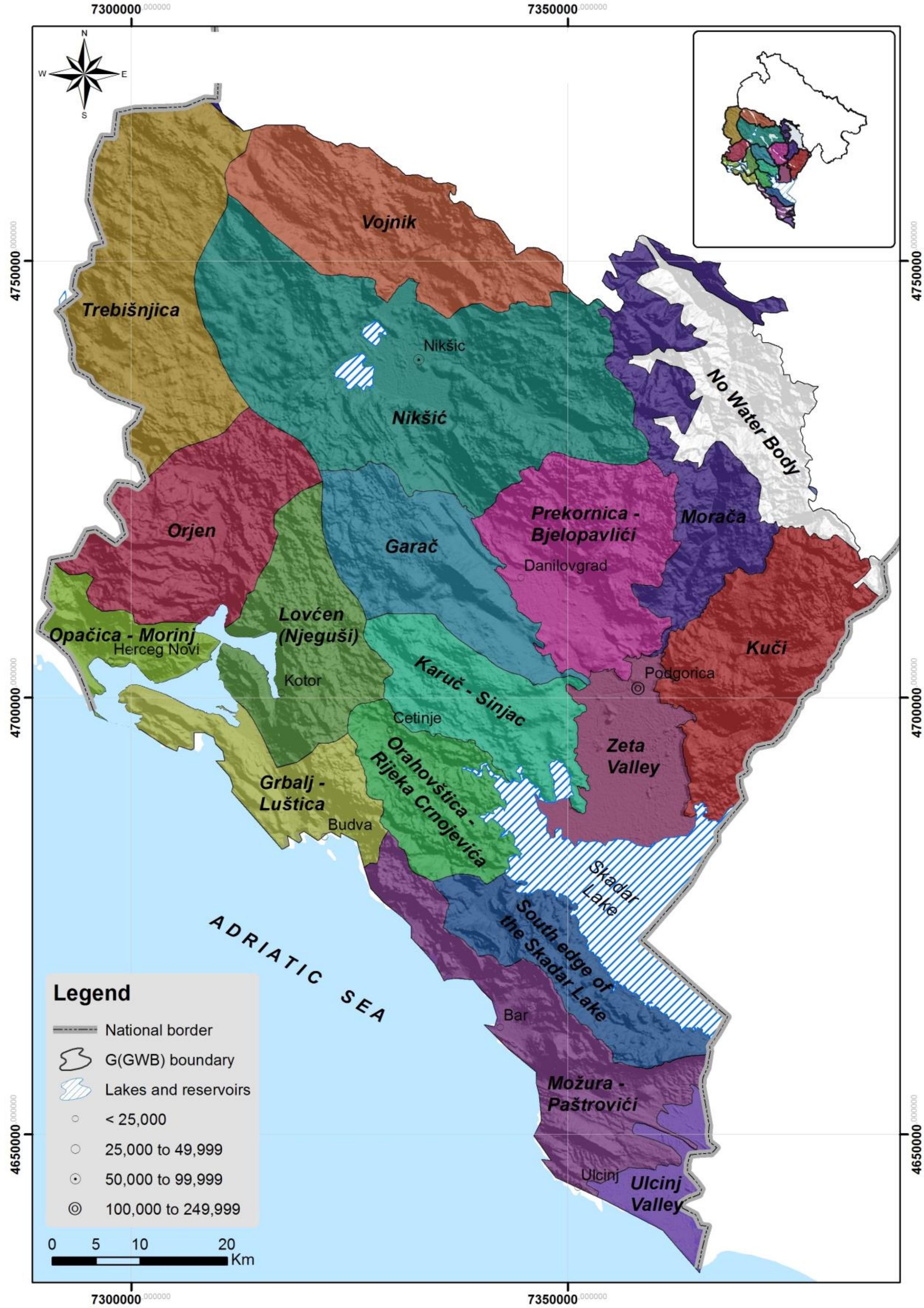
Table 3.9 shows the name, code, character, river basin and surface area of delineated GWBs and GGWBs. The table also contain the links to delineated surface water bodies of the River Basin. The names of the GWBs or GGWBs are derived in accordance with the existing main geographic / topographic element (city, mountain, basin, river). The code consists of several elements: Country code – MNE; Basin – AB (Adriatic River Basin); Water body – GW (Groundwater Body) or GGW (Group of Groundwater Bodies); Aquifer – K (karst), I (intergranular), C (complex)

A detailed description of each GWB or GGWBs shown in Figures 3.6, and 3.7 and Table 3.9 below**.** A detailed characterisation of each GW or GGW body is presented in Section 3.4.3 and in Annex 1.

[19] Data provide by Monstat 2011

**Figure 3.6 Groundwater bodies and boundaries of municipalities with minimal extracted waters (Qmin) in the Adriatic River Basin**

## Figure 3.7 Groups of groundwater bodies in the Adriatic River Basin



### Table 3.9 Groundwater bodies or Groups of Groundwater Bodies in the Adriatic River Basin

| No. | Code | Character | Name | Sub -Basin | Link to Surface Water Bodies | Area (km$^2$) |
|---|---|---|---|---|---|---|
| **1** | ME_AB_GGW_K_1 | Inner | Southern Rim of the Skadar Lake | Skadar Lake | WB 3_South west<br>WB 4_Pelagic zone | 243.3 |
| **2** | ME_AB_GW_I_1 | Transboundary | Ulcinjsko polje | Bojana | Bojana<br>TW_5<br>MNE_CW5<br>Saško | 111.1 |
| **3** | ME_AB_GGW_K_2 | Inner | Možura - Paštrovići | Adriatic | MNE_CW3<br>MNE_CW4<br>MNE_CW5 | 399.0 |
| **4** | ME_AB_GGW_K_3 | Inner | Grbalj - Luštica | Adriatic | TW_3<br>TW_4<br>MNE_CW1<br>MNE_CW2<br>MNE_CW4 | 225.9 |
| **5** | ME_AB_GW_K_4 | Transboundary | Opačica - Morinj | Adriatic | TW_1<br>TW_3<br>TW_4<br>MNE_CW1 | 136.0 |
| **6** | ME_AB_GW_K_5 | Transboundary | Orjen | Adriatic | TW_1 | 409.6 |
| **7** | ME_AB_GW_K_6 | Inner | Lovćen (Njeguši) | Adriatic | TW_2<br>TW_3 | 330.2 |
| **8** | ME_AB_GGW_C_1 | Inner | Orahovštica – Rijeka Crnojevića | Skadar Lake | WB 1_Vucko blato<br>WB 3_South west<br>Orahovštica<br>Crnojevica | 241.3 |
| **9** | ME_AB_GGW_K_7 | Inner | Karuč - Sinjac | Skadar lake | Malo blato | 277.2 |
| **10** | ME_AB_GGW_I_2 | Inner | Zeta Valley | Zeta | WB 3_South west<br>WB 4_Pelagic zone<br>Morača_5<br>Morača_6<br>Morača_7<br>Zeta_2 | 248.5 |
| **11** | ME_AB_GGW_C_2 | Inner | Prekornica - Bjelopavlići | Zeta | Morača_4<br>Zeta_3<br>Zeta_4 | 418.0 |
| **12** | ME_AB_GGW_K_8 | Inner | Garač | Zeta | Zeta_3<br>Zeta_4 | 338.4 |
| **13** | ME_AB_GGW_K_9 | Inner | Vojnik | Zeta | Sušica | 448.5 |
| **14** | ME_AB_GGW_C_3 | Inner | Nikšićko polje | Zeta | Zeta_1<br>Zeta_2<br>Zeta_3<br>Slansko Lake<br>Krupačko Lake | 990.2 |

| No. | Code | Character | Name | Sub -Basin | Link to Surface Water Bodies | Area (km²) |
|---|---|---|---|---|---|---|
| | | | | | Gračanica_1<br>Gračanica_2<br>Liverovići Reservoir | |
| **15** | ME_AB_GGW_K_10 | Transboundary | Trebišnjica (Bilećko Lake) | Adriatic[20] | Bilecko Lake | 575.5 |
| **16** | ME_AB_GGW_C_4 | Transboundary | Kuči | Skadar Lake | Cijevna<br>WB 2_North<br>Morača_4<br>Nožica<br>Mala Rijeka_1<br>Mala Rijeka_2 | 430.8 |
| **17** | ME_AB_GGW_K_11 | Inner | Morača | Morača | Morača_1<br>Morača_2<br>Morača_3<br>Morača_4<br>Mrtvica_1<br>Mrtvica_2 | 355.2 |

[20] Although Bilećko Lake is not on the Adriatic, it is part of the Adriatic Sub-Basin

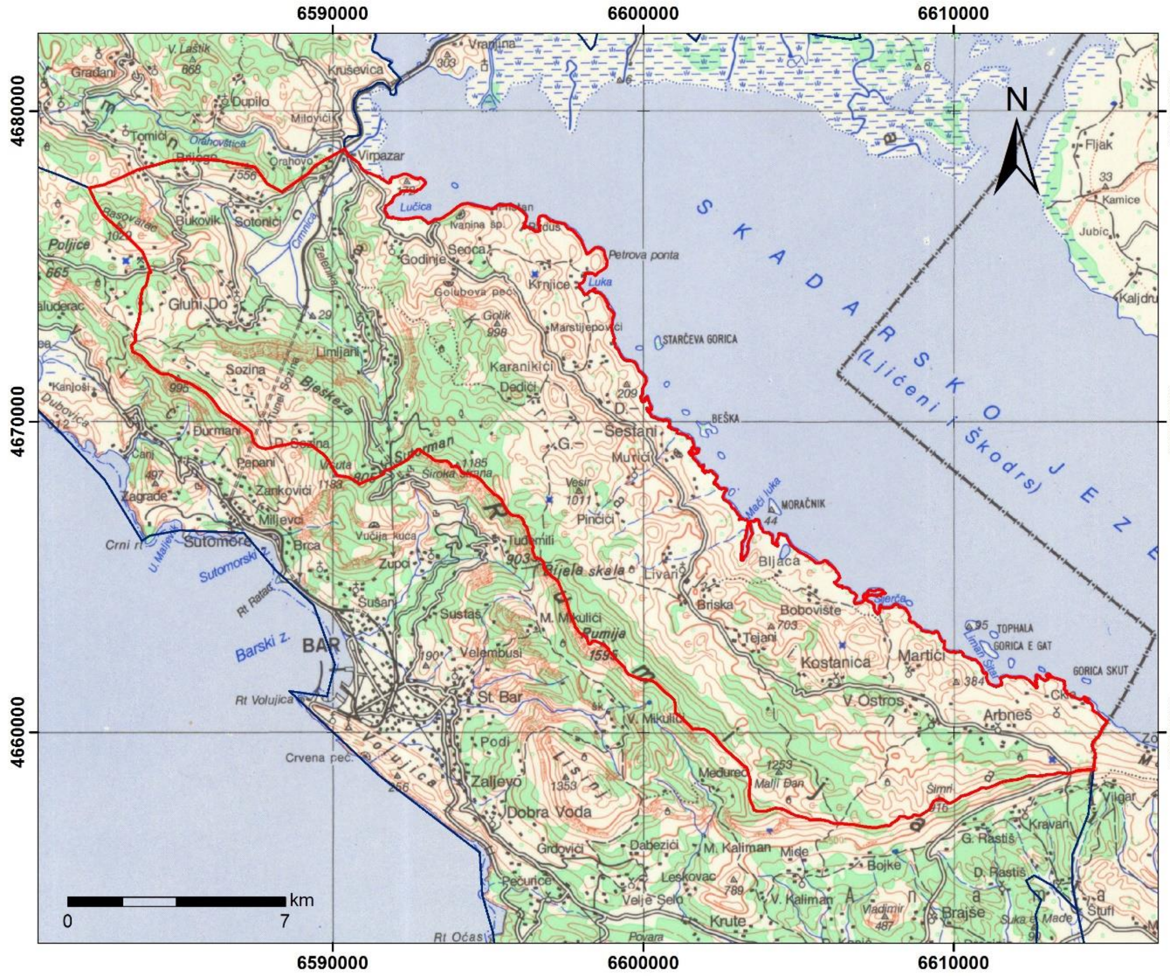
### 3.4.3 Characterization of groundwater bodies

#### Groundwater body No. 1: "Southern Rim of Skadar Lake"

The group of groundwater bodies "Southern Rim of the Skadar Lake" (ME_AB_GGW_K_1) is located in the southern part of Montenegro. It is distributed from state border within Albania the southeast to Crmnica in the northwest, and from the top of Rumija Mountain in the southwest to Skadar Lake in the northeast. The total area is 243.3 km$^2$, of which 238.5 km$^2$ is represented by karst.

The terrains are mostly hilly-mountainous, with elevations from 5 m.a.s.l in the area around Skadar Lake to 1,594 m.a.s.l at the top of Rumija Mountain. There are numerous karst landforms in these area. Permanent streams are rare at the higher altitudes because the karst terrain is very permeable. The only one permanent stream is Orahovštica River which flows through the Crmnica polje (5-30 m.a.s.l). Alluvial plains are present just along the Crmnica River.

**Figure 3.8 Geographical position of the group of groundwater bodies "Southern Rim of Skadar Lake"**



This area belongs to tectonic zone “High Karst” which is mostly built of limestone and dolomite. According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution. Besides the carbonate rocks, the flysch sediments ($T_2^1$, Pg) and andesite ($\alpha$) are also present and have role of impermeable hydrogeological barrier for groundwater flow. The Quaternary sediments are distributed locally in form of deluvium. Alluvial sediments are distributed in Godinje and along the Crmnica River.

The karst aquifer, represented by highly karstified limestone and dolomite, has dominant distribution (Fig. 1 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water. The karst aquifer is uncovered almost on the entire area, and impermeable rocks (flysch sediments and andesites) have very limited distribution. The mean annual precipitation amounts 2,461 mm/year. An assessed recharge rate (effective infiltration) is around 68% of precipitation rate, i.e. around 1,673 mm/year. According to a rough assessment the depth to groundwater level can reach depth up to 400 m in central parts. The apparent (linear) groundwater velocity determined by tracer tests range from 0.11 to 0.82 cm/s. The following hydraulic connection between swallow holes and springs were determined: swallow hole in Ostros with Van I Šitarit Spring (v=0.42 cm/s); swallow hole in Bijelo Polje with Velje Oko, Malo Oko and Okruglica Spring (v=0.11 cm/s); swallow hole in Ljevačko (Sozina) with Pod Kapom Spring (v=0.82 cm/s). The determined tracer velocities indicate that the limestone and dolomite have relatively good permeability. General groundwater flow direction is from SW to NE. The main karst springs are Raduš Spring ($Q_{min}$=0.06 $m^3/s$; Q=1.24 $m^3/s$; $Q_{max}$=50 $m^3/s$), Krnjice Spring (Q=0.7 $m^3/s$); Velje Oko (Q=1 $m^3/s$); Malo Oko (Q=0.3 $m^3/s$); Okruglica Spring (Q=0.2 $m^3/s$). Besides these main discharge points there are numerous periodical sublacustrine springs along the Skadar Lake coast. Also, there are few springs with small discharge (Q < 1 l/s) distributed at the higher altitudes.

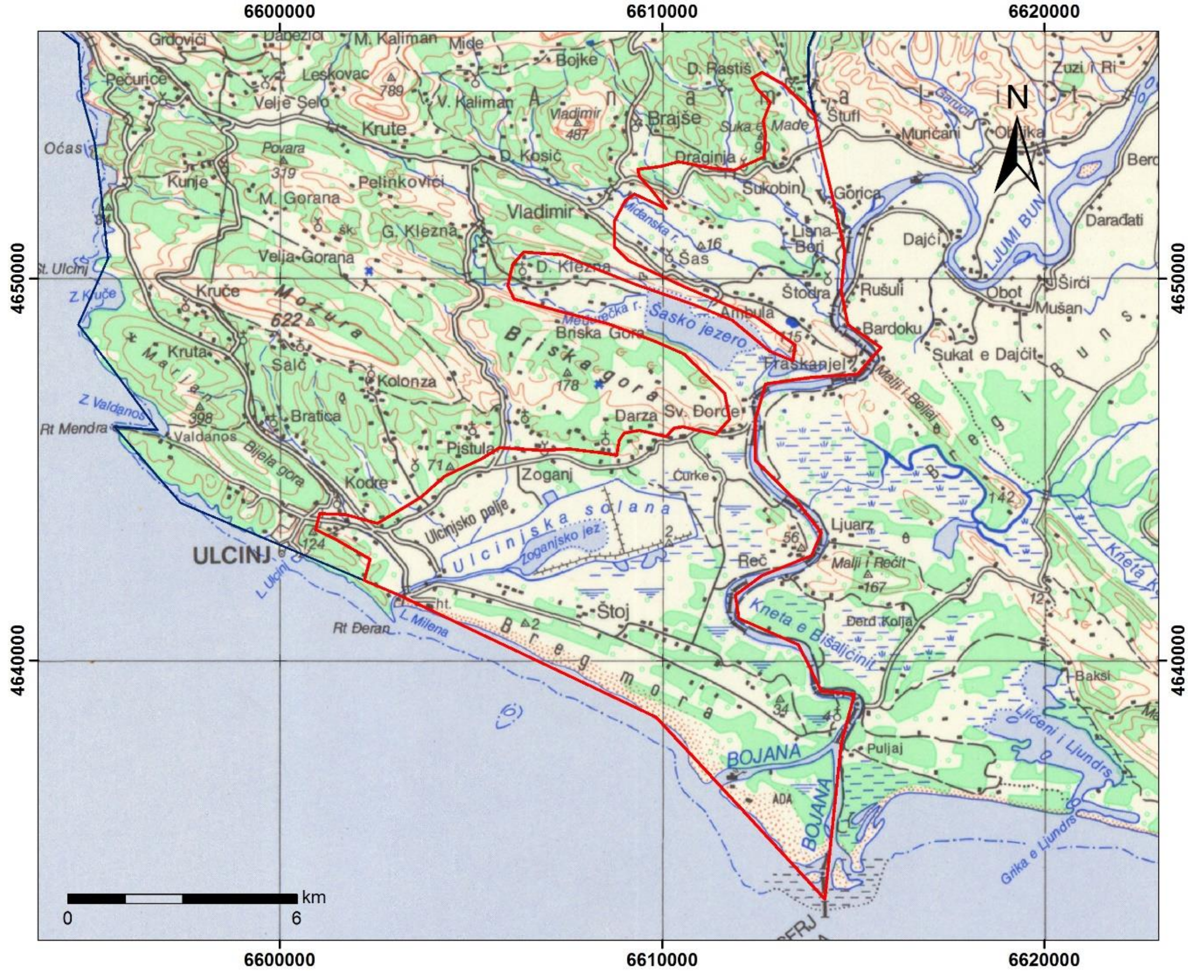
Also, the alluvial aquifer is present but just along the Crmnica River and Godinje. It is mainly consisted of clay, gravel and sand. The hydrodynamic conditions of this aquifer are variable, with confined conditions in parts where there is a clay layer over the saturated permeable zone. The alluvial aquifer has relatively good interaction with Crmnica River.

### Groundwater body No. 2: “Ulcinjsko polje”

The transboundary groundwater body “Ulcinjsko polje” (ME_AB_GW_I_1) is located in the south part of Montenegro. It is distributed from Adriatic Sea in the south to Fuša Kravari in the north, and from Bojana River in the east to Ulcinj in the west. The total area is 111.1 $km^2$.

Ulcinjsko polje is relatively flat, with few hills which rise from the limestone and flysch base. Elevation ranges from 0 m.a.s.l. along the coast of Adriatic Sea to 26 m.a.s.l. in the western part of Anomalsko polje. The main surface water bodies in this area are Bojana River, Šasko Lake and Adriatic Sea. Also, there are few smaller streams such as: Brdela stream, Miđanska River, Vija e Lišnes stream and Kravarski stream.

## Figure 3.9 Geographical position of the groundwater body “Ulcinjsko polje”




The valley is filled by alluvial sediments represented by sand, gravel, silt and clay (Fig. 2 in Annex 1). The thickness of these deposits is around 30 m in average. The bedrock is mostly built by limestone ($K_2^3$) and flysch sediments ($E_3$). From the tectonic point of view, this area belongs to the “Parahton” tectonic zone.

A groundwater recharge occurs by infiltration of atmospheric and surface water. The mean annual precipitation amounts 1,253 mm/year. An assessed recharge rate (effective infiltration) is around 30% of precipitation rate, i.e. around 376 mm/year. There are changeable hydraulic conditions within this intergranular aquifer (in same areas the aquifer is unconfined, but in the areas where clay is dominant in the surficial part, the aquifer is confined). Groundwater level is shallow. The depth to groundwater level is around 2 m in average. General groundwater flow direction is from N to S. Hydrogeological parameters indicate that the intergranular aquifer has moderate permeability ($K_f$ = 5.6 x $10^{-5}$m/s; Puri *et al*. 2009). The natural discharge of the intergranular aquifer occurs through the diffuse outflow to Adriatic Sea and Bojana River.

## Groundwater body No. 3: "Možura-Paštrovići"

The group of groundwater bodies "Možura-Paštrovići" (ME_AB_GGW_K_2) is located in the southern part of Montenegro. It is elongated along the SE-NW direction, from Ulcinj to Sveti Stefan Island. The total area of GGWB is 399 km$^2$.

The area is represented by hilly-mountainous terrains and valleys, with elevations from 0 m.a.s.l along the Adriatic coast to 1,600 m.a.s.l at the top of mountains. There are numerous surface and subsurface karst landforms, especially at the Paštrovske Mountains. There are numerous streams that mostly begin on the contact of limestone and impervious flysch sediments.

**Figure 3.10 Geographical position of the group of groundwater bodies "Možura-Paštrovići"**


This area belongs to three tectonic zones: "Parahton", "Budva-Cukali" and "High Karst". According to the Geological Map of Montenegro 1:200,000 the limestone, dolomite and cherts (T,J,K) and flysch sediments (conglomerate, sandstone and marl; $T_2^1$, $E_3$) have the dominant distribution. Besides these geological units, the volcanic-sedimentary rocks ($T_2^2$), andesite (α), alluvium (al) and deluvium (d) are also present (Fig. 3 in Annex 1).

The karst aquifer consists of karstified limestone and dolomite. The groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of small streams. Around 66% of the karst aquifer is uncovered. The mean annual precipitation amounts 1,669 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 1,000 mm/year. According to a rough assessment the depth to groundwater level is over 50m. General groundwater flow direction is from NE to SW. The apparent (linear) groundwater velocity determined by tracer tests ranges from 0.93 to 3.27 cm/s. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: swallow hole Vidran (Paštrovske Mountains) – Reževića Spring, Smokovijenac Spring and Vilina Cave ($v$=2.07-2.60 cm/s); swallow hole Dobrun (Paštrovske Mountains) – Reževića Spring, Smokovijenac Spring ($v$=0.93-0.98 cm/s); swallow hole Jama (Bjeliš, BijeloPolje) – Lončar Spring (Buljarica) ($v$=3.27 cm/s); Velja Gorana – Gač Spring; Krute –Skili Fata Spring (DonjaKlezna) ($v$=1.5 cm/s).

Intergranular aquifer is represented by alluvial sediments distributed in the area of Bar and Buljarica.

There are numerous karst springs such as: Gač Spring ($Q_{min}$=0, $Q_{max}$≈1 $m^3$/s), Salč Spring ($Q_{min}$=0.01 $m^3$/s), Skili Fata Spring,Mide Spring ($Q_{min}$=0.01 $m^3$/s), Kaliman Spring, Kajnak Spring ($Q_{min}$=0.1 $m^3$/s), Brca Spring ($Q_{min}$=0.035 $m^3$/s, $Q_{max}$≈0.8 $m^3$/s), Škurta Spring ($Q_{min}$=0.013 $m^3$/s, $Q_{max}$=0.05 $m^3$/s), Dobra Voda Spring ($Q_{min}$=0.01 $m^3$/s, $Q_{max}$≈0.1 $m^3$/s), Zaljevo Spring ($Q_{min}$=0.02 $m^3$/s), Reževića Spring ($Q_{min}$=0.5 $m^3$/s; $Q_{max}$≈10 $m^3$/s) and Smokovijenac Spring ($Q_{min}$=0.005 $m^3$/s).

### Groundwater body No. 4: “Grbalj-Luštica”

The group of groundwater bodies “Grbalj-Luštica” (ME_AB_GGW_K_3) is located in the southern part of Montenegro. It is elongated along the SE-NW direction, from Sveti Stefan Island to Luštica Peninsula. The total area is 325.9 $km^2$.

The area is represented by hilly-mountainous terrains and valleys, with elevations from 0 m.a.s.l along the Adriatic coast to 1,474 m.a.s.l at the top of mountains (Kološunske Grede). The karst landforms are mainly distributed in the area of Brajići. There are numerous streams that mostly begin on the contact of limestone (karst aquifer) and impervious flysch sediments.

This area belongs to three tectonic zones: “Parahton”, “Budva-Cukali” and “High Karst”. According to the Geological Map of Montenegro 1:200,000 the limestone, dolomite and cherts (T,J,K,E) and flysch sediments (conglomerate, sandstone and marl; $T_2^1$, $E_3$) have the dominant distribution. Besides these geological units, the volcanic-sedimentary rocks ($T_2^2$), porphyritic rocks and diabase (α, ββ), alluvium (al) and deluvium (d) are also present (Fig. 4 in Annex 1).

The karst aquifer consists of karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams. The mean annual precipitation amounts 1,866 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 1,120 mm/year. According to a rough assessment the depth to groundwater level is over 50m. General groundwater flow direction is from NE to SW. The apparent (linear) groundwater velocity determined by one tracer test is 0.53 (the hydraulic connection between swallow hole in Brajići and Spring under Pyramid has been determined).

**Figure 3.11 Geographical position of the group of groundwater bodies "Grbalj-Luštica"**


Intergranular aquifer is represented by alluvial sediments distributed in the area of Budva, Jaz and Grbalj. This aquifer is mostly confined.

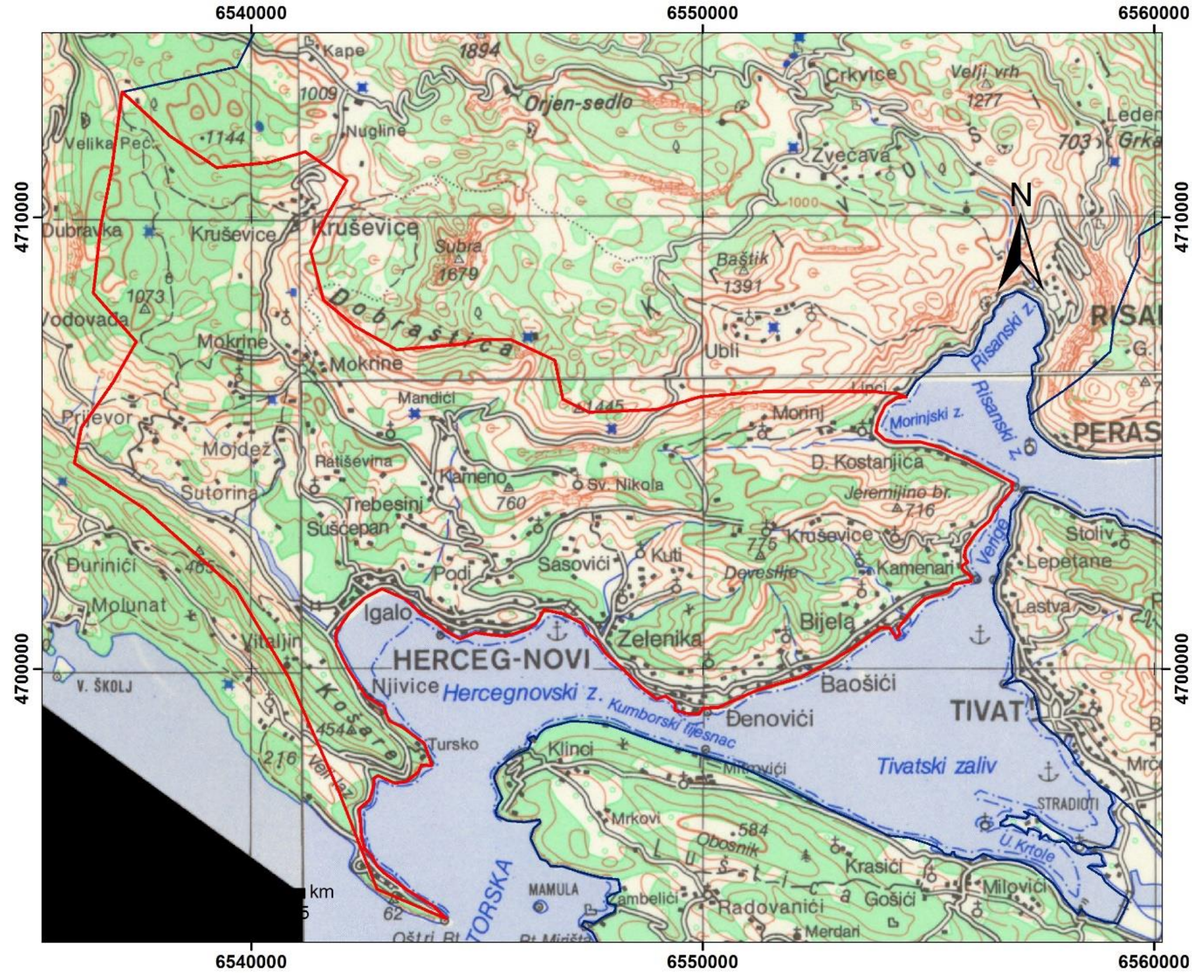
There are numerous small springs such as: Grbalj Spring, Pakočio, Rakita, Mezalinska voda, Nova Voda, Smokvica, Kaludrak (Qmin=1 l/s), Tolinjak (Qmin=1 l/s), Piratac ($Q_{min}$=2 l/s; $Q_{max}$=25 l/s), Boretska voda, Brca, Loznica ($Q_{min}$=2 l/s; $Q_{max}$=25 l/s), Tršljikovica, Podbabac, Babac, Kuljače, Spring under the Pyramid ($Q_{min}$=5 l/s), Topliš Spring-Budva ($Q_{min}$=1 l/s), Lončar ($Q_{min}$=4 l/s), Zagradac ($Q_{min}$=2 l/s).

## Groundwater body No. 5: "Opačica-Morinj"

The groundwater body "Opačica-Morinj" (ME_AB_GW_K_4) is located in the south-western part of Montenegro. It is extended from Prevlaka and border with Croatia in south to Krivošije in north, and from Verige in east to Debeli Brijeg in west. The total area is 136 $km^2$, of which around 102 $km^2$ is karst.

The area is represented by hilly-mountainous terrains, with elevations from 0 m.a.s.l. along the coast to 1,571 m.a.s.l. at the top of mountains. The karst landforms are mainly distributed in the area of Krivošije, where dolines are densely arranged in the form of polygonal karst. There are numerous streams on the slope in the background of the coast. They mostly begin on the contact of limestone and flysch sediments.

### Figure 3.12 Geographical position of the groundwater body "Opačica-Morinj"




This area belongs to three tectonic zones: "Parahtone", "Budva-Cukali" and "High Karst". According to the Geological Map of Montenegro 1:200,000 the limestone, dolomite and chert (T,J,K) have the dominant distribution. Besides the carbonate rocks, the flysch sediments (conglomerate, sandstone and marl; $T_2^1$, $E_3$), alluvium (al), deluvium (d) and glacial sediments (gl) are also present (Fig. 5 in Annex 1).

The karst aquifer is consisted of karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams. The mean annual precipitation amounts around 2,800 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,960 mm/year. According to a rough assessment the depth to groundwater level away from the coastline is over 200 m. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. General groundwater flow direction is from W to E. The average apparent (linear) groundwater velocity in the wider area determined by one tracer tests is 2.5 cm/s. The hydraulic connection of swallow hole in Ponikve (Mokrine) with Morinj and Verige Springs has been determined.

Intergranular aquifer is represented by alluvial sediments distributed in the area of Sutorina. A permeable layer consisted of gravel and sand is covered by clay (confined aquifer). The following hydrogeological parameters are obtained by pumping tests of wells and boreholes in the area of water-source “Sutorinsko polje”: $K=1.4\times10^{-3}–1.3\times10^{-2}$ m/s; $T=7.0\times10^{-3}–6.5\times10^{-2}$ $m^2$/s.

The main karst springs are Morinj Springs ($Q_{min}$=1 $m^3$/s), Opačica ($Q_{min}$=0.035 $m^3$/s) and Verige Springs, but there are also many small springs on higher altitudes such as: Česma Spring, Dizdarica Spring, Dragomanovića Spring and Lovac Spring.

### Groundwater body No. 6: “Orjen”

The groundwater body “Orjen” (ME_AB_GW_K_5) is located in the south-western part of Montenegro. It is distributed from Lipci in south to Jabuke in north, and from Jastrebica in west to Perast in east. The total area is 409.6, of which even 407.3 $km^2$ is karst.

The area is represented by hilly-mountainous terrains, with elevations from 0 m.a.s.l. along the coast to 1,894 m.a.s.l. at the top of Orjen Mountain. There are numerous surface and subsurface karst landforms in these area. It is famous by “Stone Sea” area above Risan city, where numerous deep potholes exist and quickly provide water to the submarine springs along the coast. Dolines are often densely arranged in the form of polygonal karst. Streams are very rare at the higher altitudes because the karst terrain is very permeable. There are just few periodic streams in the area of Risan and Grahovo polje. This area characterized by largest annual rainfall sum not only in Montenegro, but in entire Europe. In karstic terrains from average 3500 mm more than 80% infiltrate into aquifers.

The entire area belongs to tectonic zone “High Karst”. According to the Geological Map of Montenegro 1:200,000 the limestone and dolomite (T,J,K) have the dominant distribution. Besides the carbonate rocks, the flysch sediments (conglomerate, sandstone and marl; $T_2^1$, $E_3$), deluvium (d) and glacial sediments (gl) are also present (Fig. 6 in Annex 1).

The karst aquifer consists of karstified limestone and dolomite. The groundwater body is almost completely uncovered. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of periodic streams in the area of Grahovo polje. The mean annual precipitation amounts 3,510 mm/year. An assessed recharge rate (effective infiltration) is around 80% of precipitation rate, i.e. around 2,808 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in average. Rapid fluctuations of discharge on karst springs (in case of Sopot Qmax : Qmin > 1:100.000) indicate that the karst aquifer is very permeable and with prevailing turbulent flows. General groundwater flow direction is from NW to SE. The apparent (linear) groundwater velocity determined by one tracer test is 12.42.

**Figure 3.13 Geographical position of the groundwater body "Orien"**

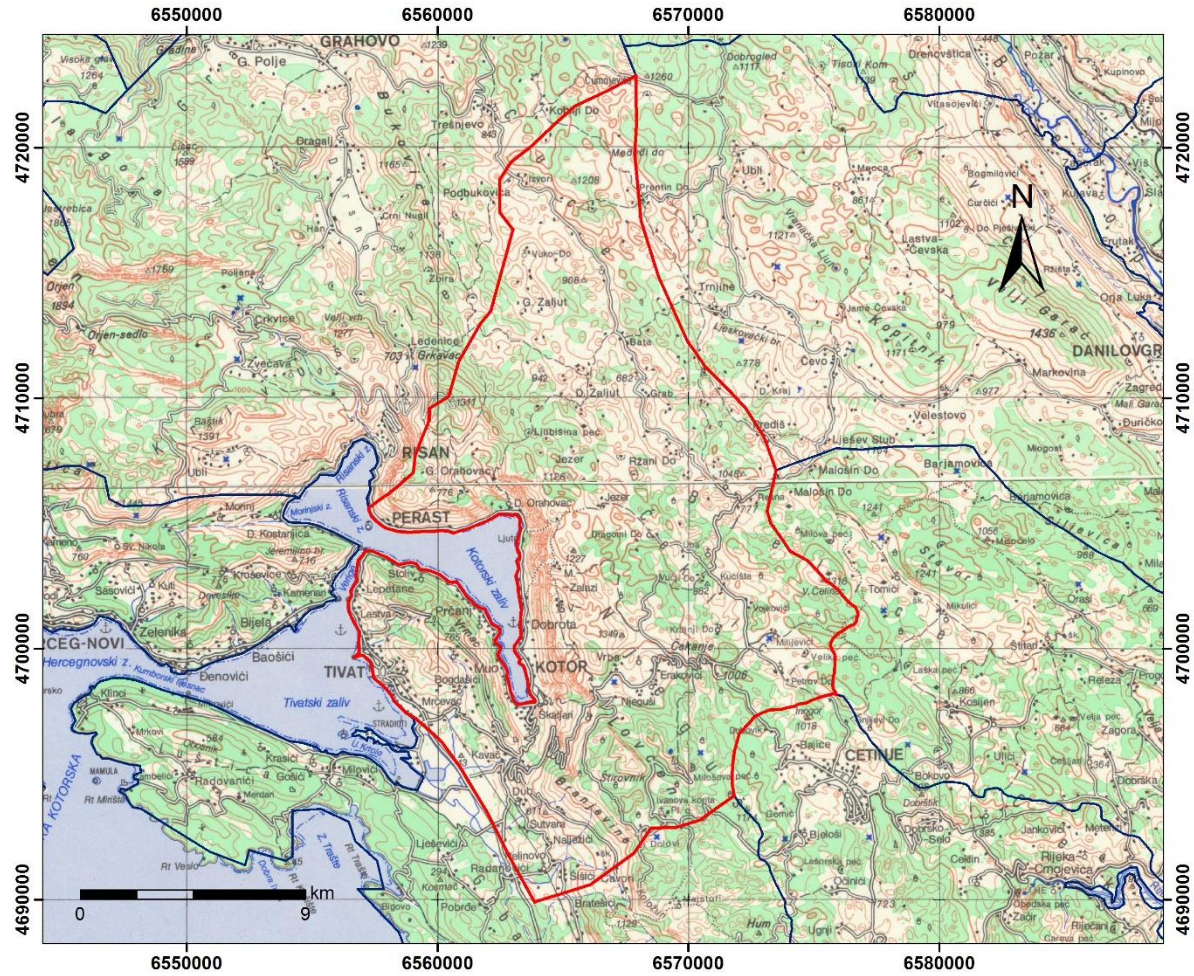

There are two strong karst springs in the Risan Bay, Sopot submarine spring ($Q_{min}$= 0.05 submarine flow; $Q_{max}$ >150 $m^3/s$, i.e. $Q_{max}$ : $Q_{min}$ > 1:100.000) and Risanska Spilja Spring ($Q_{min}$= 0; $Q_{max}$= 30 $m^3/s$), and several small springs in the area of Grahovo and Risan such as: Bljeljaj, Obodja Springs, Smokovac Spring ($Q_{min}$= 0.005 $m^3/s$), Matkova Voda, Sata Spring, Subotića Vode, Džurina Spring.

## Groundwater body No. 7: "Lovćen (Njeguši)"

The groundwater body "Lovćen (Njeguši)" (ME_AB_GW_K_6) is located in the southern part of Montenegro. It is extended from Radanovići in the south to Čumojevica in north, and from Verige in west to Resna in east. The total area is 330.2 $km^2$, of which 308 $km^2$ is karst.

The area is represented by hilly-mountainous terrains, with elevations from 0 m.a.s.l. along the coast to 1,749 m asl at the top of Lovćen Mountain. There are numerous surface and subsurface karst landforms in these area. Dolines are often densely arranged in the form of polygonal karst. Streams are very rare at the higher altitudes because the karst terrain is very permeable. Streams are only present in the area built of flysch sediments in Grbalj and background of Kotor.

**Figure 3.14 Geographical position of the groundwater body "Lovćen (Njeguši)"**




This area belongs to three tectonic zones: "Parachtone", "Budva-Cukali" and "High Karst". According to the Geological Map of Montenegro 1:200,000 the limestone, dolomite and chert (T,J,K) have the dominant distribution. Besides the carbonate rocks, the flysch sediments (conglomerate, sandstone and marl; $T_2^1$, $E_3$), deluvium (d) and glacial sediments (gl) are also present (Fig. 7 in Annex 1).

The karst aquifer is consisted of karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams. The mean annual precipitation amounts 2,370 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,659 mm/year. According to a rough assessment the depth to groundwater level in most of the mountains is over 300 m. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable and with turbulent flows. General groundwater flow direction is from E to W. The average apparent (linear) groundwater velocity determined by tracer tests is 4.4 cm/s. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: swallow hole in Ivanova Korita–Gurdić Spring (Kotor) (*v*=4.70 cm/s), swallow hole Erakovića (Njeguši)–Škurda and Gurdić Spring (Kotor) (*v*=3.80-4.04 cm/s), Duboki Do Cave (Njeguši)– Škurda Spring (Kotor) (*v*=0.09 cm/s), swallow hole Erakovića (Njeguši)–Ljuta Spring (Orahovac) (*v*=3.92 cm/s), swallow hole Koritnik (Njeguši)–Ljuta Spring (Orahovac) (*v*=2.56 cm/s), swallow hole in Trešnjevo–Ljuta Spring (Orahovac) (*v*=11.04 cm/s).

There are numerous karst springs such as: Plavda ($Q_{min}$=0.02 $m^3/s$), Spring in Tunnel Vrmac ($Q_{min}$=0.02 $m^3/s$), Gurdić ($Q_{min}$=0; $Q_{max}$=30 $m^3/s$), Škurda and Tabačina Springs ($Q_{min}$=0.1 $m^3/s$; $Q_{max}$=30 $m^3/s$), Ljuta ($Q_{min}$=0.1 $m^3/s$; $Q_{max}$=300 $m^3/s$), Cicanova Kuća Spring ($Q_{min}$=0.05 $m^3/s$).

## Groundwater body No. 8: "Orahovštica-Rijeka Crnojevića"

The group of groundwater bodies "Orahovštica-Rijeka Crnojevića" (ME_AB_GGW_C_1) is located in the southern part of Montenegro. It is distributed from Lovćen Mountain in the west to Skadar Lake in the east, and from Jankovići in the north to Paštrovska Mountain in the south. The total area is 241.3 $km^2$, of which 237.5 $km^2$ is represented by karst.

The terrains are mostly hilly-mountainous, with elevations from 5 m.a.s.l in the area around Skadar Lake to 1,749 m.a.s.l at the top of Lovćen Mountain. There are numerous karst landforms in these area. Dolines are often densely arranged in the form of polygonal karst. There is one karst polje in the northern part (Cetinje polje). Also, there is a well-developed system of karst channels which is consisted of three main caves: Cetinjska, Lipska and Obodska caves. Permanent streams are very rare at the higher altitudes because the karst terrain is very permeable. The main rivers are Orahovštica River, Poseljanska River and Crnojevića River which begins with karst springs distributed in the lower part of the GWB (western edge of Skadar Lake). Alluvial plains are present just along the Orahovštica River.

This area belongs to tectonic zone "High Karst" which is mostly built of limestone and dolomite. According to the Geological Map of Montenegro 1:200,000 the Upper Triassic limestone and dolomite ($T_3$) have the dominant distribution. Carbonate rocks are also represented by following geological units: bedded limestone with interbeds and nodules of chert and reef limestone ($T_2^2$), bedded limestone and dolomite with lithiotes and red limestone with ammonites ($J_1$), and bedded and thick bedded limestone with interbeds of chert ($K_2$). Besides the carbonate rocks the flysch sediments ($T_2^1$) and volcanic-sedimentary rocks ($T_2^2$) are also present and have role of impermeable hydrogeological barrier for groundwater flow. The Quaternary sediments are mostly distributed on areas of karst depressions (glacial and glaciofluvial deposits) and along the Orahovštica River (alluvial sediments) (Fig. 8 in Annex 1).

The karst aquifer, represented by highly karstified limestone and dolomite, has dominant distribution. A groundwater recharge mainly occurs by infiltration of atmospheric water. The karst aquifer is uncovered almost on the entire area, and impermeable rocks (flysch sediments and volcanic-sedimentary rocks) have very limited distribution. The mean annual precipitation amounts 2,853 mm/year. An assessed recharge rate (effective infiltration) is around 75% of precipitation rate, i.e. around 2,140 mm/year. According to a rough assessment the depth to groundwater level is up to 400 m, in most of mountain areas. Hydrogeological parameters indicate that the limestone and dolomite are very permeable. The recession coefficient ($\alpha$) for Crnojevića Spring ranges from 0.015 to 0.065. The apparent (linear) groundwater velocity determined by tracer tests ranges from 0.25 to 13.82 cm/s (Djordjević at al. 2010). General groundwater flow direction is from NW to SE ("Dinaric path"). The main karst springs are Podgor Spring ($Q_{min}$=0.237 $m^3/s$; $Q_{av}$=1.64 $m^3/s$; $Q_{max}$=11.9 $m^3/s$) and Crnojevića Spring ($Q_{min}$=1,12$m^3/s$; $Q_{av}$=6.15$m^3/s$; $Q_{max}$=12.26 $m^3/s$) which are located at lower altitudes (south-eastern and north –eastern part of the area). Besides these main discharge points there are few sublacustrine springs along the Skadar Lake coast (Modro Spring, Grab Spring and few nameless springs). Also, there are smaller springs at the higher altitudes such as Uganjska Spring ($Q_{av}$=10-20 l/s) and Obzovica Spring ($Q_{av}$=1 l/s).

### Figure 3.15 Geographical position of the group of groundwater bodies "Orahovštica-Rijeka Crnojevića"


Also, the alluvial aquifer is present but with limited distribution (just along the Orahovštica River). It is mainly consisted of gravel and sand with certain content of clay. The hydrodynamic conditions of this aquifer are variable, with confined conditions in parts where there is a clay layer over the saturated permeable zone. Aquifer thickness and permeability are the highest in the area of Sjenokos (T=1.52 x $10^{-2}$ – 8.0 x $10^{-2}$ $m^2/s$, $K_f$ = 1.90 x $10^{-3}$ – 1.0 x $10^{-2}$ m/s) and Orahovsko polje (T=5.0 x $10^{-3}$ – 5.0 x $10^{-2}$ $m^2/s$, $K_f$ = 3.0 x $10^{-4}$ – 3.0 x $10^{-3}$ m/s). The alluvial aquifer has very good interaction with Orahovštica River.

## Groundwater body No. 9: "Karuč-Sinjac"

The group of groundwater bodies "Karuč-Sinjac" (ME_AB_GGW_K_7) is located in the southern part of Montenegro. It is distributed from Bjelice in the northwest to Malo Blato in the southeast. The total area of the GGWB is 277.2 $km^2$.

The terrains are mostly hilly-mountainous, with elevations from 5 m.a.s.l.in the area around Skadar Lake to 1,200 m.a.s.l.in the area of Bjelice. There are numerous karst landforms in these area. Dolines are often densely arranged in the form of polygonal karst. Also, there is a well-developed system of karst channels (Volač cave, Baleškovića cave, Nova cave, Mala Jarčica cave, Velja Jarčica cave). Streams are very rare at the higher altitudes because the karst terrain is very permeable (fast percolation/infiltration of runoff water). The main rivers of this area are Bazagurska Matica and Biševina River. The first one begins from the springs of Karuč Bay, and the second one represents the outflow of Malo Blato Bay.

### Figure 3.16 Geographical position of the group of groundwater bodies "Karuč-Sinjac"


This area belongs to tectonic zone "High Karst" which is mostly built of limestone and dolomite. According to the Geological Map of Montenegro 1:200,000 only the Mesozoic (from Upper Triassic to Upper Cretaceous) limestone and dolomite are present ($T_3$, $J_1$, $J_2$, $J_3$, $K_1$, $K_2$). The Quaternary sediments are distributed just in the northern area of Malo Blato in the form of lacustrine sediments (*j*) (Fig. 9 in Annex 1).

The karst aquifer is represented by highly karstified limestone and dolomite. A groundwater recharge occurs by infiltration of atmospheric water, and there is possible recharge by infiltrated groundwater from adjacent alluvial aquifer of GWB "Zeta Valley". The karst aquifer is uncovered (unconfined) on the entire area (just thin soil layer is present). The mean annual precipitation amounts 2,700 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,890 mm/year. According to a rough assessment the depth to groundwater level is up to 400 m at most of higher altitudes, while is just a few meters closer to the Skadar Lake. Hydrogeological parameters indicate that the limestone and dolomite are very permeable ($K_f$=7.9 x $10^{-2}$ m/s; Stevanović *et al*. 2007a). The apparent (linear) groundwater velocity determined by tracer tests ranges from 0.65 to 12.5 cm/s. General groundwater flow direction is from NW to SE ("Dinaric path"). Karst springs are concentrated in two zones: Karuč Bay and Malo Blato. The following sublacustrine springs flow out into Karuč Bay: Đurovo Oko, Karuč, Volač, Studenac, Radiševo Oko, Žabino Oko, Grivo Oko and Bazagurska Spring (total discharge of springs: $Q_{min}$=2.5 $m^3/s$; Q=7 $m^3/s$; $Q_{max}$=25 $m^3/s$). Springs of Malo Blato are: Kaludjerovo Oko, Velja Šuica, Mala Šuica, Oko Krakala, Oko Bivo, Crno oko, Bolje Sestre, Oko Brodić, Biotsko oko, Oko Pod Bobovine and Krstato Oko (total discharge of springs: $Q_{min}$=5 $m^3/s$; Q=12 $m^3/s$).

### Groundwater body No. 10: "Zeta Valley"

The group of groundwater bodies "Zeta Valley" (ME_AB_GGW_I_2) is located in the central part of Montenegro. It is distributed from Zlatica in the north to Skadar Lake in the south, and from Donji Kokoti in the west to Tuzi in the east, including the capital city of Podgorica. The total area is 248.5 $km^2$.

Zeta Valley is relatively flat, with few hills ("hums") which rise from the limestone base. Elevation ranges from 5 m.a.s.l. in the area around Skadar Lake to 80 m.a.s.l. in the north-eastern part of the valley. There are five main rivers which flow through the valley: Morača, Zeta, Ribnica, Cijevna and Sitnica River. In the southern part there are many short streams such as: Plavnica, Zetica, Gostiljska River, Svinješ, Pjavnik, Velika Mrka and Mala Mrka. All of them are in hydraulic connection with glacial-fluvial sediments and indirectly with karstic aquifer in the valley base (paleo-relief).

The valley is filled by Quaternary very permeable sediments, i.e. by glaciofluvial (gravel, sand, conglomerate), alluvial (gravel, sand) and lacustrine sediments (clay, silt). The thickness of this deposit is up to 100 m. The base - bottom (paleo relief) is mostly built by limestone and dolomite (J,K), except in the southern part where marl and claystone (Pl) are distributed below the Quaternary sediments. From the tectonic point of view, this area belongs to the "High Karst" zone (Fig. 10 in Annex 1).

There are two types of aquifers in this area, intergranular (upper) and karst (lower), which are directly connected, so they can be viewed as one complex aquifer. A groundwater recharge occurs by infiltration of atmospheric and surface water. The aquifer is uncovered on the entire area of the valley (just thin layer of soil is present). The mean annual precipitation amounts 1,569 mm/year. An assessed recharge rate (effective infiltration) is around 50% of precipitation rate, i.e. around 818 mm/year. Almost the entire aquifer has unconfined groundwater flow, except in the southern part of the valley. The depth to groundwater level is around 15 m in average. General groundwater flow direction is from N to S. Hydrogeological parameters indicate that the intergranular aquifer has very good permeability (T=1.79 x $10^{-2}$ $m^2/s$, $K_f$ = 5.0 x $10^{-3}$ /s). Some of the tested wells near Tuzi have a largest recorded discharge in the country, more than 100 l/s with just a few meters of drawdown. The natural discharge of the intergranular aquifer occurs through the springs of following short streams: Plavnica, Zetica, Gostiljska River, Svinješ, Pjavnik, Velika Mrka, Mala Mrka, and many other nameless streams. The total assessed discharge is around 12 $m^3/s$.

**Figure 3.17 Geographical position of the group of groundwater bodies “Zeta Valley”**


## Groundwater body No. 11: “Prekornica - Bjelopavlići”

The group of groundwater bodies “Prekornica - Bjelopavlići” (ME_AB_GGW_C_2) is located in the central part of Montenegro. It is distributed from Zeta Valley in the southeast to Mijokusovići in the northwest, and from Frutak in the southwest to Brajovićka Ponikvica in the northeast. The total area is 418 km$^2$, of which 319 km$^2$ is karst.

The area is represented by hilly-mountainous terrains and valleys, with elevations from 31 m.a.s.l in the area of Mareza to 1,559 m.a.s.l at the top of Maglić Mountain. There are numerous surface and subsurface karst landforms in area of Prekornica. Dolines are often densely arranged in the form of polygonal karst. Streams are very rare at the higher altitudes because the karst terrain is very permeable and surface water is infiltrating fast over numerous ponors (swallow holes), but dense river network exists along Zeta River and Bjelopavlića Valley (Figure 3.18).

This area belongs to tectonic zone “High Karst”. According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite ($T_3$, $J_1$, $J_{2,3}$, $K_1$, $K_{2,3}$) have the dominant distribution. Besides the carbonate rocks, the Upper Eocene flysch sediments (conglomerate, sandstone, aleurolite, limestone and marl) are also present. Bjelopavlića Valley is filled by Quaternary clay and sand. Glacial sediments have limited distribution at the higher altitudes.

The karst aquifer is represented by highly karstified limestone and dolomite (Fig. 11 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water and partly via sinking streams. The karst aquifer is uncovered in the area of Prekornica, but it is covered by Eocene flysch (average thickness around 150 m) and Quaternary sediments (average thickness around 50 m) in the area of Bjelopavlićka Valley and its margins. The mean annual precipitation amounts 2,200 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,540 mm/year. According to a rough assessment the depth to groundwater level is over 300 m at higher altitudes, and less than 10m in the valley. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. The apparent (linear) groundwater velocity determined by tracer tests ranges from 0.5 to 3.4 cm/s (the hydraulic connection between swallow holes in Zorski Lug and Kraljičino Oko Spring). General groundwater flow direction is from NE to SW.

### Figure 3.18 Geographical position of the group of groundwater bodies “Prekornica - Bjelopavlići”

Intergranular aquifer is represented by glacial sediments distributed on the area of Radovče and Kopilje, but quantity of groundwater accumulated within these aquifers is very limited.

Karst springs are mostly concentrated along the north-eastern edge of Bjelopavlićka Valley. The main karst springs are: Mareza ($Q_{min}$=1.6 $m^3$/s, $Q_{av}$≈6 $m^3$/s; $Q_{max}$≈12 $m^3$/s), Kraljičino Oko Sprig ($Q_{min}$≈0.020 $m^3$/s; $Q_{max}$≈1 $m^3$/s), Crno Oko Spring, Vriješki Spring, Straganica springs, Iverak Spring ($Q_{av}$≈0.012 $m^3$/s), Studeno Spring (Q≈0.001 $m^3$/s), Žarića Jama Spring ($Q_{min}$=0; $Q_{max}$≈1 $m^3$/s), Braovića Jama Spring, Slatina Springs ($Q_{min}$=0.015 $m^3$/s, $Q_{av}$≈0.076 $m^3$/s; $Q_{max}$≈0.2 $m^3$/s), Smrdan Spring, Viški Springs.

## Groundwater body No. 12: "Garač"

The group of groundwater bodies "Garač" (ME_AB_GGW_K_8) is located in the central part of Montenegro. It is distributed from Ilijina Strana in the northwest to Zelenika in the southeast, and from Lipa in the west to Bjelopavlićka Valley in the east. The total area is 338.4 $km^2$, of which 335.2 $km^2$ is represented by karst.

The terrains are mostly hilly-mountainous, with elevations from 32 m.a.s.l. in the area of Komanski Bridge to 1,436 m.a.s.l. at the top of Garač Mountain. There are numerous surface and subsurface karst landforms in these area. Dolines are often densely arranged in the form of polygonal karst. Streams are very rare at the higher altitudes because the karst terrain is very permeable. The only one periodical stream is Gračanica. It begins on the flysch sediments near Bogmilovići.

This area belongs to tectonic zone "High Karst" which is mostly built of limestone and dolomite. According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite ($J_1$, $J_{2,3}$, $K_1$, $K_2$) have the dominant distribution. Besides the carbonate rocks, the Upper Eocene flysch sediments (conglomerate, sandstone, alevrolite, limestone and marl) are also present but their distribution is very limited (Fig. 12 in Annex 1).

The karst aquifer is represented by highly karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water. The karst aquifer is uncovered almost on the entire area, and impermeable rocks (flysch sediments) have very limited distribution. The mean annual precipitation amounts 2,246 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,572 mm/year. According to a rough assessment the depth to groundwater level is up to 400 m. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. The apparent (linear) groundwater velocity determined by tracer test was 5.34 cm/s (the hydraulic connection between swallow hole on Čevo and Oraška Jama Spring was established). General groundwater flow direction is from NW to SE ("Dinaric path").

Karst springs are mostly concentrated in three zones: Tunjevo, Sušica River and Bandići. The following springs are located near Tunjevo: Milojevića Spring ($Q_{min}$=0.05 $m^3$/s, $Q_{max}$≈20 $m^3$/s), Dobrik Spring ($Q_{min}$=0.005 $m^3$/s, $Q_{max}$≈0.1 $m^3$/s) and Tunjevo Spring. Periodical springs which flow out along the Sušica River are: Oraška Jama, Šabovo Oko, Grgurovo Oko, Žablje Oko, Modro Oko (total discharge: $Q_{min}$= 0 $m^3$/s, $Q_{max}$≈10 $m^3$/s). Periodical springs distributed in the area of Bandići are: Vučiji Studenac, Modro Oko, Oko Kručice, Blizanci (total discharge: $Q_{min}$= 0 $m^3$/s, $Q_{max}$≈10 $m^3$/s). Besides these springs of Bjelopavlića Valley (32-50 m asl), there are few small springs distributed on higher altitudes such as Orlujna (Čevo) Spring (Q=0.5 l/s) and Ćurkovac (Selišta).

### Figure 3.19 Geographical position of the group of groundwater bodies "Garač"


## Groundwater body No. 13: "Vojnik"

The group of groundwater bodies "Vojnik" (ME_AB_GGW_K_9) is located in the western part of Montenegro. It is distributed from Nikšićko polje edge and Vidrovan in the south to Vojnik in the north, and from Goslić in the west to Gackove Grede in the east. The total area is 448.5 km$^2$, of which 423 km$^2$ is karst.

The area is represented by hilly-mountainous terrains, with elevations from 650 m.a.s.l. in the area of Gornje Polje to 1,998 m.a.s.l. at the top of Vojnik Mountain. There are numerous surface and subsurface karst landforms in this area. Streams are very rare at the higher altitudes because the karst terrain is very permeable (just one periodic stream exists, Vidrovan (Surdup) River), but there is a dense river network in Gornje Polje.

This area belongs to tectonic zone "High Karst". According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution. Besides the carbonate rocks, the Cretaceous-Paleogene (K,Pg) flysch sediments (marlstone, claystone and marly limestone) are present along the Duga pass. Also, the glacial sediments are distributed in the area of Krnovo and Šipačno (Fig. 13 in Annex 1).

### Figure 3.20 Geographical position of the group of groundwater bodies "Vojnik"


The karst aquifer is represented by highly karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of Vidrovan River. The karst aquifer is mostly uncovered (just small part of this area is covered by the flysch and glacial sediments). The mean annual precipitation amounts 2,054 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,438 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the hilly mountain catchment area of springs. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. Hydraulic connection of swallow hole in the riverbed of Vidrovan River with Zoja and Rastovac Springs was registered. The apparent (linear) groundwater velocity determined by one tracer test is 0.37 cm/s. General groundwater flow direction is from N to S.

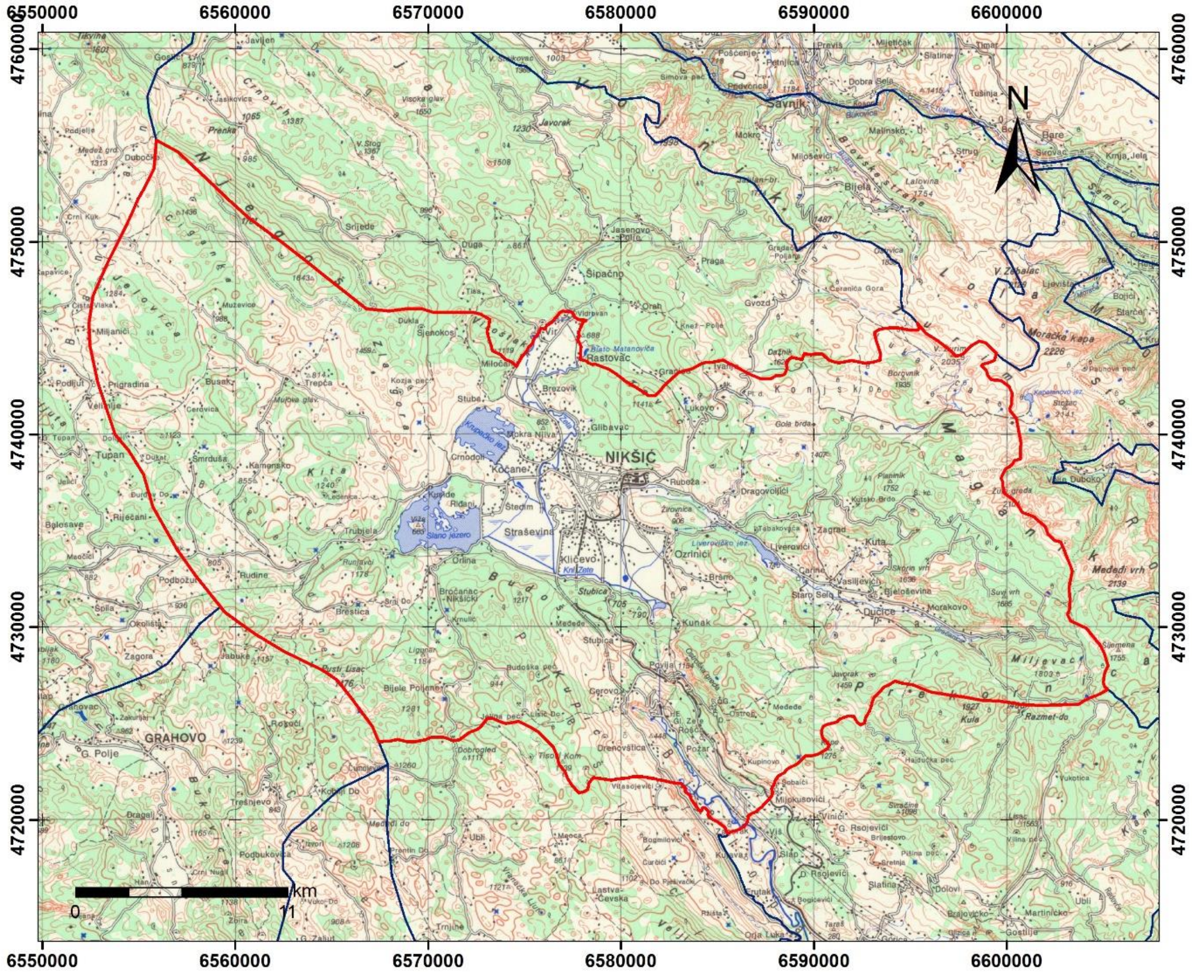
The karst springs are distributed along the northern edge of Gornje Polje. There are several strong karst springs such as: Upper Vidrovan Spring ($Q_{min}$= 0.2 $m^3$/s; Qmax≈10 $m^3$/s), Lower Vidrovan Spring ($Q_{min}$= 0.15 $m^3$/s; Qmax≈5 $m^3$/s), Vukov Spring ($Q_{min}$= 0.33 $m^3$/s), Zoja Spring, Rastovac Spring ($Q_{min}$= 0.2 $m^3$/s), Gornjepoljski Spring.

## Groundwater body No. 14: "Nikšićko polje"

The group of groundwater bodies "Nikšićko polje" (ME_A_GGW_C_3) is located in the western part of Montenegro. It is distributed from Mijokusovići in the south to Vidrovan in the north, and from Miljanići (Banjani) in the west to Maganik in the east. The total area is 990.2 km$^2$, of which 938.2 km$^2$ is karst.

The area is represented by hilly-mountainous terrains and valleys, with elevations from 50 m.a.s.l in the area of Glava Zete to 2,124 m.a.s.l in the area of Maganik Mountain. There are numerous surface and subsurface karst landforms within catchment area of Nikšić Polje. Streams are very rare at the higher altitudes because the karst terrain is very permeable, but there is a dense river network in Nikšić Polje, Župa and Bjelopavlića Valley.

### Figure 3.21 Geographical position of the group of groundwater bodies "Nikšićko polje"




This area belongs to tectonic zone "High Karst". According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution. Besides the carbonate rocks, the Cretaceous-Paleogene (K,Pg) flysch sediments (marlstone, claystone and marly limestone) are also present. Nikšić Polje is filled by limno-glacial and glacial sediments consisted of clay, sand and gravel (Fig. 14 in Annex 1).

The karst aquifer is represented by highly karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of Zeta River, Gračanica River, Mrkošnica, Grabovik. The karst aquifer is mostly uncovered in the catchment area surrounding the Nikšić Polje (just small part of this area is covered by the flysch), but in the areas of Nikšić Polje and Bjelopavlićka Valley the karst aquifer is covered by Quaternary sediments clay, sand and gravel (average thickness around 20 m). The mean annual precipitation amounts 1,941 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,359 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the catchment area above the Nikšić Polje, and around 20 m within the Nikšić Polje itself. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. The average apparent (linear) groundwater velocity determined by tracer tests is 3 cm/s. General groundwater flow direction is from NW to SE. Glava Zete and Obošničko Oko Springs represents the main discharge points.

Intergranular aquifer is represented by limno-glacial, glacial and alluvial sediments distributed in the area of Nikšić Polje and along the Gračanica River. Groundwater from this aquifer is used for irrigation and water supply of households.

There are many karst springs within this GGWB such as: Poklonci and Blaca Springs ($Q_{min}$=0.3 $m^3/s$), Studenački Spring ($Q_{min}$=0.05 $m^3/s$), Mrkošnica Spring, Krupačko Oko Spring ($Q_{min}$=0.13 $m^3/s$), Zminac and Žabica Springs ($Q_{min}$=0.1 $m^3/s$), Kusidska Springs, Slansko Oko Spring, Manito Oko Spring, Stružica and Krbanja Springs ($Q_{av}$=6.5 $m^3/s$), Bistrica Spring, Glibavačka Springs, Obošničko Oko Spring ($Q_{min}$=0.1 $m^3/s$), Glava Zete Spring ($Q_{min}$=3 $m^3/s$; Qmax=30 $m^3/s$), Svinjički Springs, Dobropoljski Springs ($Q_{min}$= 1 $m^3/s$; Qmax≈5 $m^3/s$).

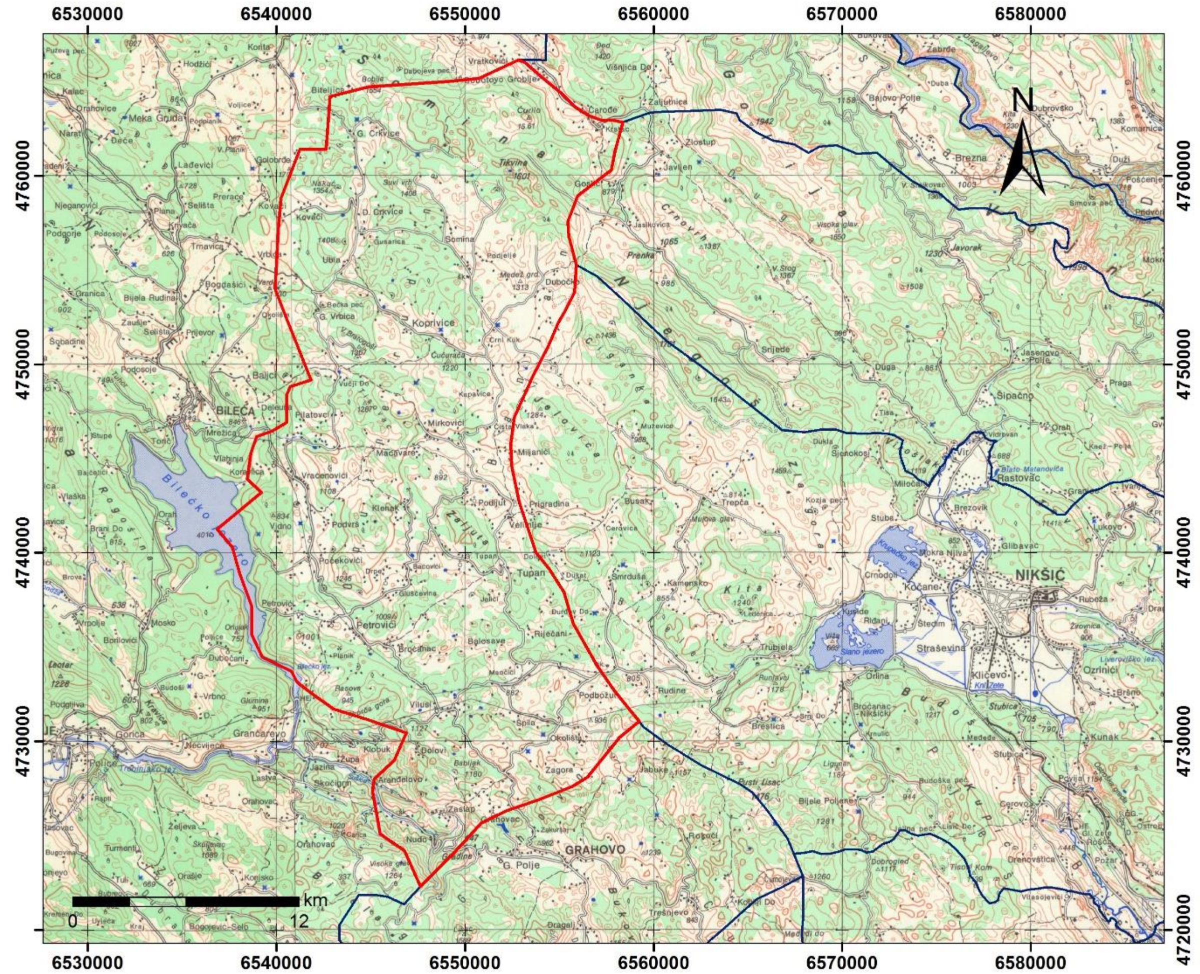
## Groundwater body No. 15: “Trebišnjica (Bilećko Lake)”

The group of groundwater bodies of transboundary character “Trebišnjica (Bilećko Lake)” (ME_AB_GGW_K_10) is located in the most western part of Montenegro. It is distributed from Jabuke in the south to Čarađe in the north, and from Miljanići (Banjani) in the east to Bilećko Lake in the west. The total area is 675.5 $km^2$, of which large majority or 667.5 $km^2$ is karst.

The area is represented by hilly-mountainous terrains, karst plateaus (Banjani) and canyons (Nudo). An elevation ranges from 347 m.a.s.l in the area of Nudo to 1,596 m.a.s.l at the top of Kape Mountain. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. Streams are very rare at the higher altitudes because the karst terrain is highly permeable. Permanent streams are present just in the area of Nudo (Zaslapnica River, Sušica River).

This area belongs to tectonic zone “High Karst”. According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution. Besides the carbonate rocks, the Cretaceous-Paleogene (K,Pg) flysch sediments (marlstone, claystone and marly limestone) are present in the area of Čarađe (Krstac), but their distribution is very limited (Fig. 15 in Annex 1).

**Figure 3.22 Geographical position of the group of groundwater bodies "Trebišnjica (Bilećko Lake)"**




The karst aquifer is represented by highly karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of small streams in the area of Čarađe. The karst aquifer is mostly uncovered / unconfined (just small part of this area is covered by the flysch). The mean annual precipitation amounts 1,578 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,105 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the hilly catchment area of springs. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. Hydraulic connection of swallow hole in Čarađe with springs in Fatničko polje and Sinjac Spring (Piva) was registered. The apparent (linear) groundwater velocity determined by the tracer test is 0.63-0.68 cm/s. General groundwater flow direction is from E to W.

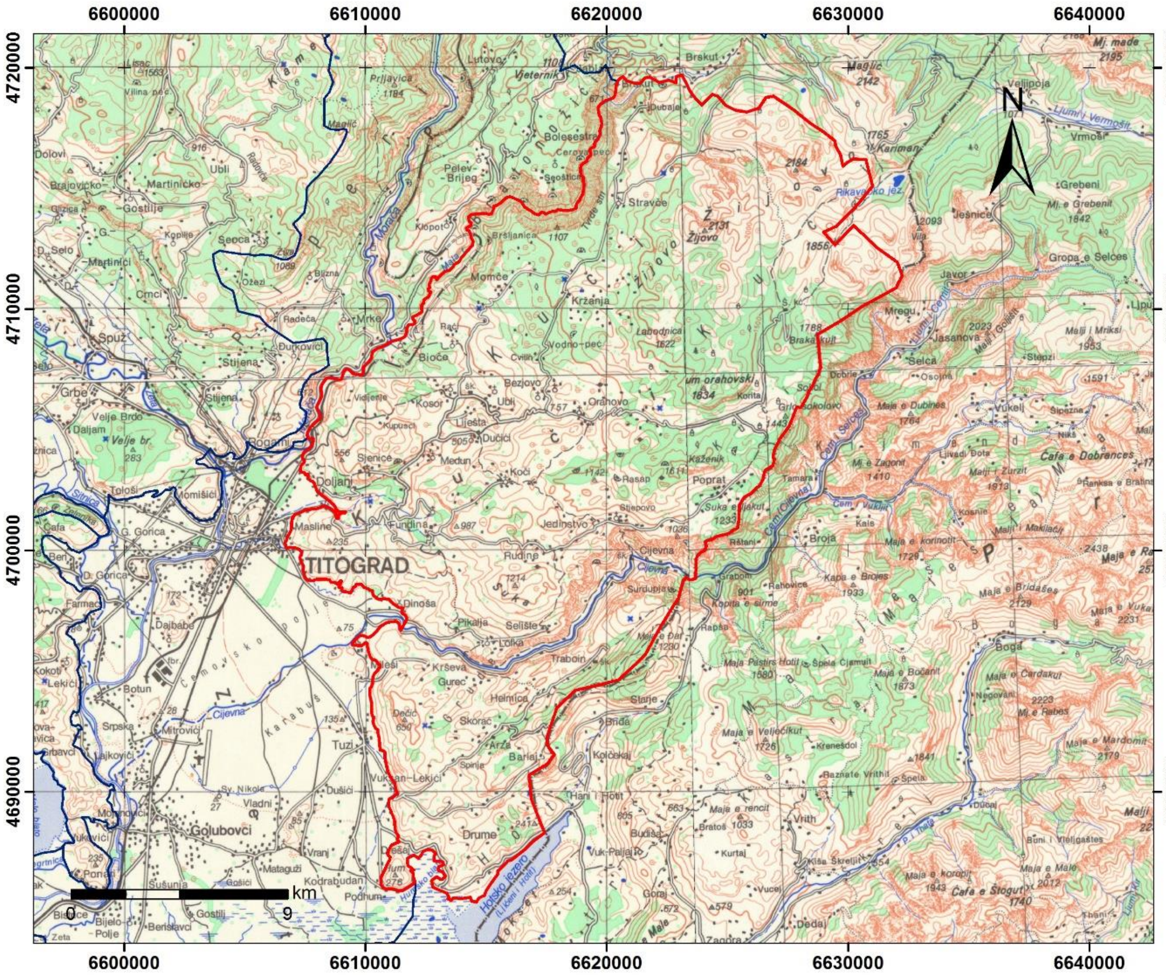
The karst springs are distributed in the area of Nudo, Čarađe and Bilećko Lake. There are several karst springs in the area of Nudo such as: Zaslapnica Spring ($Q_{min}$ =54 l/s; $Q_{av}$=168 l/s; $Q_{max}$=1381 l/s; Janković 2008); Crni Virovi; Zvjernica Spring; Bara Spring; Račevina Spring ($Q_{min}$=20 l/s), Močila Spring, Korita Spring; Česmine, Nozdre Spring, Sige Spring and Mora Spring. In the area of Čarađe there are few small springs such as: Čarađe Spring ($Q_{min}$≈1 l/s), Mali Sopot, Veliki Sopot and Ogradenac Spring. Along the north-eastern coast of Bilećko Lake (territory of Bosnia and Hercegovina) there are few strong karst springs which drain a part of this GGWB such as the source of Trebišnjica River near Bileća

### Groundwater body No. 16: "Kuči"

The group of transboundary groundwater bodies "Kuči" (ME_AB_GGW_C_4) is located in the central and southeastern part of Montenegro. It is distributed from Zeta Valley in the west to Korita Kučka in the east, and from Brskut in the north to Skadar Lake in the south. The total area is 430.8 km$^2$, of which large majority or 424.2 km$^2$ is karst.

The area is represented by hilly-mountainous terrains, with elevations from 5 m.a.s.l along the Skadar Lake coast to 2,184 m.a.s.l at the top of Surdup Mountain. There are numerous surface and subsurface karst landforms. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Cijevna River, Ribnica, Morača and Mala River, and there are periodic Vrbički stream. Permanent streams are very rare at the higher altitudes because the karst terrain is very permeable.

**Figure 3.23 Geographical position of the group of groundwater bodies "Kuči"**



This area belongs to tectonic zone "High Karst". According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution. Besides the carbonate rocks, the flysch sediments ($E_2$), represented by conglomerate, sandstone, alevrolite, limestone and marl, are distributed in the area of Fundina. Glacial sediments cover carbonate rocks in uvalas such as: Stravče, Kržanja and Kučka Korita. Glacio-fluvial sediments have limited distribution along Mala River and Cijevna River (Fig. 16 in Annex 1).

The karst aquifer is represented by highly karstified Mesozoic limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of Cijevna and Mala River. The karst aquifer of this GGWB is mostly uncovered / unconfined (just small part of this area is covered by the flysch, glacial and glacio-fluvial sediments). The mean annual precipitation amounts 2,344 mm/year (precipitation station "Orahovo"). An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,640 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in hilly areas, except along Cijevna, Morača and Mala River, and along the edge of Zeta Valley, where groundwater level is much shallower, just a few meters below surface. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. The average apparent (linear) groundwater velocity determined by tracer tests is 2.4 cm/s. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: swallow holes in the canyon of Cijevna River (close to Dinoša)–Mileš Spring, Krvenica Spring, Vitoja Spring ($v$=2.05-3.07 cm/s); swallow holes in the canyon of Cijevna River (close to Dinoša)–Ribnica Springs ($v$=0.87 cm/s), Dugačko Lake – Springs in canyon of Mala River ($v$=3.2 cm/s), swallow hole on Žijovo Mountain-Bare Spring (Mala River) ($v$=3.1 cm/s). General groundwater flow direction is from E to W, with the exception for the area between Cijevna River and Skadar Lake where general groundwater flow direction is from N to S.

Intergranular aquifer is represented by fluvio-glacial and alluvial sediments distributed along the Cijevna, Morača and Mala River. The main intergranular aquifer is on the mouth of Morača and Mala River. Groundwater of this aquifer is pumped from wells for the water-supply of Kuči. Also, groundwater can be accumulated within glacial sediments, but those aquifers are very limited in terms of its distribution and quantity of water (e.g. Kržanja intergranular aquifer). Glacial aquifers are used just for the purposes of several households.

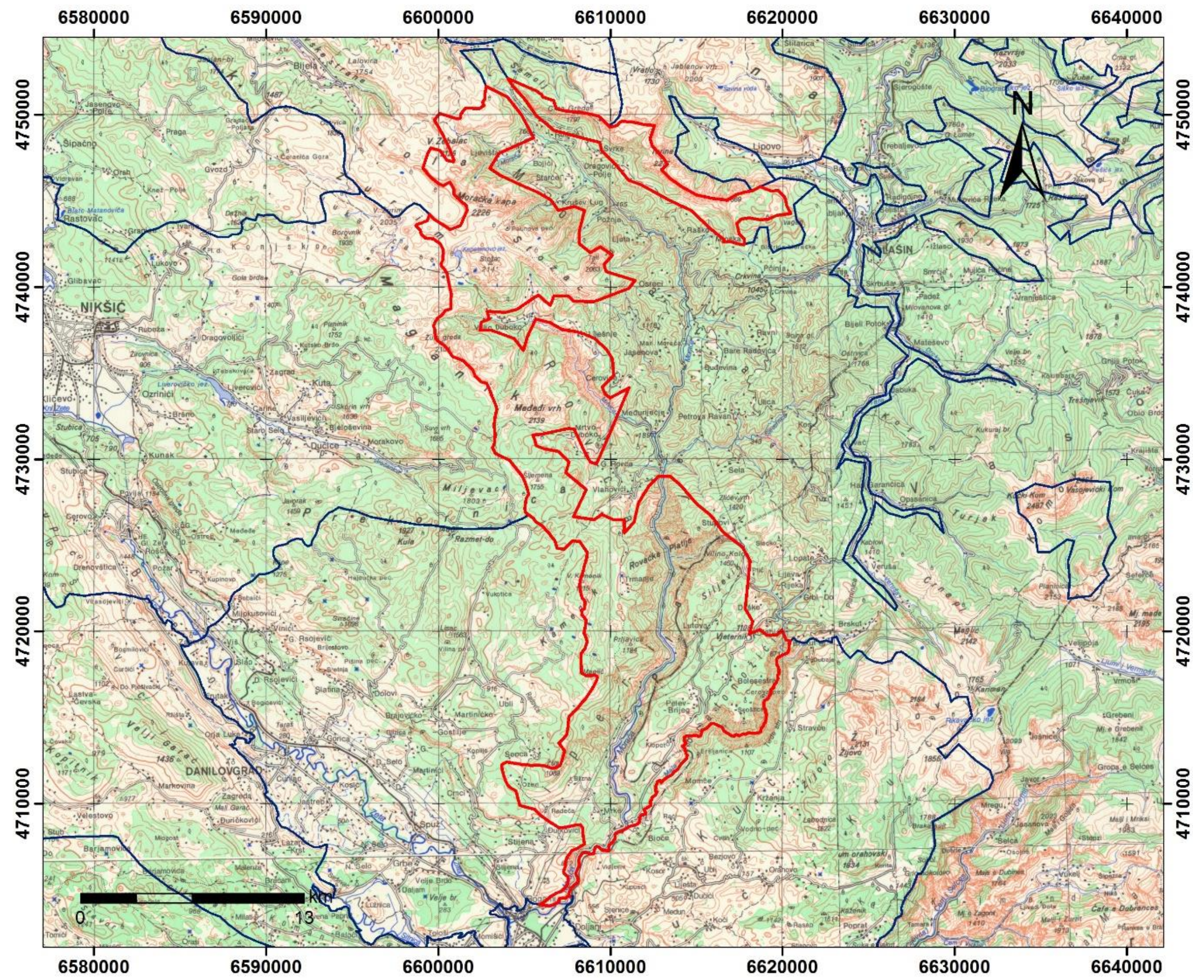
There are many karst springs within this GGWB such as: Ribnica Springs ($Q_{min}$≈0.01 $m^3$/s; $Q_{max}$≈100 $m^3$/s); Milješ Sring ($Q_{min}$= 0; $Q_{max}$≈2 $m^3$/s), Krvenica Spring ($Q_{min}$= 0; $Q_{max}$≈10 $m^3$/s; Vitoja Spring ($Q_{min}$≈0.01); Traboin Springs ($Q_{min}$≈0.002; $Q_{max}$≈0.1 $m^3$/s); Fundina Springs ($Q_{min}$≈0.001 $m^3$/s); Springs in canyon of Cijevna River; Springs in canyon of Mala River.

### Groundwater body No. 17: "Morača"

The group of groundwater bodies "Morača" (ME_AB_GGW_K_11) is located in the central part of Montenegro. It is distributed from Smokovac in the south to Gornja Morača in the north, and from Maganik Mountain in the west to Vjeternik Mountain in the east. The total area is 355.2 $km^2$.

The area is represented by hilly-mountainous terrains and valleys, with elevations from 60 m asl (Smokovac) to 2,135 m asl (the top of Maganik Mountain). There are numerous surface and subsurface karst landforms. Dolines are often densely arranged in the form of polygonal karst. The main rivers are: Morača River, Mala River and Mrtvica River, but streams are very rare at the higher altitudes because the karst terrain is very permeable.

### Figure 3.24 Geographical position of the group of groundwater bodies "Morača"




This area belongs to tectonic zone "High Karst". According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution. Besides the carbonate rocks, the glacial and glacio-fluvial sediments are present, but their distribution is very limited. The impermeable flysch of Upper Morača represented by claystone, marlstone, sandstone, breccia and conglomerate (K, Pg) is excluded from this group of groundwater bodies because it is not classified as aquifer (Fig. 17 in Annex 1).

The karst aquifer is represented by highly karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of Morača and Mala River. The karst aquifer of this GGWB is mostly uncovered, and thus unconfined (just small part of this area is covered by the glacial and glacio-fluvial sediments). The mean annual precipitation amounts 1,925 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,347 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in hilly areas, except along Morača, Mrtvica and Mala River where groundwater level is much shallower. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. The average apparent (linear) groundwater velocity determined by tracer tests is around 2 cm/s. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: Dugačko Lake–Springs in canyon of Mala River ($v$=3.2 cm/s), swallow hole on Žijovo

Mountain–Bare Spring (Mala River) (*v*=3.1 cm/s), estavelle at Monastery mill–Spring at Piletića household (between Zlatica and Bioče) (*v*=1.55-1.64 cm/s), Lazbe Kolovratske Estavelle–Spring at Piletića household (between Zlatica and Bioče) (*v*=0.35-0.89 cm/s), swallow hole on Semolj Mountain–Simov Spring (Gornja Morača) (*v*=1.25 cm/s). General groundwater flow direction is from W to E on the left side of Morača River and E to W on the right river side.

Intergranular aquifer is represented by fluvio-glacial and alluvial sediments distributed along the Morača, Mrtvica and Mala River. Groundwater can also be accumulated within glacial sediments, but those aquifers are very limited in terms of its distribution and quantity of water. Intergranular aquifers are used just for the purposes of several households.

There are many karst springs within this GGWB such as: Bijeli Nerini Springs ($Q_{min}$= 0.5 $m^3/s$), Svetigora Spring (Monastery Morača), Springs under Vjetrina, Lanjevik Spring, Spring at Piletića household, Bešića Spring, Smokovac Spring, Kaludjer Spring, Bare Spring, Springs in canyon of Mala River, Simov Spring.

## 3.5 Hydrological considerations

There are three basic issues in relation to the achievement of the goals of the Water Framework Directive that are clearly linked to hydrological measurements, namely: (i) Quantification of water balance dynamics for both surface and groundwaters for a defined spatial scale (in this case, River Basins or sub-basins) and temporal scale (from days to years), (ii) Environmental flows, which describe the timing and quality of water flows, including groundwater interactions that are required to sustain freshwater ecosystems, through which water managers strive to achieve a flow regime that provides for agreed water uses, whilst maintaining the river ecosystem, and (iii) flood risk management, which requires the use of long term hydrological and meteorological data sets and complex modelling to predict specific areas of inundation. The latter point is not covered in this RBMP and is the subject of further work currently planned to be carried out in Montenegro during 2019-2022.

Monitoring and measuring of hydro-meteorological occurrences in the Adriatic River Basin is officially conducted by the hydro-meteorological service (IHMS). There is a network of 11 hydrological stations currently in operation although this will be increased to 19 stations during late 2019 (See Section 6.2.2).

Efforts have previously been made in Montenegro to invest in the development of a hydrological forecasting model with daily time-step for forecasting of the major hydro-profiles[21]. The model is however not currently calibrated for the Adriatic River Basin.

The developed model is composed of a series of hydrological system elements describing natural phenomena and processes in simple terms. Calculation of rainfall transformation into runoff on selected hydraulic profiles was conceptualized to simulate vertical water streaming and formation of subsurface and surface runoff. Input values are rainfall and meteorological parameters, while the output is subsurface and surface runoff on characteristic hydraulic profiles. Vertical water balance is calculated in distributed manner for the entire basin area.

A very good statistical relationship has been demonstrated for the observed and modelled data for high and medium discharges. The study of low discharges of the river course is of particular importance

[21] Support to water resources management in the Drina River Basin, World Bank (2016)

for all branches of water management and of special importance for river course quality protection, where low discharges are defined as 95% guarantee of the minimum monthly discharge.

The annual discharge trend and periodicity analysis suggests that long-term changes are taking place on all hydrological stations in the Adriatic River Basin, and that they exert significant influence on estimation of average discharges. Discharge downtrends were registered on all stations for the period from 1948 to 2014. The majority of hydrological stations registered negative annual discharge trends, which is in line with the basins of South-East Europe.

Table 3.10 provides the numerical regime indicators for water regime in the Adriatic River Basin, including the sub-basin areas, the period of analysis together with the minimum and the mean and maximum annual discharges (Q). Table 3.11 highlights the characteristic elevations for Skadar lake and the Bojana River.

### Table 3.10 Long term analysis of hydrological stations in the Adriatic River Basin

| Water course | Station Name | Surface Area ($km^2$) | Period of Analysis | Characteristic water flows ($m^3/s$) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | $Q_{min}$ | $Q_{min\ sr}$ | $Q_{sr}$ | $Q_{maxsr}$ | $Q_{max}$ |
| Morača | Pernica | 440.9 | 1956-2014 | 1.14 | 3.29 | 29.04 | 428.7 | 812 |
| | Zlatica | 985.3 | 1983-2012 | 0 | 1.619 | 59.64 | 885.6 | 1,369 |
| | Podgorica | 2,628 | 1948-2014 | 7.93 | 15.78 | 159 | 1,261 | 2,073 |
| Zeta | Duklov Most | 342.2 | 1955-2014 | 0.07 | 0.271 | 18.9 | 182.9 | 286 |
| | Danilovgrad | 1,215.8 | 1948-2000 | 4.68 | 7.99 | 77.9 | 278.2 | 577 |
| Rijeka Crnojevica | Brodska Njiva | 79.3 | 1987-2002 | 0.458 | 0.676 | 6.25 | 153.9 | 228 |

### Table 3.11 Characteristic elevation in Skadar Lake and the Bojana River

| Water course | Station Name | Surface Area ($km^2$) | Period of Analysis | Characteristic elevations (a.s.l.) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | $H_{min}$ | $H_{min\ sr}$ | $H_{sr}$ | $H_{maxsr}$ | $H_{max}$ |
| Skadar lake | Plavnica | 4,179 | 1948-2014 | 4.54 | 5.107 | 6.421 | 8.444 | **10.4** |
| Bojana | Fraskanjel | 16,520 | 1960-2014 | 0.019 | 0.469 | 1.816 | 4.764 | 6.359 |

Graphical illustrations of multiyear average monthly, as well as the minimum and maximum annual water flows for each hydrological station (HS) for the stations analysed in Table 3.9 are shown below in Figures 3.25 to 3.28.

## Zeta River

Water shortage for the river of Zeta occurs in July-August-September. The absolute minimum water flows are registered in August. The period with most quantities of water for the upper stream of river of Zeta (HS Duklo) is November-December and also April. In terms of lower stream of river of Zeta (HS Danilovgrad), the high water period is between November and December (Figure 3.25).

## Morača River

Water shortage in Morača River occurs between July-August-September. The absolute minimum flow, at all hydrological stations, are registered in August, whereas in hydrological station Zlatica there are periods when the riverbed goes completely dry. The maximum flows at hydrological station Podgorica are registered in November and December, while in the upper flow, i.e. at HS Pernica the greatest water amount is in April and May. In HS Zlatica there are two water periods, i.e. November-December and April-May.

Figure 3.26 shows that the trend of mean annual water flows at HS Podgorica at river of Morača for the entire monitoring period. As one can see from the Figure, ever since 1983 there is a negative trend of mean annual water flows. Mean annual water flow for the period 1948-1983. (36 years ) is 166.3 $m^3/s$, and for the period 1986-2014 (31 years) is 149.7 $m^3/s$. The difference in water quantities in these two periods is some 10%.

HS Podgorica at river of Morača controls over 55% waters flowing to Skadar lake. HS Plavnica is the only HS at Skadar lake at which the monitoring runs continuously ever since the establishment of hydrological station in 1948.

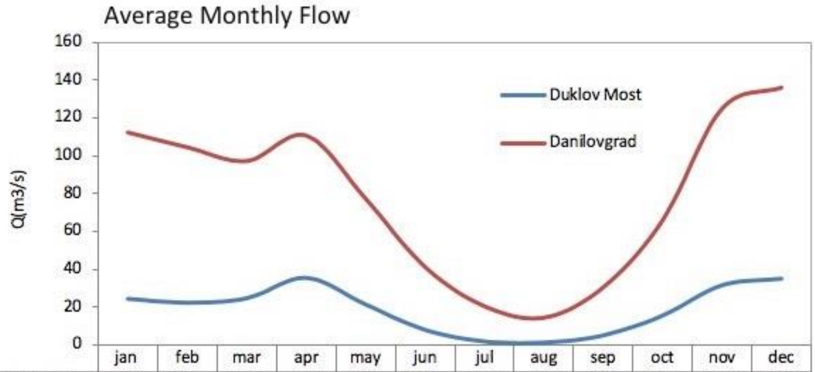
The lowest water levels at the lake are in peirod August-September, and the highest are in period December-January. Maximum water level was registered in 2010 was the concequence of many factors coming together at the same time: starting from extreme rainfall to inadequate management of accumulations in river of Drim in Albania.

Figure 3.27 shows the trends of the average annual elevations at HS Plavnica at Skadar lake, for the entire monitoring period. Same as HS Podgorica, the negative trend of the average annual elevations begins in 1983. It is not so prominent, so we can say that there are no great variations from the usual periodical dry and wet season.

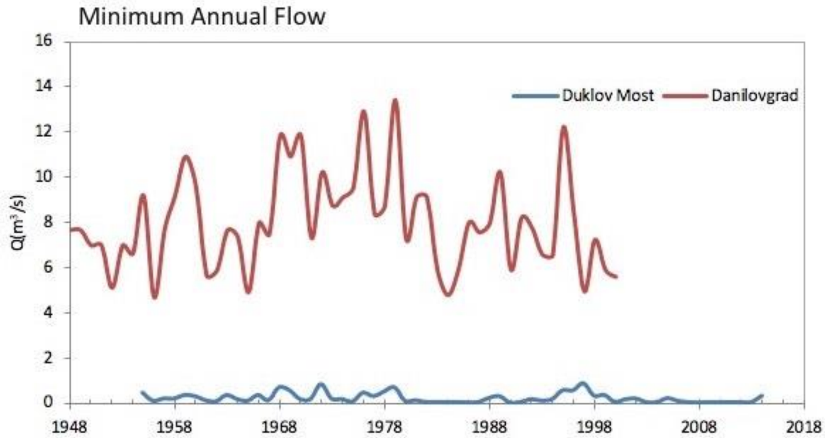
## River of Bojana

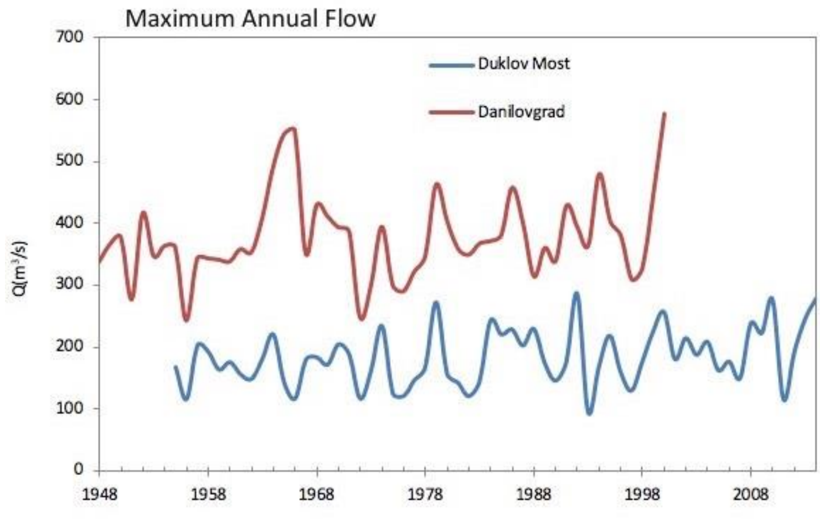
Water shortage at HS Fraskanjel is during July-August-September, while the high water level occurs from December to May (Figure 3.28). The trend of average annual water levels at HS Fraskanjel is also negative. This hydrological station has been established in 1960, so we have analysed data from the period 1960-2014. Negative trend starts in 1985, which is, in comparison to two previous HSs (HS Podgorica and HS Plavnica) consequence of different period of analysis. Analysis for river of Bojana, until now, had been only been based on monitored water levels, which is insufficient.

## Figure 3.25 Water Flows in the Zeta Basin

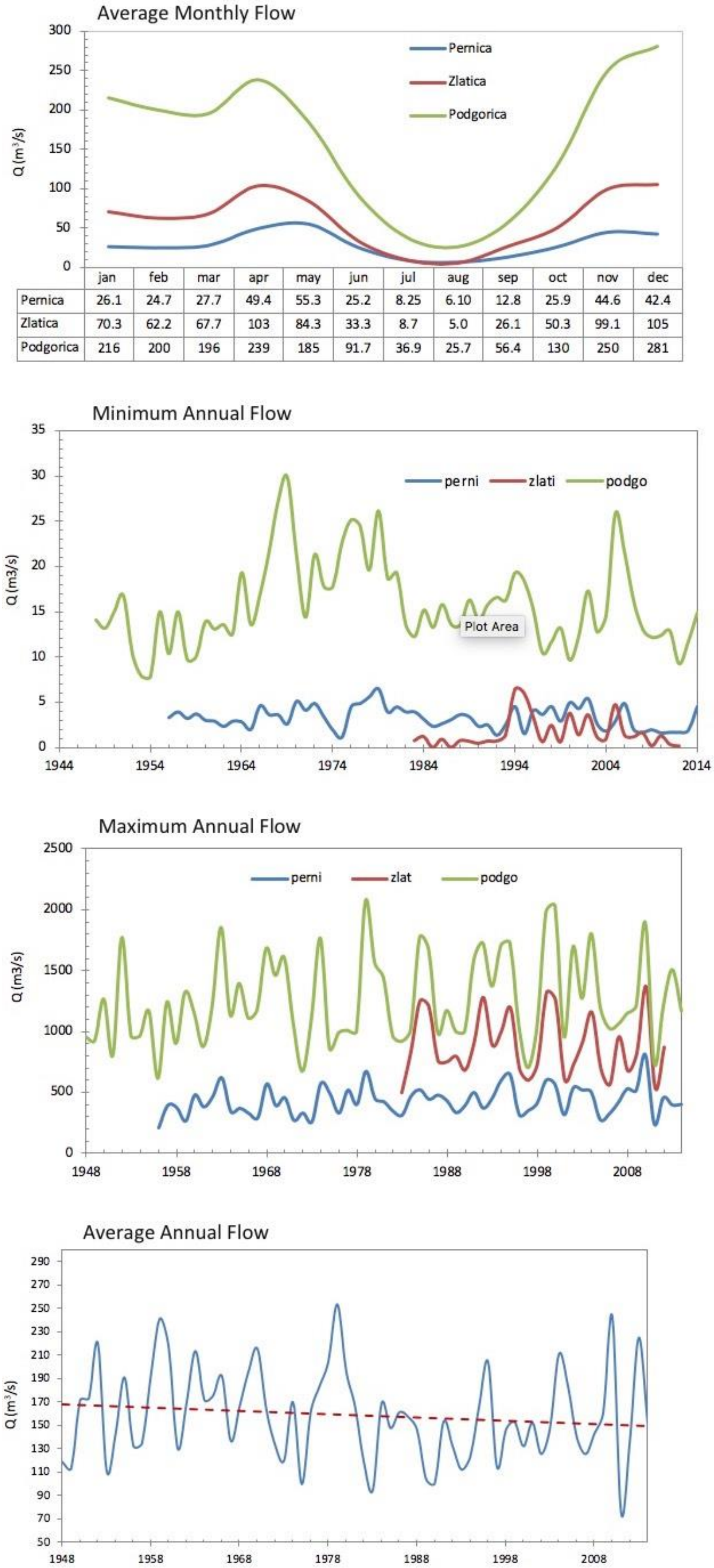



| | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Duklov Most | 24.4 | 22.3 | 24.7 | 35.4 | 21.4 | 8.04 | 1.93 | 1.32 | 5.09 | 15.6 | 31.5 | 35.0 |
| Danilovgrad | 112 | 104 | 97.1 | 111 | 77.4 | 41.5 | 20.8 | 14.7 | 30.7 | 65.9 | 125 | 136 |



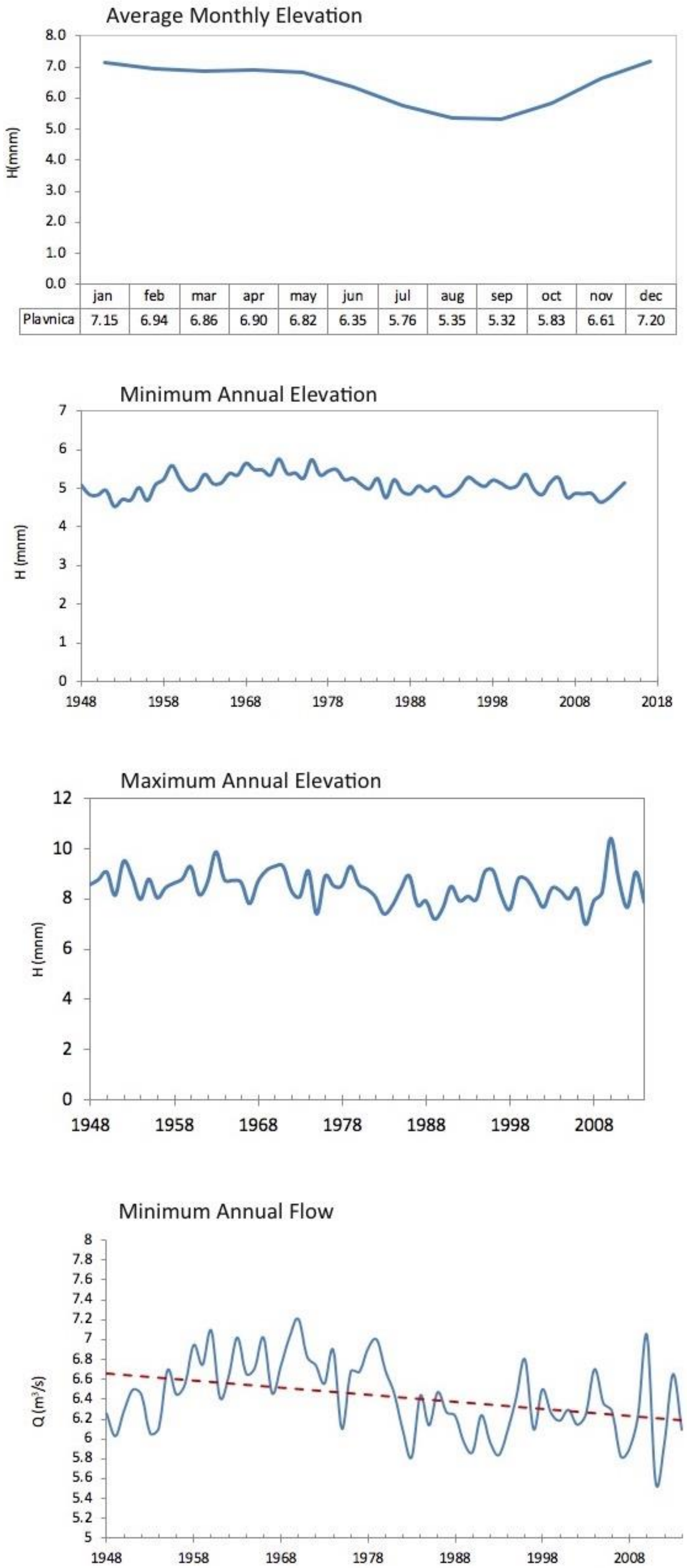



## Figure 3.26  Water flows in the Morača basin

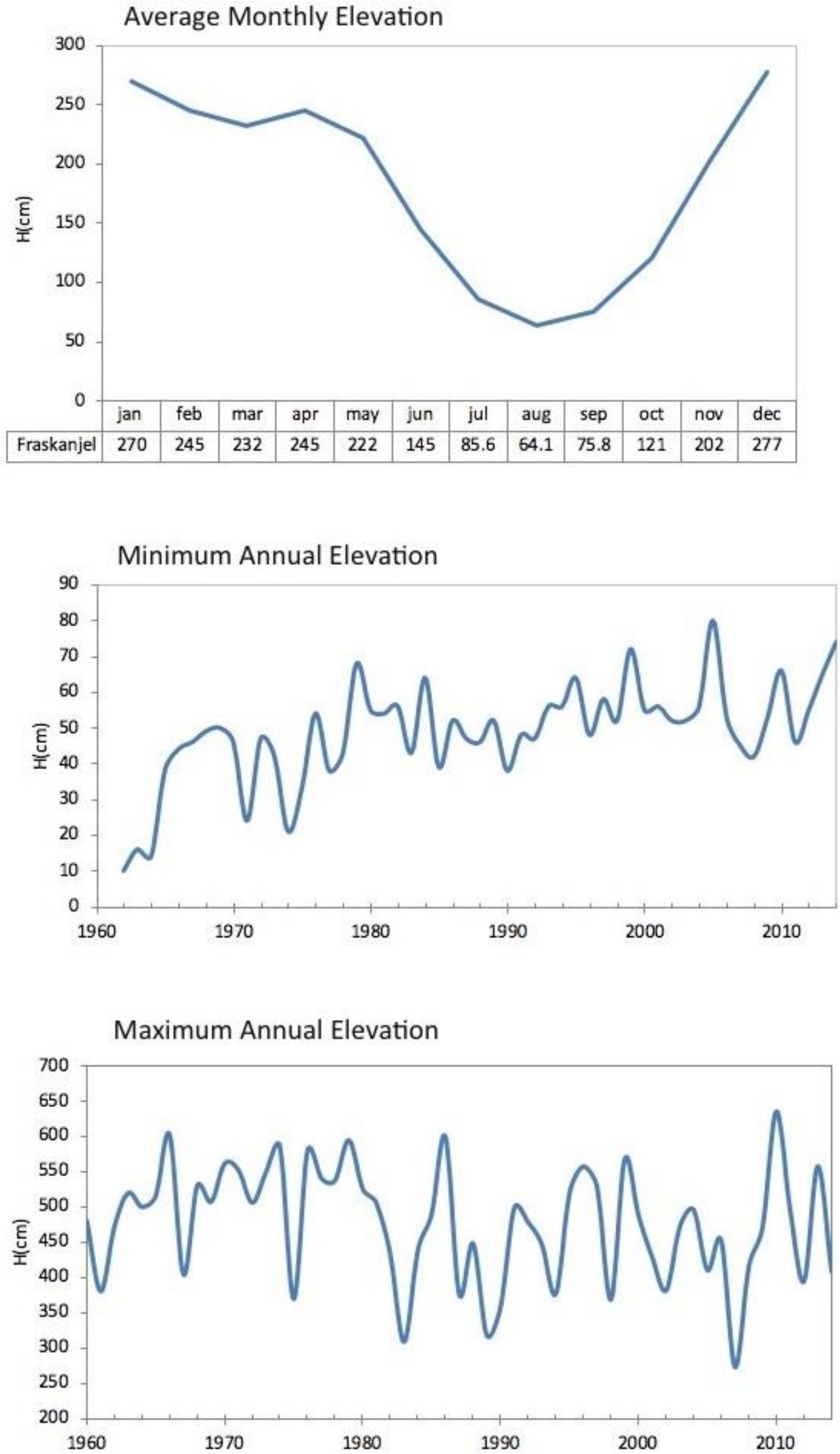



| | jan | feb | mar | apr | may | jun | jul | aug | sep | oct | nov | dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pernica | 26.1 | 24.7 | 27.7 | 49.4 | 55.3 | 25.2 | 8.25 | 6.10 | 12.8 | 25.9 | 44.6 | 42.4 |
| Zlatica | 70.3 | 62.2 | 67.7 | 103 | 84.3 | 33.3 | 8.7 | 5.0 | 26.1 | 50.3 | 99.1 | 105 |
| Podgorica | 216 | 200 | 196 | 239 | 185 | 91.7 | 36.9 | 25.7 | 56.4 | 130 | 250 | 281 |

## Figure 3.27  Water elevation and minimum average flows at HS Plavnica on Skadar Lake



## Figure 3.28 Water elevation at HS Fraskanjel on the Bojana River



Despite the work carried out by IHMS in the Adriatic River Basin, there is currently limited data available in the area, especially in relation to accurate water use and accurate water demand, in order to predict the water balance dynamics with any accuracy, according to the full requirements of the WFD. The CIS guidelines[22] clearly state:

'*Uncertainty is explained by a combination of factors such as the accuracy of input data and measurements used to estimate key parameters of the water balance, or the application of specific estimation techniques, building for example on model simulation, that cause uncertainty in the values of parameters estimated. While eliminating uncertainty would be impossible, understanding uncertainty becomes central to the correct interpretation of water balance calculations so results are adequately and cautiously used for supporting decision making'*.

To support the implementation of the WFD, due consideration needs to be given to water quantity issues to better understand the balance between water supply and water demand and the current balance or imbalance of water resources, as a pre-condition for achieving the WFD environmental objectives (in particular: Good Ecological Status for Surface Water bodies, Good Quantitative Status for Groundwater bodies, no deterioration for both water body types).

Water balances should be built in a stepwise and tiered approach, with a preliminary analysis of current management challenges helping to define the key components of the water balance that require specific attention. In addition, managers should identify time and spatial scales at which it is relevant to develop the water balance so it can help supporting management discussions and decisions. Water balances should explicitly consider the environmental demand of aquatic ecosystems in coherence with the definition of environmental flows (EF) for surface waters.

Water balances can also be used to select measures for the WFD PoM. They can help: (1) assess the effectiveness of measures proposed for improving the quantitative balance of surface and groundwater resources; (2) review existing water abstraction permits; (3) assess the relevance of water efficiency measures or development of water reuse. Complemented with information on the costs of measures, they can help prioritize potential measures based on their cost-effectiveness ratio and identify the combination of measures that can achieve a sustainable use of water resources at the lowest possible cost. In some cases, the technical, environmental and economic information provided, when linking water balances to socio-economic information, can help investigate the need for any WFD exemptions. Finally, water balances are critical to enable the comparison of the different management options including the development of new infrastructure (e.g. dams) that require an exemption under Article 4(7) of the WFD.

The accurate determination of the water balance in the Adriatic River Basin, which is ultimately essential to the RBMP, is highlighted as a task in Section 11 to be carried out in full during the RBMP cycle.

The definition of environmental flow has been studied only on Morača and Zeta Rivers in the Adriatic River Basin with a definition of the minimal EF as per the rulebook of Montenegro[23]. The rulebook provides for a comparison for each month, the mean annual minimal flow mQmin (average of minimal annual discharge over a minimal period of 10 years) with the mean monthly flow mQM(j) (average of the mean monthly discharge over a minimal period of 10 years). When the ratio mQM(j)/ mQmin is

[22] CIS No. 34: Guidance document on the application of water balances for supporting the implementation of the WFD

[23] Official Gazette of the Republic of Montenegro, No. 2/16

lower than 10, the EF for the month is equal to mQmin, when EF=mQmin. If the ration is higher or equal to 10, the EF= 20 % of mQM(j).

The methodology to calculate the environmental flow of the rivers in the Adriatic River Basin must be a compromise between the guarantee of maintaining the ecological function and components of the rivers (quality and quantity of the water) and the socio-economic use of the water resources.

The minimum environmental flows in the Morača and Zeta Rivers are shown in Table 3.12.

**Table 3.12 Minimum Environmental Flow values calculated for sub-basins in the Adriatic River Basin**

| Sub-Basin | Minimum EF Value ($m^3/sec$) | |
|---|---|---|
| | Upstream | Downstream |
| Morača | 1.3 | 2.1 |
| Zeta | 3.6 | 10.4 |

The accurate determination of the EF measurements in all rivers and downstream of water storage facilities in the Adriatic River Basin, which is ultimately essential for the maintenance of river ecosystems, is highlighted as a taks in Section 11 to be carried out in full during the RBMP cycle.

## 3.6 Climate effects

Montenegro is located in the central part of a moderately warm zone in the Northern Hemisphere (41°52' and 43°32' latitude North and 18°26' and 19°22' longitude East). Owing to its latitude, i.e. its proximity to the Adriatic and Mediterranean Seas, it has a Mediterranean climate with warm and somewhat dry summers and mild and rather humid winters.

Large bodies of water, its altitude and the position of its coastal mountains, along with the relief of its terrain affect both its local and regional climates; thus, within a small area there are big differences between the climates in the coastal and high mountains regions. There are also numerous transitional local climates in-between these areas.

The average annual air temperature ranges from 4.6°C at altitudes of 1,450 m above sea level, to 15.8°C on the coast. The average annual precipitation ranges from 800 mm in the north to around 5,000 mm in the far southwest.

On average, the annual number of days with precipitation is about 115-130 on the coast and around 172 in the north of Montenegro. The rainiest month on the coast is November, while July is the driest. Snow cover is formed at altitudes above 400 meters. On the high land it snows much more frequently in spring than in autumn.

According to the IHSM's data and taking into account the general climate complexity of the area, the following changes in extreme weather and climate events were observed up until 2010:

- Frequent, extremely high maximum and minimum temperatures
- More frequent and longer heat waves;
- Increase in the number of very warm days and nights

- Fewer frosty days and very cold days and nights;
- More frequent droughts;
- Increase in the number of wildfires
- Dry periods followed by heavy precipitation
- More frequent storms (cyclones) during colder parts of the year
- Fewer consecutive days with rain
- Fewer days with heavy precipitation
- Increase in the intensity of precipitation
- Reduced total annual quantity of snow

Monitoring and evaluation of climate shows that the Montenegrin climate has changed due to global climate changes and variability. The clearest indicators include: a significant increase in air temperature, an increase in both surface and mean sea level temperatures, and changes in extreme weather and climatic events. The most prominent changes have been recorded by IHMS in the northern region of the Adriatic River Basin is a +1.40$^{O}$C rise in temperature during the period 2001 to 2010.

Regarding precipitation, as described in the Initial National Communication of Montenegro to UNFCCC:

- There has been no significant reduction in the total level of annual precipitation
- The precipitation levels have increased during the autumn and have fallen during the spring, summer and winter but have remained within normal ranges

Climate projections were generated by Euro CORDEX with a spatial resolution of 0,11° (near 1.,5 x 12.5 Km) . The climate projections correspond to the Global Climate Model CNRM-CERFACS-CNRM-CM5, scenario RCP 45. (Representative Concentration Path 4,5 W/m2) that is the most probable climate scenario that foresee an average global warming increase of 1.4 °C in the period 2046 - 2055.

For all projections, the maximum temperature varies from -1°C (February) to +34°C (August) in the Adriatic River Basin as shown in Figure 3.29. The minimum temperature varies from -8.6°C (February) to 24.7°C (August) as illustrated in Figure 3.30.

Projected changes in temperature and in precipitation will inevitably impact on and create changes in the water balance in the Adriatic River Basin. A reduction in the amount of precipitation in comparison to the period 1961-1990 would cause a significant decrease in the average annual flow value by the end of the 21st century in comparison to flows observed during the baseline period.

Due to an envisaged increase in temperature by scenario RCP 45, the precipitation that fell as snow in winter months would fall as rain and would result in an increase in mean monthly flows values during that period, while reduced accumulations of snow would result in a decrease in mean monthly flow values during spring months.

Changes in precipitation during the winter are expected to lead to a re-distribution of the number of summer and winter droughts and to change to number of periods with the small water periods. It is expected that the number of winter droughts will decrease, while the number of summer droughts will increase. A slight increase in the number of droughts of over 30 days in length is also expected.

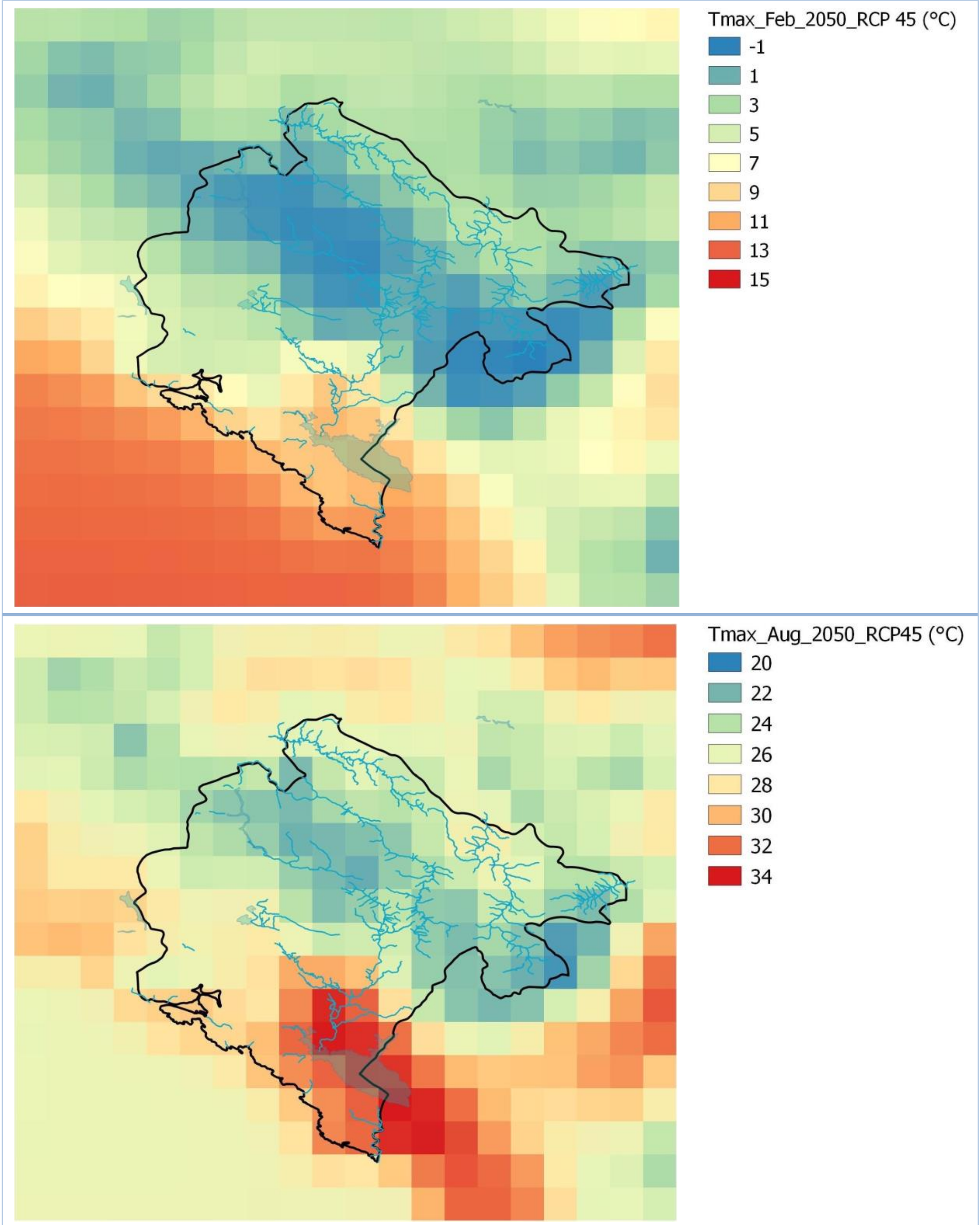
**Vulnerability of the coastal region:** The results of the vulnerability analysis clearly indicate extreme vulnerability of the environment in Montenegro's coastal region (Table 3.13), where 2/3 of it is deemed to be highly vulnerable. Regarding the size of vulnerable areas, the areas of Bar and Ulcinj (Ulcinj and the Anamal Fields, the area adjacent to the Bojana River) stand out, while most of the other highly vulnerable areas are located close to Budva (naturally preserved hinterland and parts of the coast).

### Tables 3.13 Overview of the size of vulnerable coastal areas and their share of the total surface area within municipalities[24]

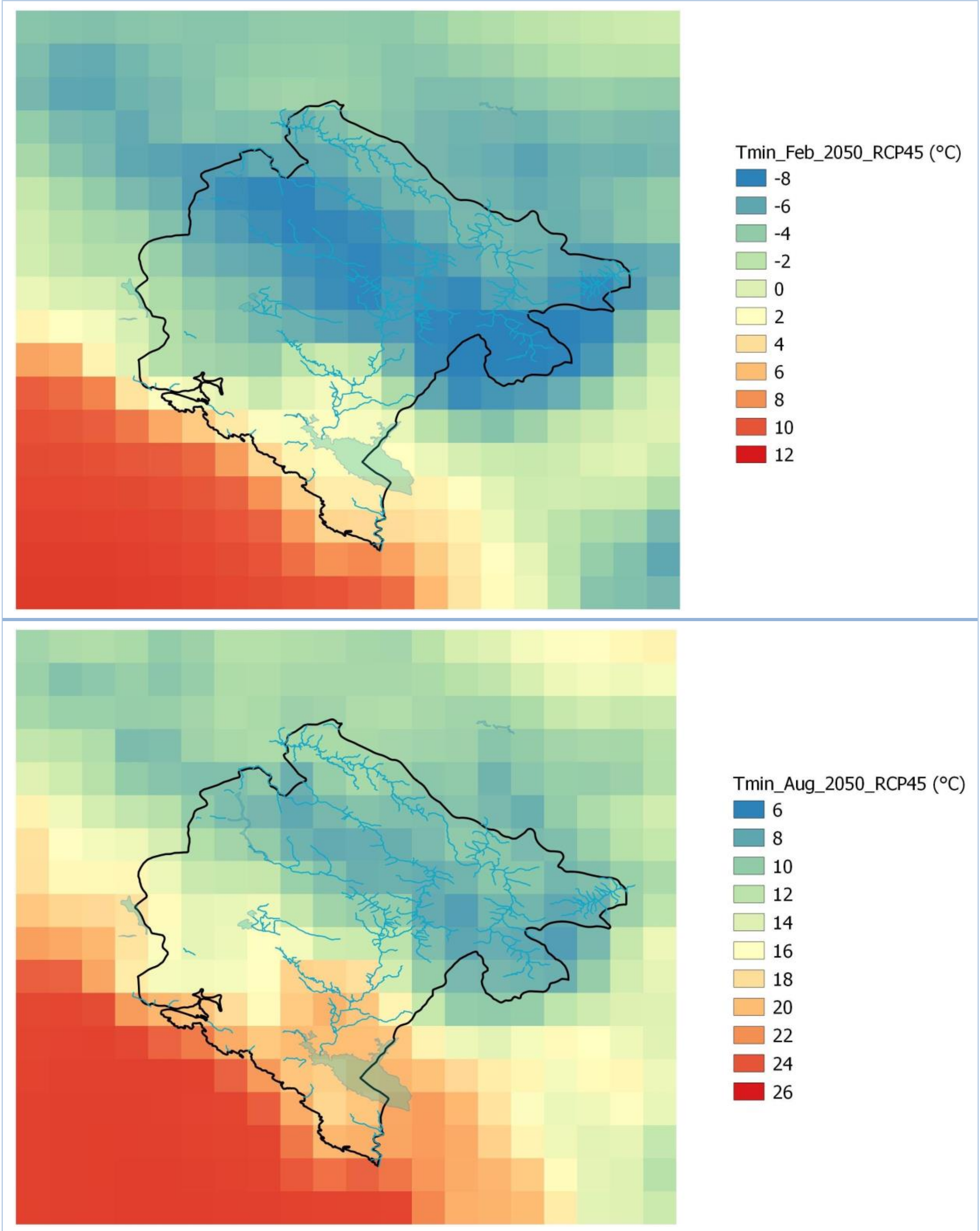
| | Very Low Vulnerability | | Low Vulnerability | | Medium Vulnerability | | High Vulnerability | | Very High Vulnerability | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Municipality** | ha | % | ha | % | ha | % | ha | % | ha | % |
| Bar | 473 | 1 | 482 | 1 | 16.24 | 35 | 13.36 | 29 | 15.38 | 34 |
| Budva | 329 | 3 | 51 | >1 | 2.40 | 19 | 3.48 | 28 | 6.33 | 50 |
| Herceg Novi | 470 | 2 | 436 | 2 | 7.5 | 33 | 7.41 | 33 | 6.55 | 29 |
| Kotor | 450 | 1 | 198 | 1 | 13.79 | 41 | 10.07 | 30 | 9.14 | 27 |
| Tivat | 256 | 6 | 133 | 3 | 1.29 | 28 | 1.07 | 23 | 1.89 | 41 |
| Ulcinj | 66 | >1 | 129 | 1 | 3.32 | 13 | 10.96 | 42 | 11.39 | 44 |
| Total | 2,044 | 1 | 1,429 | 1 | 44.54 | 31 | 46.31 | 32 | 50.68 | 35 |

[24] Data from IHMS included in the 2nd National Communication on Climate Change (2015)

## Figure 3.29 Climate projections (2050) for maximum temperature variation



## Figure 3.30 Climate change projections (2050) for minimum temperature variation



# 4 SIGNIFICANT PRESSURES IDENTIFIED IN THE ADRIATIC RIVER BASIN

## 4.1 Introduction

The purpose of the pressure and impact analysis is to identify the 'significant pressure(s)' exerted on surface water bodies and groundwater bodies. The main purpose of the 'risk analysis' is to identify the water bodies that are at risk of not achieving the required environmental objective.

### 4.1.1 Surface Waters

The DSPIR framework (Driving Force, Pressures, State, Impacts and Response) has been applied to the surface waters in ARB to identify and address the preliminary elements on pressures and provide an analysis of the impacts, which highlight the potential risk that a water body will not achieve the environmental objectives. The approach is documented in the Common Implementation Strategy (CIS) guidance developed for the EU Water Framework Directive[25].

In relation to surface waters, this section includes the following:

1. An outline of the specific requirements of the WFD and Common Implementation Strategy (CIS) guidance document;
2. A description of the of methodologies applied;
3. A description of the current available information in the country;
4. The results of assessment and analysis;
5. Recommendations for future data collection and assessment.

The analysis of the pressures on the surface water bodies was carried out at 'river segment' level but the synthesis of the pressure and the assessment of the risk of non-achievement of the environmental objectives was performed at 'water body level'.

This report provides a preliminary assessment for all surface water bodies with a final proposed risk 'expert' judgement as either 'likely not at risk', 'possibly at risk', or 'at risk'.

The analysis provided indicates the probability of significant pressures in each water body resulting from point or diffuse source pollution, abstraction and physical alterations. The analysis was competed for all 41 surface water bodies (Section 3.3).

Analysis of all surface water bodies with respect to point source pollution incorporates the following: urban wastewaters, IED plants, non-IED plants, contaminated sites, waste disposal sites, mine waters, aquaculture and hydropower installations.

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[25] CIS guidance document No. 3: http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

### 4.1.2 Groundwater

Groundwater is a resource under increasing pressure from human activities. However, for many people it is “out of sight, out of mind”. While the need to protect drinking water is well understood because of its environmental value, as groundwater happens to be the prevailing potable water source in EU (about 75% of EU inhabitants depend on groundwater for their water supply) the Member States place great emphasis on its assessment, management and precautionary protection from pollution. Such an approach is also important because more than 90% of Montenegrins also use groundwater for drinking purposes.

The Water Framework Directive (WFD 2000/60) provides general guidelines for monitoring of water quality and quantity. The Groundwater “Daughter” Directive (2006/118/EC) sets out criteria for assessing the chemical status of groundwater, as required by Article 17.2a of the WFD. Concerning the fact that EU Members States are characterized by different geology and hydrogeology, and consequently by varying water quality, the set of additional documents - Common Implementation Strategy for the Water Framework Directive (CIS) was prepared with the aim of establishing the common criteria and approach in the process of characterization and assessment of groundwater bodies throughout Europe.

The EU WFD (2000/60) contains three definitions that are broadly discussed in this report and essential for groundwater assessment:

- **Groundwater** means all water that lies below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

- **Aquifer** means a subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability that allows either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

- **Body of groundwater** means a distinct volume of groundwater within an aquifer or aquifers.

For the management purposes, WFD requires that groundwater bodies be delineated, characterized and classified (further GWB). Groundwater bodies are discussed in several CIS documents, but the most important are: Guidance No. 2 - Identification of Water Bodies, Guidance Document No. 3. Analysis of Pressures and Impacts, and Guidance Document No. 7. Monitoring under the Water Framework Directive.

The key aspect of the ‘groundwater body’ concept is that GWB is the management unit under the WFD that is necessary for the subdivision of large geographical areas of aquifer in order for them to be effectively managed. This concept considers:

- Groundwater that can provide for the abstraction of significant quantities of water (i.e. the groundwater that can and should be managed to ensure sustainable, balanced and equitable water use); and
- Groundwater that is in continuity with ecosystems and can place them at risk, either through the transmission of pollution or by unsustainable abstraction that reduces baseflows (i.e. the groundwater that can and should be managed to prevent environmental impacts on surface ecosystems).

The aim of groundwater body characterization is to establish the quantitative and chemical status of each groundwater body i.e. aquifer which supplies more than 50 people and whose abstraction is larger than 10 $m^3$/day[26]. Groundwater characterization is based on the analysis of the available environmental data - geological, hydrological, chemical, impact of human activity, etc.

The methodology for assessment of groundwater chemical status is based on EU Guidance Documents CIS No. 3 'Analysis of pressures and impacts' and also the CIS guidance document No 15, which provides the guidance on groundwater monitoring[27]. Further experiences obtained from related River Basin Management Plans and several projects conducted in the region (ICPDR, Sava Commission, Croatia, Bosnia & Herzegovina, Serbia) have also been taken into account.

The main human pressures that can influence a groundwater body chemical status are divided into two groups:

- Diffuse sources of pollution sources
- Point sources of pollution

The main components of the methodologies for assessing the risk of failure to achieve good chemical status include the following:

- The available monitoring data on water quality
- Data on existing pressures and possible impacts
- Data on the overlying strata of the groundwater bodies, and
- the corresponding vulnerability of the aquifer

In many national reports data gaps and inconsistencies have become apparent, resulting in uncertainties in the interpretation of the data. It is therefore common to establish a level of confidence: High, Medium or Low, for the assessment of groundwater qualitative status. However, in case of Montenegro, the lack of continual and systematic monitoring of groundwater quality infers that level of confidence for most of delineated GWBs and GGWBs can be considered as 'Low' based "rough assessment" as presented in Tables I-XVII in Annex 1 of this RBMP.

For the purpose of the RBMP, the quantitative and qualitative and pressures on each of the delineated Groundwater Bodies (GWB) and Group of Groundwater Bodies (GGWB) is provided in Sections 4.12 and 4.13, respectively.

Section 4.12 focuses on the application of water budgets (balances) as a coherent framework to cross-evaluate the information on drivers, pressures and impacts on water quantity (including the coherence between water extraction and water recharge, water flows between water bodies/catchments, storage changes over time, etc.) and providing a sound basis to the quantitative management of water resources.

The water budget describes the pressure on the quantitative status in relation to the water extraction and the artificial recharge. In case of the latter no such structure exists in Montenegro. According to

[26] It should be noted that if such a criterion should be deliberately applied, thousands of groundwater bodies would be delineated in a groundwater-rich country such as Montenegro (see long list of references used in Annex 3 of this RBMP).

[27] CIS guidance document No. 15: http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

Annex V, item 2.1.1 of the WFD, good quantitative status is identified when the groundwater level in the groundwater body is such that the available groundwater resources are not exceeded by the long-term annual average rate of extraction.

The parameters of risk assessment of the quantitative status are either the groundwater level or the estimated water balance of the groundwater body. However, the EU Guidance for Water Budgeting[28] does not fully recognize the specificity of karstic aquifers, which are dominant in Montenegro, even though the water budget methodology is required for this kind of aquifer system.

During the examination of the anthropogenic impact on the quantitative status of the groundwater bodies according to the WFD, the quantitative status identified for the initial characterization is based on data related to water bodies which are used for water extraction for human consumption, "providing more than 10 $m^3$ a day as an average or serving more than fifty persons as well as water bodies intended for such future use and to places of direct water discharge". However, the water budget in this report has been applied only on 17 delineated groundwater bodies (GWB) and group of groundwater bodies (GGWB) because in case of Montenegro consequential respect of above criteria would result with several thousand of such water bodies.

Qualitative analysis of the pressures on the Groundwater Bodies (GWB) and Group of Groundwater Bodies (GGWB) in Section 4.13 involves an estimation of the intrinsic vulnerability assessment of the groundwaters followed by hazard and risk assessment for diffuse and point source pollutants.

### 4.1.3 Limitations linked to availability of information and development of appropriate tools for pressure and impact analysis

Currently, in Montenegro, regarding pressures and impacts there is only a limited amount of information of sufficient quality available to fulfil the requirements of WFD. Many datasets are not standardized, and, in many instances, they are not available in the required digital format. Often, the data do not cover the geographical extent of the River Basin.

This situation was quite normal, in many Member States during the period from 2000 to 2004 when WFD was initially implemented, i.e. many relevant data were missing. However, the Directive and the Guidance document on Pressures and impacts analysis (IMPRESS)[29] leaves room for expert judgement for informed decision making. The WFD and IMPRESS states, in this respect, that the degree of confidence should be mentioned and how to progressively fill and increase the required datasets.

### 4.1.4 Links with operational monitoring

Risk analysis is considered for the design of monitoring programmes. In particular, an operational monitoring network has to be defined in order to identify the status of water bodies at risk of not achieving the environmental objectives of WFD. The purpose of the operational monitoring is to establish the status of waterbodies identified at being at risk of failing to meet their environmental objectives and to assess any changes in the status of such bodies resulting from the programmes of

[28]European Commission, 2015: Guidance document on the application of water balances for supporting the implementation of the WFD, Final – Version 6.1 – 18/05/2015, Technical report 2015/090

[29]IMPRESS, 2002. Guidance for the analysis of pressures and impacts in accordance with the Water Framework Directive. Common Implementation Strategy Working Group 2.1, 156 pp. Office for Official Publications of the European Communities.

measures. The operational monitoring network is required to encompass all water bodies identified "at risk" and target the specific quality elements that are related with the cause of the risk (for further details see Section 6). The appropriate design of monitoring programmes requires knowledge of the significant pressures and their related impact on the status of water bodies at risk.

### 4.1.5 Links with Programme of Measures and economical aspects

In many cases, it is possible to identify the source(s) of pollution or the pressures that have a significant impact on the status of the water bodies. In such cases, measures can be planned, and their cost estimated. The expected effect of these measures must also be evaluated as well as the time required to see significant improvement in the status of the water bodies. The Programme of Measures for each surface and groundwater body, including basic and supplementary measures are detailed in Section 10.

## 4.2 Key elements of pressure and impact analysis of surface waters

### 4.2.1 Knowledge based assessment

The assessment of whether the pressure on a water body is significant (or not) is based on:

- The knowledge of the pressures within the catchment area, which have an impact on the waterbodies
- A conceptual understanding, of water flow, chemical transfers, and biological functioning of the water body within the catchment system.

Various sources of information have been used for identifying the significant pressure, these include:

- Monitoring data, where available;
- Numerical modelling, that will simulate the impact of numerous pressures, as available;
- Conceptual understanding, e.g. by testing the magnitude of pressure of an indicator against a rule that indicates directly if a pressure is significant.

### 4.2.2 Processes related to the analysis of water body 'at risk' and the environmental objectives

Key elements of the analysis and definitions are as follows:

**DPSIR approach**, which considers Driving forces, Pressures, State, Impacts and Response for analysis the interactions between the natural resources and human activities.

- **Driving forces (D)**: An anthropogenic activity that may have an environmental effect: e.g. population change in various areas, development and changes in agriculture and, industrial activities, tourism.
- **Pressure (P)**: The direct effect of the driver, e.g. changing the flow, the physico-chemical parameter, population of species.
- **State (S)**: The condition of the water body resulting from both natural and anthropogenic factors (physical, chemical, and biological characteristics). It is assessed through quality

elements and the programme of surveillance monitoring[30]. Additional information may be found in research results and short-term studies.

- **Impact (I)**: The environmental effect of the pressure, which is dependent on the type of pressure and on the vulnerability of the receiving ecosystem (surface water bodies, groundwater bodies, protected areas, lakes, transitional waters and coastal waters).
- **Response (R)**: The measures taken to improve the status of the water body, e.g. restricting abstraction, limiting points sources discharges, developing best practice for agriculture, awareness of zones, etc.

**Significant pressure**: The Member States have to estimate and identify the significant water abstraction for urban, industrial, agricultural and other uses, including seasonal variations and total annual demand, and of loss of water in distribution systems. 'Significant' is interpreted as meaning that the pressure contributes to an impact that may result in the failing of WFD Article 4(1) Environmental Objectives.

**Types of pressure**: In the case of surface waters the WFD requires the identification of significant pressures from:

- Point sources of pollution
- Diffuse sources of pollution
- Modifications of flow regimes through abstractions or regulation
- Morphological alterations
- Other pressures such as the estimation of land use patterns, including identification of the main urban, industrial and agricultural areas and, where relevant, fisheries and forests

**Water body at risk**: Member States have to assess the susceptibility of the status of water bodies to the pressures identified above. This exercise aims at identifying the likelihood for the water bodies to fail to meet the environmental objectives set under Article 4 at a specific deadline. The water bodies, which are likely not to achieve the environmental objectives, are usually called in short: "water bodies at risk".

**Degree of confidence and future data collection**; During the first WFD cycle many data and information have to be collected, organized, controlled, formatted and aggregated at different geographical scales. In many instances, the needed information is missing. This has an impact on the quality of the assessment related to 'significant pressure', 'status of water bodies' and the identification of 'water bodies at risk'. Therefore, the degree of confidence of the assessment made must be indicated and taken into consideration in the development of mitigation measures.

**Programmes related to water bodies at risk**: For a water body at risk, further characterization shall, where relevant, be carried out to optimize the design of both the monitoring programmes required under Article 8, and the programmes of measures required under Article 11 of the WFD.

**Prospective analysis**: The prospective analyses and related economic analysis are to be performed to identify at which time good ecological and/or chemical status or good ecological potential (for artificial or heavily modified water bodies) is likely to be achieved considering the socio-economic trends and programme of measures. Three reasons are considered as relevant under the WFD to

[30]Surveillance Monitoring aims to allow assessment of long-term changes in natural conditions; the efficient and effective design of future monitoring programmes; validation of the impact assessment procedure detailed in Annex II of the Directive; and the assessment of long-term changes resulting from human activity.

justify that the objectives will not be achieved at the end of one WFD six-year cycle. i.e. natural conditions, technical reasons and/or disproportionate costs.

### 4.2.3 Diversification of approach and degree of confidence

The identification of significant pressures and their resulting impacts (which in turn lead to a reduced status) involved the use of different approaches:

- Field surveys
- Inventories
- Numerical tools (e.g. modelling)
- Expert judgement
- A combination of tools

The magnitude of the pressure was compared with a threshold or criteria, relevant to the water body category and type, in order to assess its significance. The degree of confidence, which depends on the quantity and availability of data, was also assessed.

### 4.2.4 WFD requirements and WISE reporting

The reporting to the Water Information System for Europe (WISE) is related to part of Article 5 (WFD) regarding pressures and impacts analysis. In the CIS guidance document No.3, which provides the list, format and code to be used for the pressure and impact.

Information regarding the pressures and impacts on surface water bodies should be reported at surface water body level according to the reporting scheme developed by the European working group “Data Information Sharing” for the sake of the WFD reporting.[31]

Significant pressures should only be reported for water bodies that have been identified as being at risk. For example, the mere existence of point sources of pollution in a water body is not a reason to report point sources as a significant pressure. The pressure or impact should only be reported if it is significant, alone or in combination with other.

### 4.2.5 Importance of pressure/impact and risk analysis for the WFD process

The overall importance of pressure and impact and risk analysis for WFD related activities is shown in Table 4.1. For the purpose of this document, the collated information was used for the following purposes:

- Describing the “driving forces”, especially land use, urban development, industry, agriculture and other activities which lead to pressures, without regard to their actual impacts;
- Identifying “pressures” with possible impacts on the water body and on water uses, by considering the magnitude of the pressures and the susceptibility of the water body;
- Assessing the “impacts” resulting from the pressure; and,
- Evaluating the water body “at risk” of failing to meet the WFD environmental objective.

In addition, the ecological and/or chemical monitoring data from the water body can be used to refine the identification of significant pressures.

[31] WFD Reporting guidance, CIS No 35, 2016

**Table 4.1 The relationship between pressure and impact and risk analysis for the design of the River Basin Management Plan**

| Inclusion on the River Basin Management Plan | Article /Annex of WFD | Information Flow |
|---|---|---|
| Identification of water bodies for which alternatives may be appropriate | Article 4 | Bidirectional - feedback and readjustment |
| Information for use in the economic analysis of water use | Article 5 | Bidirectional - feedback and readjustment |
| Design of monitoring programmes | Article 8 | Bidirectional - feedback and readjustment |
| Design of Programme of Measures (POMs) | Article 11 | Bidirectional - feedback and readjustment |
| Information for producing an interim overview of the significant water management issues | Article 14 | One-way reporting |
| Information for use in water body identification and refinement | Annex II | Bidirectional - feedback and readjustment |
| Identification of potential reference sites | Annex II | Bidirectional - feedback and readjustment |
| Identification of potential inter-calibration sites | Annex V | Bidirectional - feedback and readjustment |

## 4.3 General Methodology for Surface Waters

### 4.3.1 Methodological steps

The WFD guidance document No.3 on pressures and impact assessment recommends that pressure and impact analysis should be focused in such a way that the effort involved in assessing whether any water body (or group of water bodies) is at risk of failing to achieve its environmental objectives is proportionate to the difficulties involved in making that judgment. Taking into account both the above-mentioned considerations and the available information and datasets, the following methodological steps have been undertaken: (i) global screening and overview, (ii) identification of individual and significant pressures, (iii) risk assessment, and (iv) further steps.

**Step 1: Global screening and overview**

This step aims at identifying a preliminary screening the potential global pressure on river segment and water bodies.

The European Environment Agency (EAA) has published an “assessment of status and pressures in 2009”, where the importance of the population density and percentage of arable land has been outlined. In addition, an ‘interpolation method ‘has been developed to estimate the status of water body where monitoring data are insufficient.

The data available for describing the pressures is often scarce or not available at a detailed level for the entire territory. A general approach is therefore to utilize datasets (Corine land cover, population etc.) of high quality that are available and cover the whole territory of Montenegro. A screening method was tested for water bodies catchments and maps were produced presenting class of magnitude of the "global pressure" on water bodies.

The method developed for the RBMP use only land cover and population density in order to map the magnitude of pressure(s) on each surface water body. This method enabled to the rapid identification of a number of water bodies under high pressure, which could be considered likely "at risk", and a number under low pressure likely "not at risk". This global assessment was compared to more detailed analyses, in order to validate the judgment whether the water body is 'at risk' or not.

### Step 2: Identification of individual and significant pressures of various types

This step aims at using available datasets to provide specific areas on a map related to the river segments and water bodies that are under at risk for each type of the following pressures: (1) point source pollution, (2) diffuse source pollution, (3) abstraction, (4) physical pressures, and (5) Other significant pressures.

### Step 3: Risk assessment

This step aims at identifying the water body 'at risk' or 'not at risk' and the degree of confidence of the judgment by using the results of pressure analyze and the monitoring datasets.

The degree of confidence on the judgement is dependent on the quality of the information on pressures and the availability of monitoring data (qualitative, quantitative), together which provide an assessment of the status of the surface water bodies.

For the risk assessment indicators, the current status and the magnitude of the impact on water bodies were used to assess the 'risk'.

### Step 4: Strategy and next steps

This step aims to provide guidance on future data collection. It makes also the links with other requirements of the WFD, such the programme of monitoring and the WIS.

## 4.4 Information for pressure and Impact Analysis

### 4.4.1 Types of information

The information considered relevant, which was collected for the pressure and impact analysis, was as follows:

- Scientific or technical papers or reports, summarizing findings on a specific aspect, which may also include photographic representation to provide an idea on the context.
- Governmental publications (e.g. MARD, MSDT, IHMS, WA, GSM)
- Datasets that have been routinely monitored over a long enough period. This is for example the case for the hydrological data and the monitoring data of IHMS.
- Inventory of pressures and pollution sources even though these data are not always up-to-date and do not cover all the type of point pollution pressure or do not cover the whole area of the surface or groundwater bodies in the ARB.
- Information collected from specialists/experts of a specific field.
- Information collected in the field by measurements (GPS, sampling, hydrological observations, etc.).
- GIS shape files (vector and raster) and other geographical information; such as the river network and its catchment, CORINE land cover, the coordinates of the stations, water abstractions and discharges, spring, wells, settlements, road etc.

### 4.4.2 Information related to the DPSIR approach

The information gathered are for the following purposes:

- Describing the "driving forces", especially land use, urban development, industry, agriculture and other activities which lead to pressures, without regard to their actual impacts;
- Identifying "pressures" with possible impacts on the water body and on water uses, by considering the magnitude of the pressures and the susceptibility of the water body;
- Assessing the "impacts" resulting from the pressure; and,
- Evaluating the water body "at risk" of failing to meet the WFD environmental objective.

### 4.4.3 Information and data on driving forces

For the analysis of pressures and impacts, it is necessary to include information on the 'driving' forces. The information is derived from statistical institutes and reports on the general economic situation.

Two important drivers are (i) the increase or decrease of population in the different part of the countries and (ii) sectoral developments (Table 4.2).

### Table 4.2 Socio-economic information on driving forces

| Description of Data |
|---|
| **Population Census 2011 and evaluation** |
| **Evolution and analysis of indicators (World Bank);** |
| **Selection of socio-economical information** |
| **Sector review of the economy, from public institutions (Agriculture, industry, tourism, environment). Identification of trends, such as the support to agro-ecology, the impact of the size of the farms, the developments of infrastructure for irrigation, the policy for small and medium hydropower development** |
| **Water price and cost recovery** |

## 4.4.4 Information and data on pressures

For the purpose of the pressures, where available, the information was collected from multiple sources for point source pressures, diffuse source pressures, abstraction pressures and physical alterations, which are shown in Tables 4.3, 4.4, 4.5 and 4.6, respectively. Other relevant pressures and their data sources are also provided in Table 4.7.

### Table 4.3 Point source pressures

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 1.1 Point – Urban waste water | Urban development | Discharges of raw or partially treated urban waste water which are identified as point sources. | MSTD |
| 1.2 Point - Storm Overflows | Urban development | Overflows from separated or combined sewers identified as point sources. | MTSD |
| 1.3 Point - IED plants[32] | Industry | Industrial point sources from plants included in the E-PRTR[33]. | MARD; WA; MSDT/EPA IPPC |
| 1.4 Point - Non IED plants | Industry | Any industrial point sources not included in the E-PRTR. | MARD; WA; MSDT/EPA IPPC |
| 1.5 Point - Contaminated | Industry | Pollution resulting from an abandoned industrial site or a site contaminated due | MSDT/EPA |

[32] Installations in Montenegro that fall under the provisions of the Industrial Emissions Directive (IED) and medium combustion plants in accordance with 2015/2193 Directive

[33] E-PRTR (European Pollutant Release and Transfer Register) listing refers to large facilities with releases to water reported.

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| Sites/Abandoned industrial sites | | to past industrial activities, illegal dumping of industrial waste or a pollution accident and which is identified as point source. | |
| 1.6 Point - Waste disposal sites | Urban development | Point sources due to urban or industrial waste disposal sites. | MSDT/EPA |
| 1.7 Point - Mine waters | Industry | Point sources due to the collection of water in an open pit or underground mine which has to be brought to the surface in order to enable the mine to continue working. | MSDT/EPA |
| 1.8 Point - Aquaculture | Aquaculture | | MARD |
| 1.9 Point – Other | | Other point sources not included in the categories above. | N/A |

## Table 4.4 Diffuse source pressures

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 2.1 Diffuse - Urban run off | Urban development; Industry | Storm overflows and discharges in urbanized areas not identified as point sources, | MSDT/EPA |
| 2,2 Diffuse – Agricultural | Agriculture | | MARD: Expert Judgement |
| 2,3 Diffuse – Forestry | Forestry | | MARD; Expert Judgement |
| 2,4 Diffuse – Transport | Transport | Diffuse pollution from road and train traffic, aviation and infrastructure | No data |
| 2.5 Diffuse – Contaminated sites/Abandoned industrial sites | Industry | Pollution resulting from an abandoned industrial site or a site contaminated due to past industrial activities, illegal dumping of industrial waste or a pollution accident and which is identified as diffuse source. | MSDT/EPA |

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 2.6 Diffuse - Discharges not connected to sewerage network | Urban development | Pollution resulting from urban waste water not connected to sewers and identified as a diffuse source | WA; Expert Judgement |
| 2.7 Diffuse - Atmospheric deposition | Agriculture;<br>Energy non-hydro;<br>Industry;<br>Transport;<br>Urban development | Diffuse pollution from atmospheric deposition from any<br>origin | No data |
| 2.8 Diffuse – Mining | Industry | Pollution from mining activities which are identified as diffuse (for point sources see categories above) | WA; MSDT/EPA |
| 2.9 Diffuse – Aquaculture | Aquaculture | | MARD |
| 2.10 Diffuse – Other | Any driver/<br>Other | Other point sources not included in the categories above. | N/A |

## Table 4.5 Abstraction Pressures

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 3.1 Abstraction/Flow Diversion – Agriculture | Agriculture | Includes water transfers and abstractions for irrigation and livestock breeding | MARD |
| 3.2 Abstraction/Flow Diversion – Public Water Supply | Urban development | Includes water transfers | MSDT |
| 3.3 Abstraction/Flow Diversion – Industry | Industry | Abstraction for industrial processes | MSDT; MARD; WA |
| 3.4 Abstraction/Flow Diversion – Cooling water | Industry; Energy<br>non-hydro | | No data |
| 3.5 Abstraction/Flow Diversion - Fish farms | Aquaculture | Typically, off-line fish farms | No data |
| 3.6 Abstraction/Flow Diversion – other | Recreation | Abstraction for any other purpose not<br>listed above | Expert Judgement |

## Table 4.6 Physical Alterations

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 4.1.1 Physical alteration of channel/bed/riparian area/ shore of water body for flood protection | Flood protection | Refers largely to longitudinal alterations<br>to water bodies | MSDT; GIZ |
| 4.1.2 Physical alteration of channel/bed/riparian area/ shore of water body for agriculture | Agriculture | Refers largely to longitudinal alterations to water bodies, which includes land drainage to enable agriculture activities | MARD |
| 4.1.3 Physical alteration of channel/bed/riparian area/ shore of water body for navigation | Transport | Refers largely to longitudinal alterations to water bodies | Expert Judgement |
| 4.1.4 Physical alteration of channel/bed/riparian area/ shore – other | | Refers largely to longitudinal alterations to water bodies | Municipalities |
| 4.1.5 Physical alteration of channel/bed/riparian area/ shore – unknown or obsolete | | In case the driver for the physical modification<br>is unknown. | N/A |
| 4.2.1 Dams, barriers and locks for hydropower | Energy - hydropower | | MoE; MARD |
| 4.2.2 Dams, barriers and locks for flood protection | Flood Protection | | MSDT; GIZ |
| 4.2.3 Dams, barriers and locks for drinking water | Urban development | | WA; Municipalities |
| 4.2.4 Dams, barriers and locks for irrigation | Aquaculture | | No data |
| 4.2.5 Dams, barriers and locks for recreation | Recreation | Small dams are used in rivers to create recreational areas (bathing waters) and also angling areas | WA; MSDT;<br>Municipalities |
| 4.2.6 Dams, barriers and locks for industry | Industry;<br>Energy non-hydro | Dams are sometimes created to provide freshwater for large industry e.g., typically for cooling purposes | MSDT |
| 4.2.7 Dams, barriers and locks for navigation | Transport | | No data |
| 4.2.8 Dams, barriers and locks – other | | | No data |
| 4.2.9 Dams, barriers and locks – unknown or obsolete | | | No data |
| 4.3.1 Hydrological alteration – agriculture | Agriculture;<br>Transport | A change in the flow regime (e.g., due to land drainage) | MARD |

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 4.3.2 Hydrological alteration – transport | Transport | A change in the flow regime - typically due to inland navigation | No data |
| 4.3.3 Hydrological alteration – hydropower | Energy – hydropower | A change in the flow regime (e.g., hydropeaking) | MoE; Expert judgement |
| 4.3 Hydrological alteration – public water supply | Urban development | A change in the flow regime | MARD; WA |
| 4.3.5 Hydrological alteration - aquaculture | Fisheries and aquaculture | A change in the flow regime | No data |
| 4.3.6 Hydrological alteration – other | | | MARD |
| 4.4 Physical loss (or part of) whole water bodies | Flood Protection; Climate change | Dry river beds etc., | MARD |
| 4.5 Other hydromorphological alterations | | Other hydromorphological alterations not included in any of the categories above, including alteration of water level or volume for purposes not identified above. | MARD |

## Table 4.7 Other Pressures

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| 5.1 Introduced species and diseases | Transport, Fisheries and Aquaculture; Tourism and recreation | Includes invasive alien species | Expert Judgment; Eu funded survey |
| 5.2 Exploitation of/removal of animals/ plants | Recreation; fisheries and aquaculture | Commercial fishing or recreational/sports angling, commercial harvesting of plants or algae from water bodies, | No data |
| 5.3 Litter/fly tipping | Urban development; Transport | Includes illegal waste deposits, litter from ships, etc., (All waste from land area) | Expert Judgment |
| 6.1 Groundwater recharges | Agriculture Energy – non-hydro; Industry; | | IHMS; DIKTAS; Municipalities |

| Pressure | Main Drivers | Clarification on Pressures | Data Sources |
|---|---|---|---|
| | Urban development | | |
| 6.2 Groundwater – alteration of water<br>level or volume | Industry<br>Urban development | This category includes activities to alter the level of groundwater in order to carry out an underground activity (typically mining or large civil works), This does not include the alteration of the water level due to current or past overexploitation of the groundwater resources | IHMS; MARD; WA; Academic studies |
| 7. Other anthropogenic pressures | | Other pressures not included in any other category | N/A |
| 8. Unknown Pressures | | Only relevant where status is lower than good, and pressure is unknown | N/A |
| 9. Historical pollution | | In cases where for example a groundwater body is significantly polluted by past activities / pressures that no longer exist | N/A |

### 4.4.5 Information and data on impact from anthropogenic pressures

The impact on a water body results from the pressures combined with the vulnerability to the pressure of the receiving bodies, i.e. groundwater, rivers and lakes. The status of the water body is therefore different from the impact. It must also be taken into account that the status of a water body can also be influenced by natural phenomena.

For surface running waters, the hydrological regime of the river provides an indication on the vulnerability. In this regard, essential information is provided by the flow duration curve. This curve gives the probability that a flow will be exceeded at a particular point on the river. With additional hydro-climatic information and data on the size, it is possible to approach the flow at the outlet of each water body.

The duration of the residence time of water in a lake/reservoir also provides an indication on the vulnerability to the pollution. The longer the residence time, the longer the pollution is likely to stay. Other phenomena must of course be considered, such as the circulation of the water in lakes/ reservoirs during different seasons.

For groundwater, the permeability of the soil and the layer of the geological layer above or the location gives an indication on the vulnerability of the ground water bodies to point source pollution, and to a lesser extent from diffuse source pollution, especially from agriculture, e.g. nitrates, phosphates and pesticides.

The flow duration curve on gauging stations that have long enough records of data are available in Institute of hydrometeorology and seismology of Montenegro. Although extrapolation between the various stations can be performed, in many instances, the situation is more complex due to storage and abstraction for various purposes, especially agriculture and drinking water.

### 4.4.6 Information and data on status of water bodies

Table 4.8 highlights the main sources of information used in this report for the analysis of pressures on the surface waters in the Adriatic River Basin.

**Table 4.8 Main sources of information on status of water bodies**

| Type | Data Processing | Outputs |
|---|---|---|
| - Climatic and hydrological data<br>- Level at monitoring station<br>- Flow at gauging station | Flow duration curve at monitoring | Statistics and flow duration curve |
| Water quality parameters at monitoring stations | Combining datasets and interpretation of data through classification | Assessment of the physico-chemical and biological parameters |
| Springs and wells inventory | Digitization of datasets | Production of shape files for GIS |
| Technical studies of impact assessment of 'hot spots' of pollution | Collated information | General qualitative appreciation of the impact of 'hot spots' |

### 4.4.7 Information on 'Response' to improve the status of water bodies

The data on 'response' is not actually the main focus of this section of the RBMP. The responses to pressures are in fact to be dealt in the subsequent RBMPs after re-assessment of the ecological status following the introduction of a specific Programme of Measures (PoMs).

The full compliant programme of monitoring of waters, in accordance with the requirements of EU legislation, will be established during 2019 as detailed in Section 6. Specific mitigation measures will be planned to be implemented from 2021 in order to improve the ecological and chemical status of impacted water bodies. It is expected that there will be mainly be actions regarding the rehabilitation and development of sewage network as well as building of waste water treatment plants in urban areas. Except for the facilities already in place, it is expected that the new installations will be in service in time to have a positive impact on the water body status before 2021.

However, assumptions can be taken until 2021, which include:

- Pressure will continue due to the further development of tourism;
- The pressures on the water bodies will move from rural areas towards medium and large cities areas. The pressure will decrease in the upper basins and increase in plains and populated areas, medium size and large towns.
- Most of the farms have only several hectares and the small villages in rural area are more and more depopulated. It is assumed that the trend in the agriculture and in the rural sector will not move towards intensification.

As a result, in general the pressure will be expected to decrease at the northern part of Montenegro and increase in the plains and populated areas, as well as in medium size and large towns.

## 4.5 Land use and population pressures

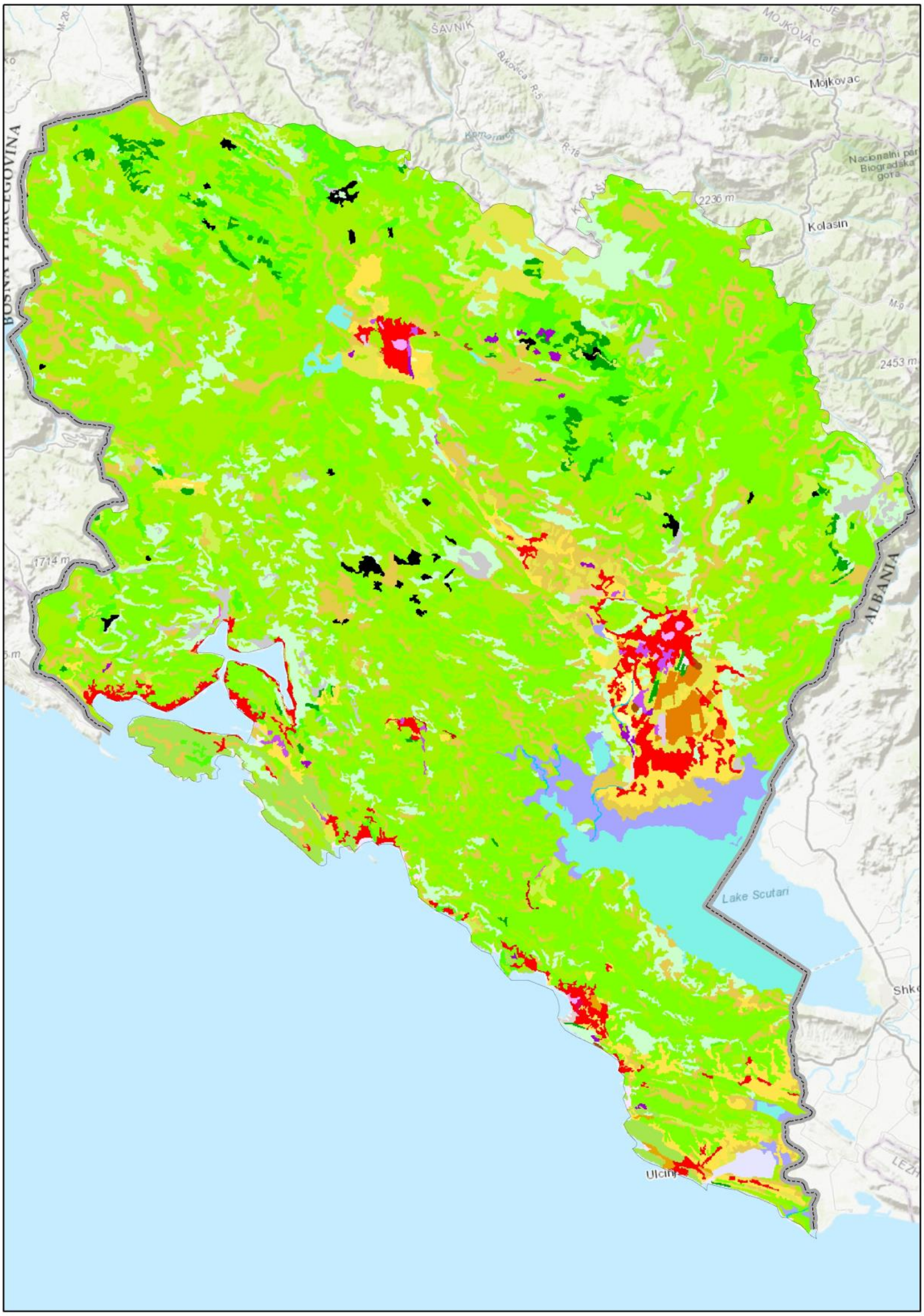
### 4.5.1 Magnitude of pressure using land use

In a context of relatively scarce data regarding the type of pressure (Section 4.4.4), an overall approach of potential pressures was undertaken based on information for land use. The information produced at European level as Corine land cover (CLC)[34], was used as primary source of information. Figure 4.1 shows the main distribution of land uses for the Adriatic River Basin.

Several analyses were performed in order to assess the overall level of potential pressures on the territory, especially on individual water catchments and water bodies. Firstly, based on the CORINE land cover, five groups of land use types present in the Adriatic River Basin were established as shown in Table 4.9.

[34]Corine ( COoRdinate INformation on the Environment) land cover assessment is based on data from 2012

## Figure 4.1  Land use map of the Adriatic River Basin (CORINE 2012)



# Corine land cover classes

## 1. Artificial surfaces

### 1.1 Urban fabric

- 1.1.1. Continuous urban fabric
- 1.1.2. Discontinuous urban fabric

### 1.2 Industrial, commercial and transport units

- 1.2.1. Industrial or commercial units
- 1.2.2. Road and rail networks and associated land
- 1.2.3. Port areas
- 1.2.4. Airports

### 1.3 Mine, dump and construction sites

- 1.3.1. Mineral extraction sites
- 1.3.2. Dump sites
- 1.3.3. Construction sites

### 1.4 Artificial, non-agricultural vegetated areas

- 1.4.1. Green urban areas
- 1.4.2. Sport and leisure facilities

## 2. Agricultural areas

### 2.1 Arable land

- 2.1.1. Non-irrigated arable land
- 2.1.2. Permanently irrigated land
- 2.1.3. Rice fields

### 2.2 Permanent crops

- 2.2.1. Vineyards
- 2.2.2. Fruit trees and berry plantations
- 2.2.3. Olive groves

### 2.3 Pastures

- 2.3.1. Pastures

### 2.4 Heterogeneous agricultural areas

- 2.4.1. Annual crops associated with permanent crops
- 2.4.2. Complex cultivation patterns
- 2.4.3. Land principally occupied by agriculture
- 2.4.4. Agro-forestry areas

## 3. Forest and seminatural areas

### 3.1 Forests

- 3.1.1. Broad-leaved forest
- 3.1.2. Coniferous forest
- 3.1.3. Mixed forest

### 3.2 Shrub and/or herbaceous vegetation associations

- 3.2.1. Natural grassland
- 3.2.2. Moors and heathland
- 3.2.3. Sclerophyllous vegetation
- 3.2.4. Transitional woodland shrub

### 3.3 Open spaces with little or no vegetation

- 3.3.1. Beaches, dunes, and sand plains
- 3.3.2. Bare rock
- 3.3.3. Sparsely vegetated areas
- 3.3.4. Burnt areas
- 3.3.5. Glaciers and perpetual snow

## 4. Wetlands

### 4.1 Inland wetlands

- 4.1.1. Inland marshes
- 4.1.2. Peat bogs

### 4.2 Coastal wetlands

- 4.2.1. Salt marshes
- 4.2.2. Salines
- 4.2.3. Intertidal flats

## 5. Water bodies

### 5.1 Inland waters

- 5.1.1. Water courses
- 5.1.2. Water bodies

### 5.2 Marine waters

- 5.2.1. Coastal lagoons
- 5.2.2. Estuaries
- 5.2.3. Sea and ocean

### Table 4.9 Corine land cover types allocated by pressures groups

| Code Corine Land Cover Class (2012) | Pressure Group | Nomenclature |
|---|---|---|
| 1 | 1 | Artificial areas |
| 2.1 | 2 | Arable land |
| 2.2 | 2 | Permanent crops |
| 2.3 | 3 | Pastures |
| 3.1 | 4 | Forested and Semi-Natural Areas |
| 3.2 | 4 | Semi-natural vegetation |
| 3.3 | 4 | Open spaces and bare soil |
| 4.1 | 4 | Wetlands |
| 5.1 | 4 | Inland waters |

The first class includes all artificial surfaces indicating the higher level of potential pressures, mostly related to urban areas, industries or mining activities. Class 2 covers the agricultural activities, which highlight the agricultural activities that are more likely to include a higher level of pressures (mostly from diffuse pollution; irrigated and non-irrigated arable lands, vineyards, orchards) as well those including pastures and non-intensive agricultural practices, that are related to a lower level of pressures. The third class incorporates the low pressures types, such as forest covers, bare rocks and natural areas. Classes 4 and 5 refer to inland wetland, which are sensitive to pollution and inland waters, which are the main recipient of pollution, respectively.

With GIS processing, it was possible to assess the general exposure to land use related pressures for the catchments and water bodies. This mostly helps identifying two main outcomes:

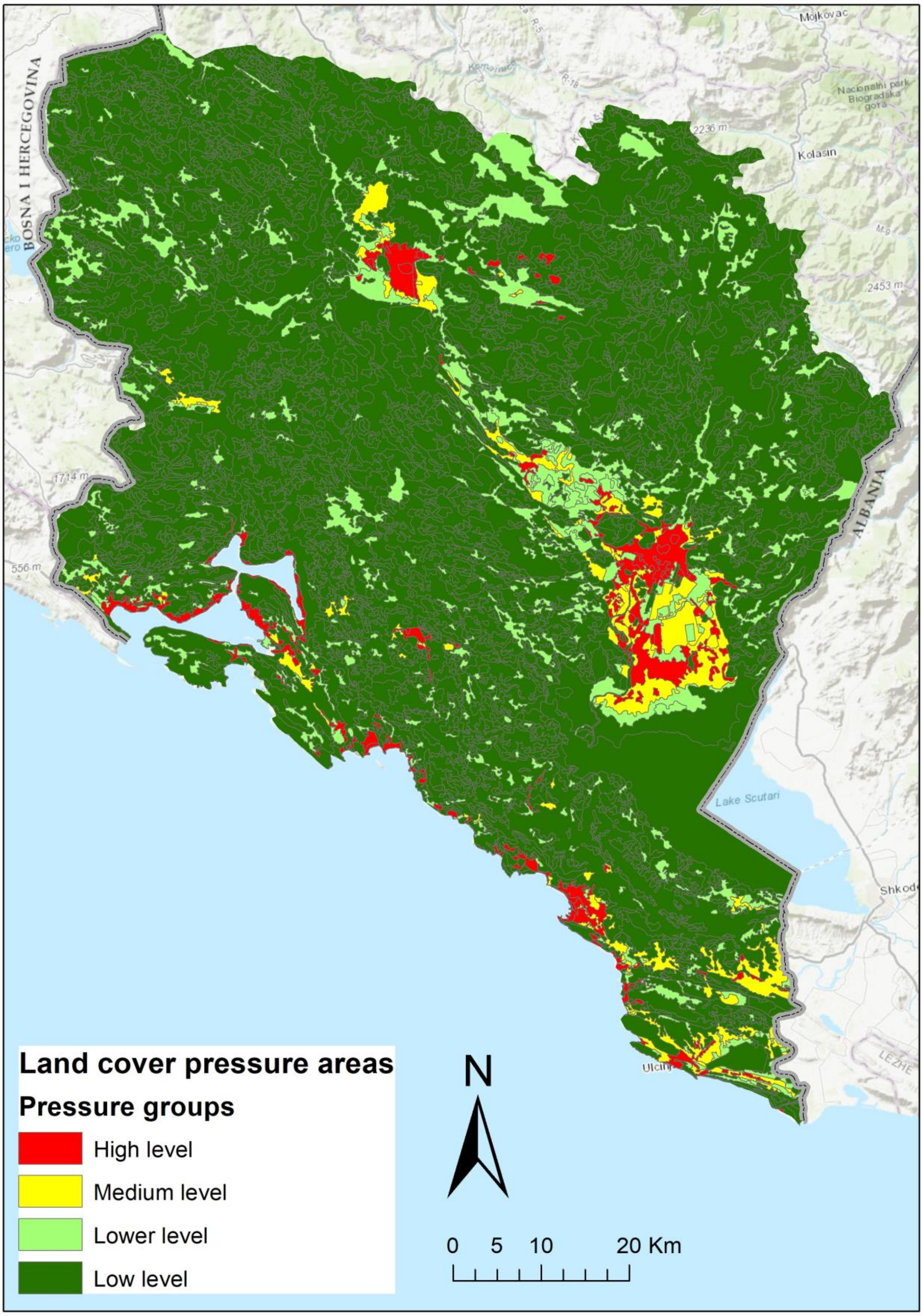
- Catchments and water bodies exposed to a high level of pressures (i.e. with a significant share of Corine land cover pressures types falling under the Group 1). Those water bodies are consequently likely to be at risk;
- Catchments and water bodies under low level of land used related pressures (i.e. with a significant share of low-level land use related pressures Groups 3 and 4)

Figure 4.2 illustrates the computational analysis of the high, medium and low pressure on water bodies in the Adriatic River Basin using indicators from Corine land cover. The vast majority of Group 3 and 4 falls under the lower pressure category (green). Figure 4.2 also highlights “hot spot” catchments (red) where the proportion of urban areas and intensive agricultural areas are higher than 60%. The areas in yellow provide less significance as regards the exposition to land use related pressures, i.e. showing patterns that are more mixed.

The analysis of land use is simply a pre-screening to further analysis, by indicating preliminary information on sub-catchments that are “probably at risk” and also “probably not at risk”.

One should underline that this method does not account for the cumulative effects or pressures along the river streams. Nevertheless, this pre-screening is helpful for further analysis of all other information on pressures (especially point sources and hydromorphological alterations) as illustrated in the following chapters.

**Figure 4.2 High, medium and low pressure on water bodies in the Adriatic River Basin using indicators derived from Corine land cover**



### 4.5.2 Intensity of pressure using density of population

The population of the Montenegro is 620,029 inhabitants[35].

The area of the Adriatic River Basin (ARB) is 6,650 $km^2$ or 47.8% of the surface area of Montenegro with 442,193 inhabitants, which makes up 71.4% of the total population.

The density of population in the Adriatic River Basin as shown in Figure 4.3, is, on average, 64 inhabitants per $km^2$, which is more than the average value for the whole country but below the value for EU 28 (116 per $km^2$).

The State territory is administratively divided into 24 municipalities, with municipal centers that are bearers of local self-government. There are 11 main municipalities in the Adriatic River Basin. 9 municipalities are located completely in the Adriatic River Basin. Kolašin (47%), Nikšić (96%) and Podgorica (88.2%) are also located in the Adriatic River Basin but with some territory in the Danube River Basin. Similarly, the municipalities of Plužine (4.5%) and Šavnik (1.1%) also reside in the Adriatic River Basin, albeit to a very small extent. The difference between administrative boundaries and river basin boundaries adds some presently unresolvable complications when it comes to determining the exact density of the population inside of the Adriatic River Basin. The figures shown in Table 4.10 below do not take into account these differences.

The information related to population pressure is obtained for the following purposes:

- Describing the "**driving forces**", especially land use, urban development, industry, agriculture and other activities which lead to pressures, without regard to their actual impacts;
- Identifying "**pressures"** with possible impacts on the water body and on water uses, by considering the magnitude of the pressures and the susceptibility of the water body.

#### Table 4.10 Number of inhabitants and population density in the Adriatic River Basin

| Municipality | Surface ($km^2$) | Population[32] | Density (Inhabitants/$km^2$) |
|---|---|---|---|
| Bar | 598 | 42,048 | 70 |
| Budva | 122 | 19,218 | 157 |
| Cetinje | 899 | 16,657 | 19 |
| Danilovgrad | 501 | 18,472 | 37 |
| Herceg Novi | 235 | 30,864 | 131 |
| Kolašin[36] | 418 | 8,380 | 9 |
| Kotor | 335 | 22,601 | 67 |

[35] Data gathered from census 2011 together with data recorded for the new municipality of Tuzi created in 2018

[36] 47% of Kolašin Municipality is inside the Adriatic River Basin. The accurate calculation of the population residing in the Adriatic River Basin is not possible. Surface area determined by GIS.

| | | | |
|---|---|---|---|
| Nikšić[37] | 1,959 | 72,443 | 35 |
| Podgorica[38] | 1,263 | 185,937 | 133 |
| Tivat | 46 | 14,031 | 305 |
| Tuzi | 236 | 12,096 | 67 |
| Ulcinj | 255 | 19,921 | 78 |
| Adriatic River Basin | **6,867**[39] | **442,193**[40] | **64** |
| Montenegro | **13,910** | **620,030** | **45** |

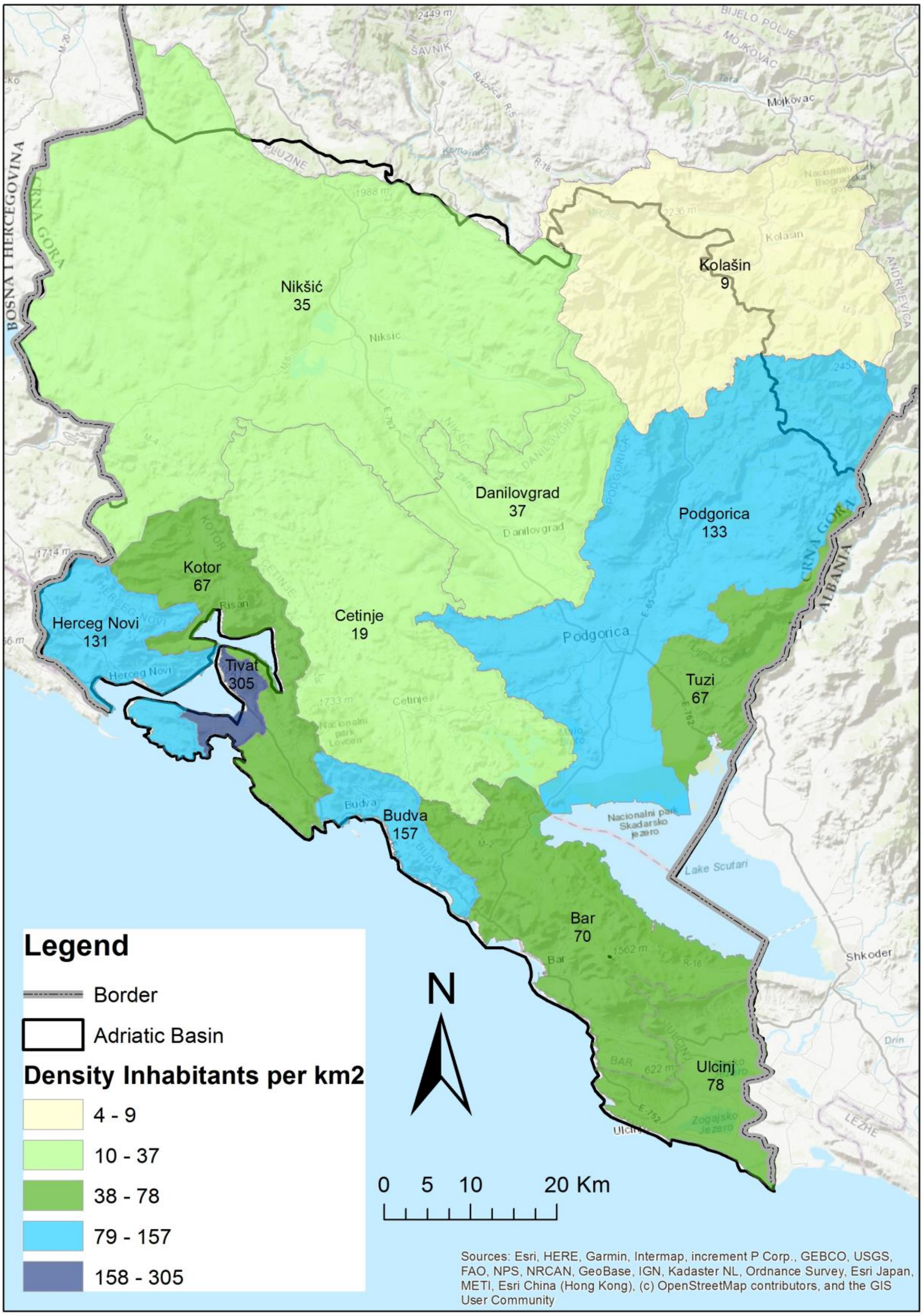
[37] 96% of the Nikšić Municipality is inside the Adriatic River Basin. The accurate calculation of the population residing in the Adriatic River Basin is not possible. Surface area determined by GIS.

[38] 88.2% of the Podgroica Municipality is within the Adriatic River Basin. The accurate calculation of the population residing in the Adriatic River Basin is not possible. Surface area determined by GIS.

[39] Official figure, GIS shape files provided by MARD are slightly less (2%) in total area.

[40] Population figure are not accurate due to the difference between admistrative boundaries and the river basin distict boundaries. The figure refected in Table4.10 is based on census data collected in 2011.

**Figure 4.3 Population density by municipalities**



### 4.5.3 Driving forces

The Gross Domestic Product (GDP) in Montenegro has been estimated (source: EUROSTAT) at 3,625 million Euros in 2017. Comparing the figures for 2016, the GDP has a growth rate of 4.59%, which is more than the growth rate for 2016 which was of 2.9%.

These figures reflect the dynamism of the Montenegrin economic activity, in particular compared with the situation of the Euro zone where the average expected growth rate remained between 1.0 and 1.6% for 2017.

The current economic situation has helped to reduce the unemployment rate from 18% in 2014 to 17.7% in 2016, which remains a high value and thus a major challenge for the Montenegrin economy in the coming years.

The GDP per inhabitant is of 6,424 Euros in 2017 to be compared with the same ratio of 25 500 Euros for EU 28. Montenegro is also still behind the new EU Members States like Croatia (11,479 Euros) and Slovenia (20,690 Euros).

The macro-economic framework, for the period 2017 -2019, is based on the assumption of real GDP growth of 3.2% in 2017, 4.4% in 2018 and 2.6% in 2019. In the period 2017-2019, the growth of the Montenegrin economy, due to the growth of investment activity and engagement of domestic potentials, primarily in the construction and transport sector, as well as multiplicative effects on related sectors. The strong contribution of the construction sector will be encouraged by the involvement of domestic operators in the construction of infrastructure, new tourist capacities and energy facilities. In the operational phase of the functioning of these projects, a significant growth of the potential of the economy is expected, with multiplying effects on the entire economy. A special contribution is also expected from the agricultural sector, given the significant investments in this sector, and the effects would be visible through the substitution of food imports and increased exports. Average projected growth rate of GDP for the period 2017-2019 is 3.4%.[41]

In 2016, the Agriculture accounted for 8% of the GDP, Industry for 32.9% and services for 59.1%.[42]

**The Agriculture accounted for 8 % of the GDP**. The Montenegro is covered by 2,558 km$^2$ of agriculture land which accounts for 18.5% of its territory. The biggest part of these 2,400 km$^2$ (94%) are perennial meadows and pastures. That is reason why the agriculture provide activity to only 1% of the labor forces is characterized by a large number of small agricultural units in rivers valleys.

**Industry accounts for 32.9 % of the GDP**. The industrial sector is still characterized with the legacy of the socialist period with large factories with important pollution and quiet obsolete process. A large number of factories do not work because it is closed or under acquisition. Significant factories have been privatized and funds have been invested in modernizing the technological process and protecting the environment. Currently, the focus is on the development of small businesses. Also, construction is expanding due to the construction of large facilities such as the highway, numerous tourist complexes, etc.

Finally, **services account for 59.1 % of the GDP**. The largest share in GDP is the income from tourism in the coastal region.

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[41]Economic Reform Programme of Montenegro 2017 – 2019, Government of Montenegro, January 2017

[42] Statistical Yearbook 2017

## 4.6 Point sources of pollution

### 4.6.1 Point sources of pollution from agglomerations

In the analysis of sources of pollution originating from the population two groups were recognized: permanent population and occasional population during the tourist season.

The population of the Adriatic River Basin is 442,192 inhabitants with a population density of 64 inhabitants per km$^2$. In this part of the country there are two largest cities: Podgorica and Nikšić, where 62.8% of the total population of the Adriatic River Basin reside (41.6% of the total population of Montenegro).

The Urban Wastewater Treatment Directive (91/271/EEC) set a schedule for the treatment of agglomeration according to their size. Agglomerations areas have first to be delineated. In November 2017, the Government adopted the Rules on the agglomerations ("Official Gazette of Montenegro", 078/17).

The pollution fluxes are originating from various pathways. The point sources of pollution are mainly discharge of wastewaters into rivers through sewage systems. The wastewaters are coming from households and industries, which are connected to public sewage systems. The wastewaters from towns and surrounding urban areas have to collect in units called “agglomerations”. In accordance with Article 8 of the Law on Municipal Waste Water Management ("Official Gazette of Montenegro", No. 002/17 of 10/01/2017) the definition of an agglomeration is as follows:

‘Agglomeration is an area where the population and / or economic activities are concentrated in such a way that municipal wastewater can be collected and carried to the wastewater treatment plant or to the final discharge point.’

Agglomerations have been identified in the Adriatic River Basin according to the Official Gazette of Montenegro, No. 078/17 of 23 November 2017 (Table 4.11).

#### Table 4.11 Agglomerations in the Adriatic River Basin

| Municipality[43] | Agglomeration | Settlements | Agglomeration Population | Maximum Capacity of Agglomeration (PE) |
|---|---|---|---|---|
| Bar | Bar 1k | Djurmani, Mišići, Zgrade, Papani, Brca, Čanj, Zagrađe(Bjelila), Sutomore(Naj Nehaj, Mirošica 1, Mirošica 2, Ratac, Staro Sutomore, | 4,554 | 30,000 |

[43] Although is 47% territory of the Municipality of Kolasin in the Adriatic basin area, Kolasin municipality is not included in the table 3.11 because there is no agglomerations with ≥2000 PE. Also, The Rules on the borders of the sub-floor areas and the small-basin areas ("Official Gazette of Montenegro", No. 015/16 of 03.03.2016) did not define precisely the boundaries of individual sub-watersheds and it is not possible to determine affiliation with a particular river basin district. This is the reason why this Regulation requires revision.

| Municipality[43] | Agglomeration | Settlements | Agglomeration Population | Maximum Capacity of Agglomeration (PE) |
|---|---|---|---|---|
| | | Zelen), Đenđinovići (Rutke), Zankovići (Gorelac) I Miljevci (Pobrđe) | | |
| | Bar 2 | Šušanj (Glavanovići, Gromanići, Paladini, Perajkovići, Vitići,Zeleni Pojas), Zupci, Sustaš (Mandarinići, Podsustaš), Bar (Ilino, Makedonsko,Sokolana, Topolica, Žukotrlica), Bjeliši, Polja (Murvice Kopljeva), Čeluga (Donja I Gornja), Burtaiši (Ahmetov Brijeg, Donji Marovići, Gornji Bjeliši, Popovići, Rena, Ronkula), Velembusi(Biskupada, Gornji Marovići), Čeluga(Donja Čeluga, Gornja Čeluga), Stari Bar(Baukovo, Belveder, Brbot, Gornja Rena, Gretva, Podgrad), Tomba(Donja Tomba, Gornja Tomba), Bartula, Zaljevo(Donje Zaljevo, Gornje Zaljevo) | 30,811 | 67,000 |
| | Bar 3 | Dobra Voda (Nišice), Pečurice, Bištine I Dubrava | 1,644 | 7,000 |
| | Bar 4 | Kunje (Bušat, Komina) | 424 | 3,000 |
| Budva | Budva 1 | Budva, Borati, Bečići, Cucuke, Viti Do, Pržno, Sveti Stefan, Rađenovići, Drobnići, Rijeka Reževići, Krstac, Katun Reževići | 15,545 | 95,000 |
| | Budva 2 | Petrovac Na Moru, Novoselje, Kaluđerac, Buljarica | 1,887 | 16,000 |
| | Budva 3 | Prijevor-Jaz | 712 | 4,000 |
| Cetinje | Cetinje 1 | Cetinje, Bajice | 14,772 | 20,000 |
| Danilovgrad | Danilovgrad 1 | Danilovgrad, Orja Luka (Pažići, Grlić) | 5,450 | 7,000 |
| | Danilovgrad 2 | Spuž | 1,722 | 3,500 |
| Herceg novi | Herceg novi 1 | Baošići, Bijela, Đenovići, Herceg Novi, Igalo, Jošice, Kumbor, Kuti, Meljine, Podi, Provodina, Sasovići, | 29,179 | 85,000 |

| Municipality[43] | Agglomeration | Settlements | Agglomeration Population | Maximum Capacity of Agglomeration (PE) |
|---|---|---|---|---|
| | | Sušćepan, Sutorina, Zelenika | | |
| | Herceg novi 2 | Luštica-Rose | 300 | 2,000 |
| | Herceg novi 3 | Luštica-Žanjice | | 2,000 |
| Kotor / Tivat | Kotor 1-Tivat 1 | Bogišići, Donja Lastva, Đuraševići, Gošići, Krašići, Lepetani, Mrčevac, Tivat-Dobrota, Donji Orahovac, Donji Stoliv, Dražin Vrt, Kavač, Kotor, Muo, Perast, Prčanj, Radanovići, Risan, Škaljari | 32,793 | 72,000 |
| | Tivat 2 | Milovići, Radovići | 581 | 3,500 |
| | Kotor 2 | Bigova | 101 | 2,000 |
| | Kotor 3 | Donji Morinj, Kostanjica | 348 | 2,500 |
| | Kotor 4 | Lastva Grbaljska | 537 | 3,500 |
| Nikšić | Nikšić 1 | Nikšić, Ozrinići | 59,341 | 90,000 |
| Podgorica | Podgorica 1 | Podgorica, Botun, Srpska | 152,812 | 200,000 |
| | Golubovci 1 | Ljekovići, Mitrovići, Golubovci, Mojanovići, Mahale, Goričani, Šušunja, Balaban, Gostilj, Berislavci, Mataguži | 12,007 | 15,000 |
| Tuzi | Tuzi 1 | Tuzi, Gornji Milješ, Donji Milješ, Vuksanljekići | 6,656 | 10,000 |
| Ulcinj | Ulcinj 1 | Bijela Gora, Bratica, Kodra, Ulcinj, Donji Štoj, Gornji Štoj) | 13,449 | 65,000 |

The Urban Wastewater Treatment Directive requires that only settlements with a population in excess of 2,000 be provided with sewers. The point pollution pressure from towns over 500 inhabitants is considered as significant. The settlements under 500 inhabitants were considered as a potential source of diffuse pollution. The number of inhabitants and the populations above 2,000 inhabitants in main cities and towns in the Adriatic River Basin are shown in Table 4.12 and 4.13, respectively.

### Table 4.12 Population categories of cities and towns in the Adriatic River Basin

| Population | Adriatic River Basin |
|---|---|
| >100,000 | 1 |

| Population | Adriatic River Basin |
|---|---|
| 100,000 – 50,000 | 1 |
| 50,000 – 20,000 | - |
| 20,000 – 10,000 | 7 |
| 10,000 – 5,000 | 1 |
| 5,000 – 2,000 | 4 |
| 2,000 – 1,000 | 1 |

### Table 4.13 Populations above 2,000 inhabitants in main cities and towns in the Adriatic River Basin

| Rank | City/Town | Urban Population | Urban Sewage Network Coverage (%)[44] | Sub-River Basin[45] |
|---|---|---|---|---|
| 1. | Podgorica | 156,200 | 65 (S) / 60 (P) | Morača |
| 2. | Nikšić | 57,290 | 48 (S) / 53 (P) | Zeta - Morača |
| 3. | Herceg Novi | 19,620 | 70 (S) / 70 (P) | Adriatic Sea |
| 4. | Bar | 17,700 | 100 (S) / 100 (P) | Adriatic Sea |
| 5. | Budva | 15,930 | 95 (S) / 95 (P) | Adriatic Sea |
| 6. | Cetinje | 14,160 | 40 (S) / 40 (P) | Skadar Lake |
| 7. | Kotor | 12,710 | 15 (S) / 42 (P) | Adriatic Sea |
| 8. | Ulcinj | 10,707 | 90 (S) / 91 (P) | Adriatic Sea |
| 9. | Tivat | 10,140 | 50 (S) / 90 (P) | Adriatic Sea |
| 10. | Danilovgrad | 6,890 | 30 (S) / 30 (P) | Zeta - Morača |
| 11. | Bijela | 3,691 | No data | Adriatic Sea |
| 12. | Golubovci | 3,110 | No data | Morača |
| 13. | Sutomore | 2,004 | No data | Adriatic Sea |

[44] Sewage network coverage is presented as the % for either spatial coverage (S) or for the urban population connected (P)

[45] Sub-River Basins in the Adriatic River Basin are shown in Figure 3.1

The main source of pollution in the rivers is arising from the agglomerations. Prevailing pollutants in Montenegro are mainly the result of wastewater from point sources, i.e. settlements and industry. There are only a limited number of wastewater treatment plants (WWTP).

With respect to the Adriatic River Basin, as early as 2005, the Government of Montenegro adopted an important strategic position in the field of waste water (*Master plan for wastewater Costal Region and Municipality of Cetinje)*, in line with the policy documents provided and planned for the construction of sewage treatment plants and wastewater in urban parts of the municipality, as well as bringing the system into a state in accordance with the the Urban Wastewater Treatment Directive (UWWTD)[46].

The status of existing wastewater treatment works in the municipalities in the Adriatic River Basin, are presented in Table 4.14 with their locations provided in Figure 4.4.

The status of wastewater treatment plants under construction and planned in the Adriatic River Basin is presented in Table 4.15.

## Table 4.14 Existing Wastewater treatment plants in the Adriatic River Basin

| Municipality | Location | Design capacity (PE) | Type of treatment | Comment |
|---|---|---|---|---|
| Bar | Virpazar | 1,000 | • Primary treatment<br>• Secondary treatment | Treatment plant dysfunctional |
| Budva | Budva | 100,000 | • Primary treatment<br>• Secondary treatment | • No effluent disinfection<br>• 2,659,721 $m^3$/day volume of wastewater treated<br>• 2,919 tons/annum of sludge produced |
| Budva | Jaz | 1,000 | • Primary treatment<br>• Secondary treatment | No effluent disinfection |
| Cetinje | Rijeka Crnojevića | 1,000 | • Primary treatment<br>• Secondary treatment | Treatment plant dysfunctional |
| Herceg Novi | Herceg Novi | 65,300 | Primary treatment | • Effluent disinfection<br>• 2,789,947 $m^3$/day volume of wastewater treated |
| Nikšić | Nikšić | 110,000 | • Primary treatment<br>• Secondary treatment<br>• Tertiary treatment – N & P removal | • Effluent disinfection<br>• 3,193,395 $m^3$/day volume of wastewater treated<br>• No sludge treatment (sludge stored on-site) |
| Podgorica | Podgorica | 55,000 | • Primary treatment<br>• Secondary treatment | • No effluent disinfection |

46 Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment with its amendments (Directive 98/15/EC and Regulations (EC) 1882/2003 and (EC) 1137/2008

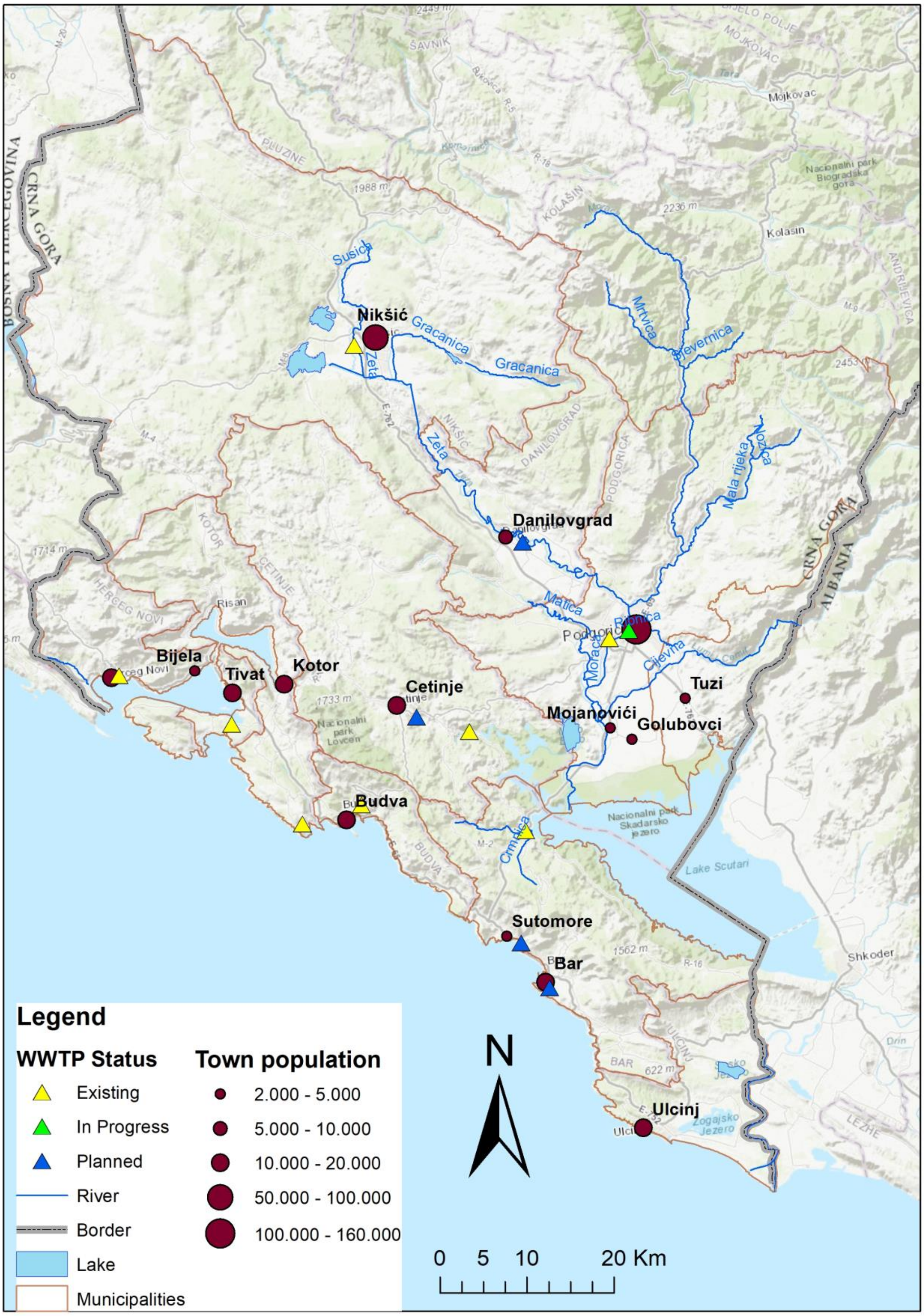
| Municipality | Location | Design capacity (PE) | Type of treatment | Comment |
|---|---|---|---|---|
| | | | | • 4,516,875m$^3$/day volume of wastewater treated<br>• 5,806 tons/annum of sludge produced<br>• No sludge treatment (sludge stored on-site) |
| Tivat & Kotor | Tivat/ Kotor | 72,000 | • Primary treatment<br>• Secondary treatment | No effluent disinfection |

### Table 4.15 Wastewater treatment plants under construction and planned in the Adriatic River Basin

| WWTP | Design Capacity (PE) | Start Date |
|---|---|---|
| **In Progress** | | |
| Podgorica | 235,000 | 2019[47] |
| **Planned** | | |
| Bar (Centre) | 68,000 | Not Specified |
| Bar (Sutomore) | 30,000 | Not Specified |
| Cetinje | 13,400 | Not Specified |
| Danilovgrad | 6,000 1st Phase<br>12,000 Final Phase | Not Specified |
| Kotor & Tivat<br>(Sludge drying Plant) | 68,000 | Not Specified |

[47] In September 2019 a contract was signed for the construction of a Waste Water Treatment Plant (WWTP) in Podgorica.

**Figure 4.4 Urban wastewater point pressures and location of functional WWTPs in the Adriatic River Basin**



### 4.6.2 Industrial activities

During the 1990s, due to wars and economic blockade, the total economic activity in Montenegro decreased considerably. Consequently, industrial production recorded a constant downward trend in the same period. In addition, during this period, and later during the transition period, the structure of the Montenegrin economy has changed significantly in favor of the services.

As a consequence of all these trends, statistics show that in the early 1990s, the share of industrial production in total production was at the level of 40%, while in 2000 it decreased to 19.1%, while in 2012 it further dropped to 10.4%.

Due to these circumstances, the number of large companies has decreased, and emphasis is placed on the development of small and medium-sized enterprises. The number and type of main enterprises in the Adriatic River Basin are presented in Table 4.16 together with the rivers which are the recipient of any potential pollution.

**Table 4.16 Main enterprises and recipient rivers in the Adriatic River Basin**

| Main Enterprise Types (number of enterprises) | Recipient River of Potential Pollution |
|---|---|
| Bauxite (1), Meat processing (1), Paper and cardboard (1) | Cetinje |
| Aluminum production (1), Bakery Products (1), Chemical industry - hygiene products (1), Pharmaceutical products (1), Plantation shrubs and vineyards (1), Processing of fruits and vegetables (1), Gravel Extraction (3) | Morača |
| Fish processing (1) | Rijeka Crnojevica |
| Animal feed (1), Bakery Products (1), Bauxite (1), Brewery (1), Dairy products (1), Fish processing (1), Grain mill products (1), Intensive livestock (1), Juice production (1), Meat processing (1), Metal construction (1), Stone processing (1), Tea and coffee (1), Wood processing (1) | Zeta |
| Bakery Products (1), Meat processing (1) | Discharge to Adriatic Sea |

Permits issued by the EPA control the pollution from industries. The operators have to install the required system to prevent and control pollution, as per the IPPC Directive /Industrial Emission Directive (IED).

Although the Law on Integrated Prevention and Control of Environment (Official Gazette of the Republic of Montenegro, No. 080/05, Official Gazette of Montenegro, No. 054/09, 040/11, 042/15) was adopted in 2005 and several times it has been harmonized with EU directives, to date, a small number of IPPC licenses have been issued. Nationally, there are only 5 IPPC permissions[48], so this cannot be the primary source of information.

[48] IPPC permissions received: landfill Livade in Podgorica (2), landfill Mozura in Bar, Toscelik Alloyed Engineering Steel in Niksic, Thermo-electricity power plant in Pljevlja, and Plant for acetylene production in Bijela.

Neither the EPA nor the Water Administration has established a pollutant cadaster. In order to form a database, it is necessary to prepare and send questionnaires to operators in order to collect data on the discharges and the quality of discharged water.

Another source of information is data obtained from the Water Administration, based on Water Permits and fees paid by operators for affected and discharged water.

The main source of information is the Master Plan for Collection and Treatment of Waste Water for the Montenegrin Coast and the Municipality of Cetinje, which were adopted in 2005. At the moment, these documents are being revised, so the data presented will be updated if is necessary. Also, data from the study for Water Supply and Wastewater Disposal, Adriatic Coast in Montenegro from 2007 have been used.

In order to express the potential point pressures related to industrial sites, a selection from the database was performed for activities that could impact waters. The sectors of industries, which were distinguished, are the following: transport, bakeries, meat processing, food industry, metallurgy, chemical, pharmaceutical, wood-paper processing, construction and electricity production.

According to available data, the following waterbodies have point source pressures that originate from industry (IED and non IED plants): Zeta_2 (SWB 21), Morača_5 (SWB 18), Zeta_4 (SWB 28), Morača_6 (SWB 30), WB2_North (SWB 37) (Tables 4.36 and 4.37). Of the listed waterbodies, Zeta_2 , Zeta_4 and Morača_6 are under the strongest negative impact by industry.

As for groundwater, the pollution can arise from sites from mines, quarries, contaminated areas and landfills (Table 4.17).

### Table 4.17 Point source pollution of importance to groundwaters

| Point Source | Pressure | Data Used |
|---|---|---|
| Mine Sites | Former Mine Sites; Active Mine Sites | Register of former and current mine sites |
| Quarry Sites | Accidental Spillages in Active Mine Sites | Environmental inspectorate data |
| Contaminated Sites | Sites with contaminated land associated with such activities as: energy production; metal works and refinery; chemical manufacturing; pharmaceutics; dairy production; paper pulp manufacturing; wood treatment; organic solvent coating; electroplating. | Licensed activity sites that are/maybe/or had contaminated land issues |
| Landfills | Waste license landfill sites and old landfills/dumps | EA- waste/IPPC department List of Current permits landfills and list of old dumps |
| Oil Industry Infrastructure | Large production. Storage facilities or import facilities. | List of licensed IPPC/ VOC site |

### 4.6.3 Tourism

Tourism is the most important economic sector in Montenegro. Montenegro attracts a great number of tourists annually. The number in 2016 was over 1.8 million, according to the survey conducted by Monstat. Tourism in Montenegro is being reaffirmed in recent years, followed by a series of infrastructure projects, aimed at reinventing Montenegro as an elite tourist destination in the future, for tourists from all over the world, especially from the region and particularly the countries of the European Union.

The coast and the mountains, because of their proximity can be characterized as the main comparative advantage of Montenegro in the wide variety of the competition in the tourism market. With all the other benefits, climate is a crucial prerequisite for the successful development of tourism. Montenegro has a pleasant summer climate and is ideal for bathing and summer tourism. Winter rainfall is heavy on the coast, while the mountains are suitable for all kinds of winter sports. The Municipality of Budva with Bečići is currently, qualitatively and quantitatively, the most important tourist resort on the coast. Budva is closely followed by Bar and Herceg Novi. According to the projections in municipality Tivat, Luštica peninsula and marina "Porto Montenegro" Tivat and municipality Ulcinj, because of its potential in Ada Bojana, the Long Beach and Valdanos, will experience rapid growth by 2020 and become primary tourist destinations. Thanks to its natural beauty and favorable geographic and other climatic conditions, as well as the efforts and achievements by providers of tourist services, in a relatively short period of time, Montenegro arose comparing to the competitor destinations in the Mediterranean, reaching the international level of service quality and exceeding the expectations when it comes to the evaluation and protection of natural resources, sustainability and innovation.

The pollution from tourism is estimated based on the number of tourists, overnights and number of beds in tourist facilities (see Section 4.6.4)

Table 4.18 shows that according to the Statistical Yearbook, the total number of guests in 2016 was 1,859,939, with 11,707,548 overnight stays. Over 95% tourists were registered in the Adriatic River Basin, i.e. in 6 coastal municipalities (1,895,939 tourists).

#### Table 4.18. Tourism in Adriatic Basin (2017)[49]

| Municipality[50] | Population (Number of Inhabitants) | Arrivals of tourists | | | Overnight stays of tourists | | |
|---|---|---|---|---|---|---|---|
| | | Foreign | Domestic | Total | Foreign | Domestic | Total |
| Bar | 42,048 | 164,274 | 10,828 | 175,102 | 1,630,468 | 43,169 | 1,673,637 |
| Budva | 19,218 | 821,795 | 26,648 | 848,443 | 4,731,639 | 92,879 | 4,824,518 |
| Danilovgrad | 18,472 | 2,912 | 132 | 3,044 | 13,149 | 360 | 13,509 |
| Kotor | 22,601 | 111,785 | 1,004 | 112,789 | 463,455 | 3,352 | 466,807 |
| Nikšić | 72,443 | 7,291 | 1,524 | 8,815 | 17,902 | 4,454 | 22,356 |

[49] MONSTAT: Survey on arrivals and overnights stays of tourists, total 2017.

[50] No data available for Tuzi

| Municipality[50] | Population (Number of Inhabitants) | Arrivals of tourists | | | Overnight stays of tourists | | |
|---|---|---|---|---|---|---|---|
| | | Foreign | Domestic | Total | Foreign | Domestic | Total |
| Podgorica | 185,937 | 131,681 | 14,514 | 146,195 | 228,170 | 33,049 | 261,219 |
| Tivat | 14,031 | 90,379 | 6,005 | 96,384 | 850,213 | 19,329 | 869,542 |
| Ulcinj | 19,921 | 179,366 | 9,731 | 189,097 | 1,115,200 | 53,800 | 1,169,000 |
| Herceg Novi | 30,864 | 281,203 | 13,433 | 294,636 | 2,203,855 | 139,815 | 2,343,670 |
| Cetinje | 16,658 | 9,296 | 11,592 | 20,888 | 26,759 | 36,531 | 63,290 |
| **Total** | **442,193** | **1,799,982** | **95,411** | **1,895,393** | **11,280,810** | **426,738** | **11,707,548** |

This sector is important it is characterized by significant variability in water demand, namely temporal variability with significant peaks during the summer period when water availability is at its lowest; and spatial variability with the tourism industry being concentrated along the coasts, which can experience significant water imbalances and water quality deterioration of coastal bathing zones.

The main causes of the tourist demand for freshwater are:

- **Higher water consumption due to tourist population.** In certain tourist areas and especially in the dry season of summer the local population of a destination can increase many times (sometimes more than ten). This increase in population means a proportional or over proportional increase in water consumption. In some areas water demand during the peak tourism months can be much higher than the demand of local population in a whole year.

- **Higher water demands due to tourist facilities.** There are a variety of constructions and tourist facilities that imply additional water demand. This means for hotels 20%, for camping sites 40% more consumption and cost than in the businesses of their colleagues without pool (Ecologic 2007)[51].

- **Higher water demands due to the urbanization of tourist areas.** In most cases, tourism development forces urbanization of tourist areas. Tourists need a lot of services and facilities like transport, trade, banking, post, hospitals, leisure etc. which are offered by people that have to leave in the tourist area. This leads to an increase of the local population (at least during the tourist season) that has important implications no only on water demand but also on land use. Additional pressures on water recourses and on land are caused by the growth of second homes in inlands and coastal regions during the past decades.

- **Higher water demands due to tourism supporting activities.** In many tourist areas the development of tourism can cause a boost in activities like construction and intensive agriculture which use more water than in the case without tourism.

In general, the key impacts of tourism on water resources are as follows:

[51] ECOLOGIC (2007), EU Water saving potential, Final Report, Institute for International and European Environmental Policy, Berlin.

- **Over-exploitation of groundwater.** In many touristic coastal regions, the main source of fresh water is groundwater and not surface water. By means of example, many relevant studies and reports show that overexploitation of groundwater is considerable in many tourist destinations (EEA 2003)[52]. That means that the volume of abstracted groundwater cannot be renewed and without a change of this trend the groundwater will disappear. Additionally, over-exploitation of groundwater provokes saline water intrusion that has negative impacts on the quality of drinking water and increases the salinity of agricultural land leading to less production and/or increased use of fertilizers. Last but not least wetlands whose hydrological dynamic are directly linked to aquifers can suffer by a decrease in the groundwater table. These threats are reduced since a new water supply system was opened in Skadar basin in 2009 by tapping source Bolje sestre, which actually supply almost entire Montenegrin coastal area.

- **Degradation of the quality of water.** Pollution of surface and groundwater in tourist areas can be caused by urbanization, solid waste, agricultural and other economic activities or by insufficient or non-existent waste water treatment. In many tourist areas hotels and other facilities have no own treatment plans and are not connected to any sewage system. In other cases, the increase of waste water during the tourist season cannot be absorbed by the public treatment systems because of restraint capacity reducing the effectiveness of treatment. Pollution of surface and groundwater has negative impact on the quality of freshwater but also on the quality of the water of wetlands as well as sea water. According to EEA (2000)[53], tourism contributes to 7% of all pollution in the Mediterranean basin, with a similar or greater figure (due to lack of wastewater treatment facilities) anticipated in the Adriatic Sea. One of main pollution sources are numerous septic tanks and dry toilets in coastal rural area and weekend settlements from which sewage water freely flow or percolate to underlying aquifers and move towards the sea and beaches.

- **Increased investments for water management.** In order to satisfy the great demand of water due to tourism public authorities (local, regional or national) are enforced to invest money in different projects like studies, dams, drillings, new hydrological plans, extension or regeneration of water supply networks (see below).

- **Pressures on wetlands areas and other aquatic systems.** Both wetlands and also the marine ecosystems are in danger because of tourist activities like hotel buildings, infrastructure, urbanization, water consumption, water pollution, solid waste, exploitation of protected areas and species for tourist purposes etc.

The strategic development plans of the regional economy of the Adriatic River Basin are based on the expansion of tourism and related industry and are therefore conditional upon the achievement of a sufficient and steady provision of drinkable water in adequate quantities and in a timely fashion.

Recognizing the problems associated with potable water requirements to the coastal locations, and the lack of available groundwater sources (notwithstanding the problems mentioned above of groundwater depletion on related ecosystems), to solve this matter the Central Government developed a large project on the construction of a regional water supply, which has been completed by the Montenegrin regional water supply company, Regionalni Vodovod Crnogorsko Primorje (PEW). The regional water supply is based on the use of drinkable water from the springs of Bolje Sestrjie in the Skadar Lake Sub-Basin. The supply system provides up to 4 times the volume of water that is likely

[52] EEA, (2003), Europe's Water, An indicator-based assessment, Copenhagen

[53] EEA, (2000), Europe's environment: the third assessment, European Environmental Agency Copenhagen

to be required in the coastal region in the future. However, despite this fact, some of the municipalities along the coast are still using part of water from their previous groundwater sources even though the water from regional waterworks (pipeline of 140 km) is sufficient to cover increased demands during peaks of touristic season.

### 4.6.4 Invasive Aquatic Species

The main threats of non-native aquatic species are the consequence of their potential invasiveness. All invasive species are non-native but not all of non-native species become invasive. In order to become marked as invasive, some non-native species have to start with rapid and effective reproduction within the new ecosystem. Furthermore, they can quickly come to occupy a new ecological niche and to become part of this ecosystem complex food chain.

Non-native species result in a competitive pressure for food and space with domestic species and could affect their decreasing in number or even extinction. Furthermore, the arrival of a new species may also be a vector for a new disease or parasite that could negatively affect the whole ecosystem by destroying the significant number of species within or even crashing the food chain. Such changing of species composition in one freshwater ecosystem can also lead to a change of the physical/chemical parameters and drive in time to its complete environmental decomposition.

Although non-native species are not identified in the main text of the WFD, they are mentioned in the Directive’s annexes as an important environmental pressure and as such require special attention and appropriate risk analysis (i.e. identification, assessment, management and communication).

The zoogeographic uniqueness of the Balkans, which reflected in high level of endemism, (i.e. a species being unique to a defined geographic location) along with the strong pressure it sustains from the introduction of non-native fishes, deserves appropriate attention. So far this has been lacking despite an increased awareness of the risks and potential adverse effects posed by non-native species introduction into specific water bodies, e.g. Skadar Lake.

The main threats in Adriatic River Basin come from following invasive fish species: gibel carp - *Carassius gibelio*, pumpkinseed- *Lepomis gibbosus*, brown bullhead -*Ameiurus nebulosus*, rainbow trout - *Oncorhynchus mykiss*, Eurasean perch – *Perca fluviatilis*, topmouth gudgeon - *Pseudorasbora parva* and grayling - *Thymallus thymallus*. Further studies are required to evaluate the future ecological and economic effects within the river basin.

Due to inadequate and illegal stocking or an inefficient attempt to establish so called “biological control” of disease in the aquatic ecosystems, several WBs currently have problems with alien species. These include: Blećko lake (SWB 6), Krupac lake (SWB 25), Slasnko lake (SWB26), WB1_ Vučko blati (SWB 36), WB2_ North (SWB 37), W3_Suth west (SWB 38), W4_Pelagic zone (SWB 39), Šasko lake (SWB 40), Malo blato lake (SWB 41) (Table 4.37).

### 4.6.5 Pollution loads

Regarding pollution loads in terms of PE (based on $BOD_5$, assuming 1 Population Equivalent (PE) = 60 g/d), the $BOD_5$ of the wastewaters to be discharged to the municipal sewerage networks was assumed to be 300 mg/l for all types of activity, apart from the food industry, slaughterhouses and leather processing, as they are known to produce wastewaters with high organic pollution load. For these types of wastewaters $BOD_5$ was assumed to be 500mg/l, corresponding to the maximum allowable concentration of wastewaters discharges to sewerage networks (compliant with Montenegrin legislation)[54].

During rainfall events, runoffs from transport infrastructure, contaminated sites, and polluted soil may cause serious groundwater pollution. Poorly managed disposal wastes, products spread on the ground, atmospheric pollutants deposits are also other potential sources of pollution, which can in part be considered as diffuse sources of pollution.

Taking in consideration the population equivalent of households (Section 4.6.1), industrial activities (Section 4.6.2) and tourism (Section 4.6.3), the ratio of $BOD_5$ for the main agglomerations in the River Basins in Montenegro have been calculated (Table 4.19 and Figure 4.5).

### Table 4.19 Population of main towns and $BOD_5$[5] demand share of households, tourism and industries in the Adriatic River Basin[55]

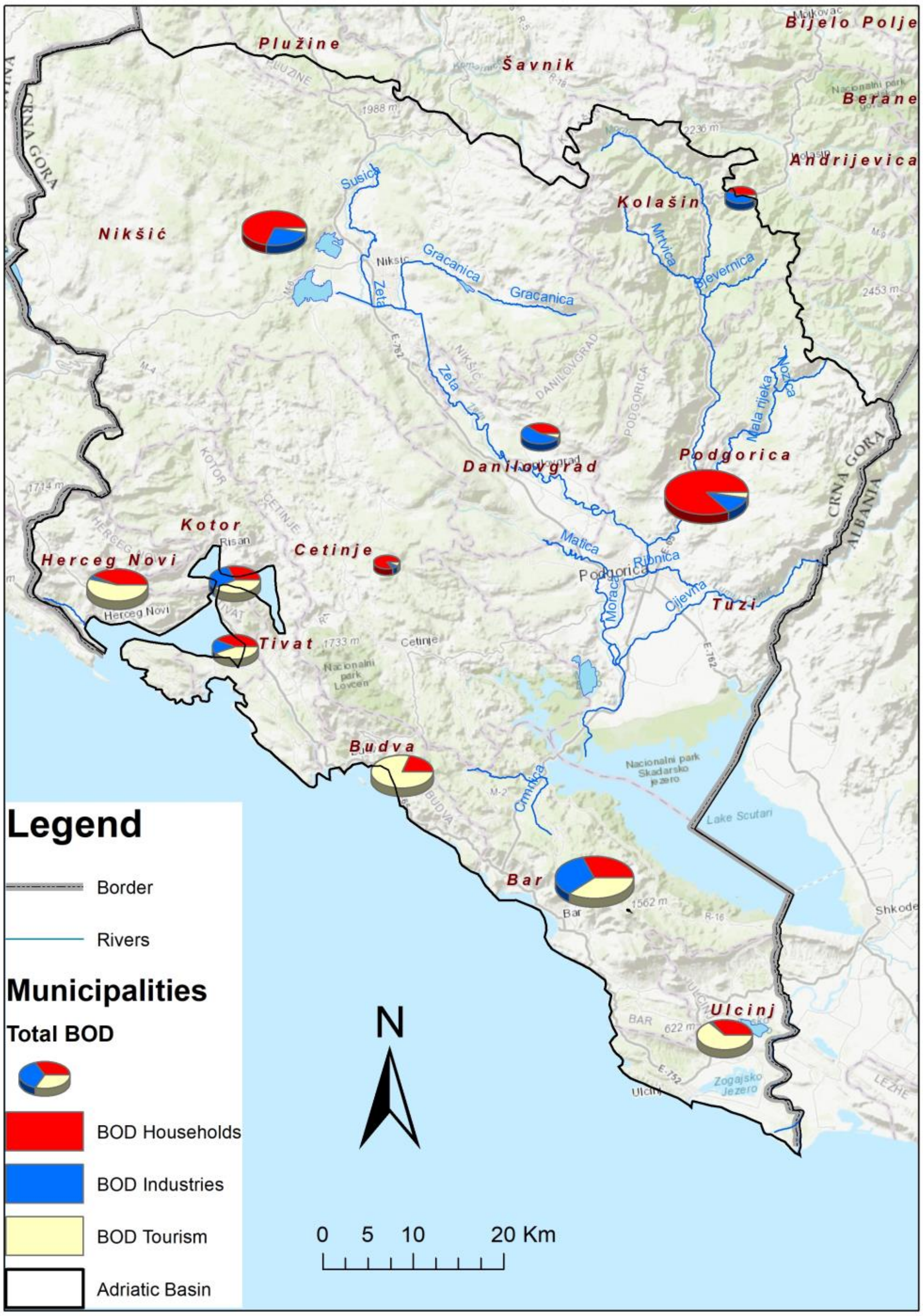
| Town/City | Basin | Urban Population | $BOD_5$ Households (kg/day) | $BOD_5$ Industries (kg/day) | $BOD_5$ Tourism (kg/day) | Total $BOD_5$ (kg/day) |
|---|---|---|---|---|---|---|
| Podgorica +Tuzi | Morača | 156,200 | 9,445 | 1,149 | 332 | 10,926 |
| Bar | Adriatic Sea | 17,700 | 3,033 | 2,867 | 3,726 | 9,626 |
| Nikšić | Zeta - Morača | 57,290 | 4,528 | 1,804 | 200 | 6,532 |
| Budva | Adriatic Sea | 15,930 | 1,187 | 18 | 4,817 | 6,022 |
| Herceg Novi | Adriatic Sea | 19,620 | 2,448 | 168 | 3,134 | 5,750 |
| Ulcinj | Adriatic Sea | 10,830 | 1,695 | 83 | 3,064 | 4,842 |
| Kotor | Adriatic Sea | 12,710 | 1,290 | 1,094 | 1,740 | 4,124 |
| Tivat | Adriatic Sea | 10,140 | 1,392 | 453 | 1,434 | 3,279 |
| Danilovgrad | Zeta - Morača | 6,890 | 937 | 1,291 | 128 | 2,356 |

[54] Pravilnik o kvalitetu i sanitarno-tehničkim uslovima za ispuštanje otpadnih voda u recipijent i javnu kanalizaciju, načinu i postupku ispitivanja kvaliteta otpadnih voda, minimalnom broju ispitivanja i sadržaju izvještaja o utvrđenom kvalitetu otpadnih voda ("Službeni list Crne Gore", br. 045/08 od 31.07.2008, 009/10 od 19.02.2010, 026/12 od 24.05.2012, 052/12 od 12.10.2012, 059/13 od 26.12.2013)

[55] BOD loads are determined as annual averages

| Town/City | Basin | Urban Population | $BOD_5$ Households (kg/day) | $BOD_5$ Industries (kg/day) | $BOD_5$ Tourism (kg/day) | Total $BOD_5$ (kg/day) |
|---|---|---|---|---|---|---|
| Cetinje | Skadar Lake | 14,160 | 913 | 90 | 71 | 1,074 |

**Figure 4.5 Relative estimation of Biological Oxygen Demand (BOD5) from industries and households and tourism in the towns over 10,000 inhabitants and from 2,000 to 10,000 inhabitants**



### 4.6.6 Solid waste disposal

It is clear that leakages (leachates) from uncontained landfills solid waste dumpsites adversely affect surface water and also groundwater sources, especially where aquifers are shallow and geologic formations allow infiltration. Municipal or industrial waste disposal can also threaten surface waters through littering and surface runoff.

In the territory of Montenegro, 243,941 tons of solid waste are generated annually, of which 80% is in the Adriatic River Basin (Table 4.20).

**Table 4.20 Quantities of municipal waste produced and collected in the Adriatic River Basin[56]**

| City | Generated waste (tons) | Collected waste (tons) | Collection (%) |
|---|---|---|---|
| Podgorica +Tuzi | 66,602 | 64,125 | 96 |
| Bar | 24,000 | 21,891 | 91 |
| Budva | 23,100 | 22,492 | 95 |
| Nikšić | 20,359 | 18,000 | 88 |
| Herceg Novi | 18,521 | 16,838 | 91 |
| Kotor | 12,500 | 11,820 | 95 |
| Ulcinj | 11,625 | 9,328 | 80 |
| Tivat | 8,100 | 7,993 | 96 |
| Cetinje | 6,080 | 4,864 | 80 |
| Danilovgrad | 4,658 | 2,950 | 63 |
| **Adriatic River Basin** | **195,545** | **180,301** | **92** |
| **Montenegro** | **243,941** | **218,233** | **89** |

Almost the entire amount of collected waste is deposited in some type of landfill. Only two sanitary landfill are currently in operation in the Adriatic River Basin:

- Regional sanitary landfill "Možura", on territory of the municipality of Bar, for municipalities Bar and Ulcinj. Capacity of landfill is 1 million $m^3$
- Regional sanitary landfill "Livade", on territory of the municipality of Podgorica, for municipalities Podgorica, Danilovgrad and Cetinje. Capacity of landfill is 2,880,000 $m^3$. Deponija" Ltd. is planning to build a leachate treatment plant for the leachate generated in sanitary cells on landfill “Livade”. Upon the completion of the project, Deponija Ltd. will receive

[56] Source: Revision of the National Waste Management Strategy 2014-2020 and National Waste Management Plan 2014-2020, 2015

a certificate for quality processing of leachate in accordance with the Law on Waters and the Regulations on the discharge of treated water into the recipient of sewerage system.

In most of the cities of Montenegro, municipal waste is disposed of at urban waste disposal sites, but there are also a large number of unregulated landfills. Montenegro has a plethora of regulations and rulebooks under the Law on Waste Management (Off. Gazette of Montenegro", No. 64/11) concerning waste management, which are line with the EU requirements for disposal of hazardous and non-hazardous solid waste. However, despite the extensive legal framework surrounding waste management, nationally there are 155 unregulated landfills with a volume of less than 100 $m^3$, 68 with a capacity of 100-1000 $m^3$ and 50 of a capacity of more than 1000 $m^3$. Table 4.21 reflects the situation in the Adriatic River Basin. A large number of disposal sites are located on the bank of the river or near a watercourse.

A basic analysis was undertaken based on the location of landfills and their proximity to river streams. Figure 4.6 shows the location of landfills and waste disposal dumpsites, indicating a potential pressure from the entry of leachate production into both surface and groundwaters.

### Table 4.21 Landfills and waste dumps in the Adriatic River Basin

| Municipality | | Name of Location | Type of Waste | Capacity of Disposal Sites ($m^3$) |
|---|---|---|---|---|
| **Bar** | | | | |
| | 1. | Ćafe | Mixed municipal waste, electrical waste | >1,000 |
| | 2. | Sutomore, Rutke | Different types of waste | |
| | 3. | Dobre vode | Different types of waste | |
| | 4. | Utjeha | Different types of waste | |
| **Ulcinj** | | | | |
| | 1. | Old city landfill | Municipal and construction waste | 84 |
| | | Near all beaches | Municipal waste | |
| **Budva** | | | | |
| | 1. | Kruševice | Earth and stone | 1,500 |
| | 2. | Blizikuće | Earth and stone | 2,500 |
| | 3. | Mažići, | Earth and stone | 2,500 |
| **Kotor** | | | | |
| | 1. | Old city landfill | Municipal waste | >3,000 |
| | 2. | Metkova voda | Mixed municipal and construction waste | >1,000 |
| **Tivat** | | | | |
| | 1. | Lovanja | Different types of waste | >1,000 |
| **Herceg novi** | | | | |
| | 1. | Igalo - Žvinje | Mixed municipal and construction waste | >1,500 |

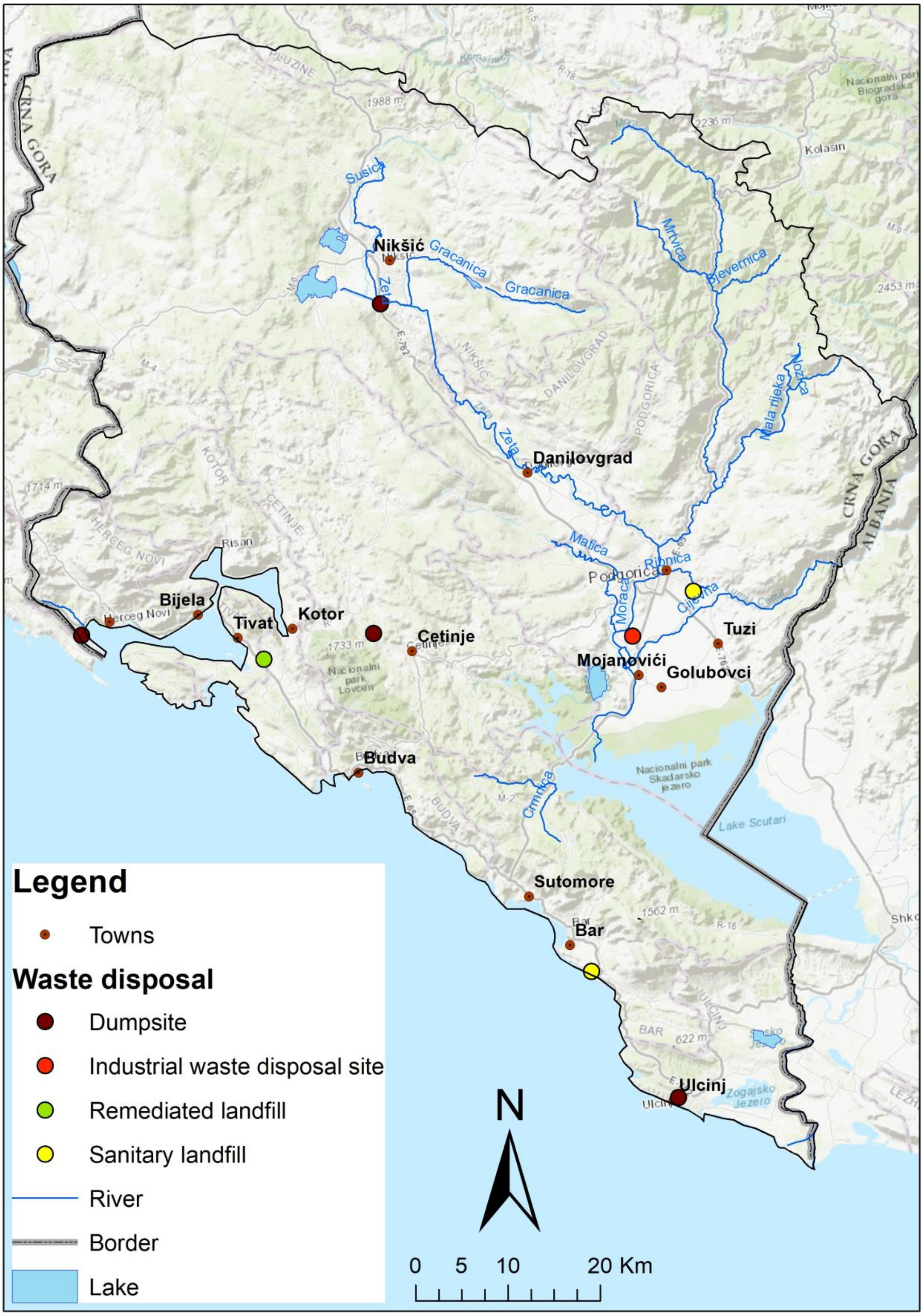
| Municipality | | Name of Location | Type of Waste | Capacity of Disposal Sites ($m^3$) |
|---|---|---|---|---|
| | 2. | Igalo - Sutorina | Mixed municipal and construction waste | >150,000 |
| | 3. | Igalo, roud Njivice-Zivinje | Mixed municipal and construction waste | 700 |
| | 4. | Igalo, roud Igalo Mojdez | Mixed municipal and construction waste | 1,000 |
| | 5. | Roud Podi-Kameno | Mixed municipal and construction waste | 700 |
| | 6. | Roud Meljine-Kameno | Mixed municipal and construction waste | 500 |
| | 7. | Dizdarica | Mixed municipal and construction waste | 800 |
| | 8. | Kumbor | Construction waste | 500 |
| | 9. | Baosici | Construction waste | 1,000 |
| **Podgorica**[57] | | | | |
| | 1. | Konik, park | Mixed municipal and construction waste | >5,000 |
| | 2. | Konik, above the landfill | Mixed municipal and construction waste | >2,000 |
| | 3. | Old airport | Mixed municipal and construction waste | >3,000 |
| | 4. | Mareza | Mixed municipal and construction waste | >5,000 |
| | 5. | Cemovsko polje | Mixed municipal and construction waste | >2,000 |
| | 6. | Golubovci- Botun | Mixed municipal and construction waste | >200 |
| | 7. | Mitrovici | Mixed municipal and construction waste | >1,100 |
| | 8. | Kuce Rakica | Mixed municipal and construction waste | >500 |
| | 9. | Daljevac | Mixed municipal and construction waste | >2,000 |
| | 10. | Mamulja | Mixed municipal and construction waste | >200 |
| | 11. | Mataguzi | Mixed municipal and construction waste | >500 |
| | 12. | Vukovci | Mixed municipal and construction waste | >1,200 |
| | 13. | Tuzi -Sipcanik | Mixed municipal and construction waste | >1 100 |
| | 14. | Tuzi - Elezovici | Mixed municipal and construction waste | >750 |
| | 15. | Dinose - bridge | Mixed municipal and construction waste | >3,000 |
| | 16. | Dinose | Mixed municipal and construction waste | >500 |
| **Nikšić** | | | | |
| | 1. | Gračanica | Mixed municipal and construction waste | >3,000 |
| | 2. | Kapino Polje | Municipal and construction waste | >1,500 |
| | 3. | Mislov do, Budoš, city landfill | Mixed municipal, animal and waste from slaughterhouses | |

[57] Data included for Tuzi municipality as data was collected prior to the establishment of the Tuzi municipality

| Municipality | | Name of Location | Type of Waste | Capacity of Disposal Sites (m$^3$) |
|---|---|---|---|---|
| **Danilovgrad** | | | | |
| | 1. | Lazine | Construction waste | 1,500 |
| | 2. | Pazici | Construction waste | 200 |
| **Cetinje** | | | | |
| | 1. | Vrteljka, city landfill | Mixed municipal and construction waste | >1,000 |

As stressed above, there are only few regulated landfills while there are many which are unregulated. Moreover, there are numerous illegal waste disposal sites which are, by the unwritten rule, placed near by watercourses or on their banks and/or surrounding slopes. As a result, numerous surface water bodies are under a negative impact. The most endangered surface water bodies are: Morača_5 (18), Zeta_2 (21), Gračanica_2 (24), Zeta_4 (28), Ribnica (29), Morača_6 (30), WB 2_North (37) (Table 4.36).

## Figure 4.6 Waste disposal point pressures in the Adriatic River Basin



### 4.6.7 Aquaculture

Over the past years in Montenegro a number of trout fisheries were built within the Adriatic River Basin. The main characteristics of two largest fisheries in the Adriatic River Basin, located in Podgorica and Nikšić are given in a Table 4.22. In addition to these fisheries there are about 30 more on the territory of Montenegro with the size between 250 and 1000 $m^2$ (in total about 10,500 $m^2$) , which do not have precise data.

There are concerns from excessive nutrients entering the system from fish farms. All fish farms are mostly small, family owned concerns (or owned by small enterprises), producing 5–20 tones per year with the exception of four larger farms (two within the Adriatic Basin) that produce 60–150 tones per year, ran by private companies.

**Table 4.22 The main fisheries in the Adriatic Basin[58]**

| Name of farm | Location | Area ($m^2$) | Production (tonnes/year) | Water Requirement ($m^3$/24h) |
|---|---|---|---|---|
| Mareza | Podgorica | 4,000 | 150 | 67,000 |
| Rastovac | Nikšić | 2,100 | 60 | 35,000 |
| Other fisheries | | 10,500 | NA | 175,000* |
| **Total** | | **16,600** | **210** | **277,000** |

*The water requirement distributed proportionally based on the surface (10,500 $m^2$)

Although there is no intensive aquaculture within the Adriatic drainage area, there are two SWBs where this activity has significant impact during summer months during lowest water level regime. First one is Zeta_4 (SWB 28) were there are two cage type trout farms. The second is Ribnica (SWB 29), a fish farm with its own spring (Table 4.36).

## 4.7 Diffuse sources of pollution

### 4.7.1 Agricultural activities

As shown in Table 4.23, Nikšić and Podgorica are municipalities with the most agricultural land, together making 68% of total available agricultural land in Adriatic Basin. According to data provided by Monstat, Nikšić indicates the largest increase of number of agricultural holdings - by 2,705 holdings or 39.29% from the period 2003-2010.[59]

The municipality with the most efficient use of agricultural land is Danilovgrad, using 82% of available land, while efficiency for whole basin is 57% - which emphasizes almost half of the area is classified as un-utilized. More than 95% of the land is categorized as meadows and pastures, while the other categories such as kitchen gardens, vineyards, orchards and nurseries, together comprise less than 5%.

[58] STRATEGIJA UPRAVLJANJA VODAMA CRNE GORE - 2017

[59] MONSTAT: STRUCTURE OF AGRICULTURAL HOLDINGS, Podgorica 2012

### Table 4.23 Agricultural land by categories of exploitation in the Adriatic Sea Basin[60]

| Municipality | Total Agriculture Holdings | Total available agricultural land (ha) | Total used agriculture land (ha) | Total used agriculture land (%) |
|---|---|---|---|---|
| Bar | 1,814 | 4,116 | 2,443 | **59** |
| Budva | 203 | 550 | 116 | **21** |
| Cetinje | 895 | 4,763 | 928 | **19** |
| Danilovgrad | 2,993 | 11,462 | 9,448 | **82** |
| Herceg Novi | 522 | 1,645 | 579 | **35** |
| Kotor | 362 | 2,557 | 1,965 | **77** |
| Nikšić | 6,886 | 38,265 | 17,737 | **46** |
| Podgorica + Tuzi | 7,276 | 26,720 | 17,789 | **67** |
| Tivat | 169 | 322 | 110 | **34** |
| Ulcinj | 1,731 | 4,439 | 2,708 | **61** |
| **Total** | **22,851** | **94,839** | **53,821.2** | **57** |

The valley of the Zeta and Morača Rivers has arable land that is used for growing vegetables and fruits. In the valley of Morača near Podgorica there is one of the largest and most beautiful vineyards in Europe - Cemovsko polje, with area of 2,300 ha, with 11.5 million vines of grapevines. However, the wine production may represent a significant pressure at local level on surface and groundwater water bodies due to the spreading of pesticides, herbicides and fungicides used for commercial vine cultivation.

Agricultural production is recognized as a contaminant of surface waters, soil, air, and has a negative impact on the flora and fauna. Pollution of water and land from agriculture arises from wastewater from livestock farms and rinsing of mineral fertilizers and used chemicals from arable land.

The level of vulnerability of water due to these processes depends on the type of fertilizers used, the efficiency of their use, the types of crops and livestock, the environmental protection systems, agricultural practices and other factors of agricultural production.

The amount of mineral and other fertilizers used in agriculture in Montenegro as a whole on an annual basis is approximately 4,000 tons with about 3,000 tons manure. The amount of chemical plant protection products used in agriculture in Montenegro is 185 tons per year[61]. The exact figures for the Adriatic River Basin are unknown.

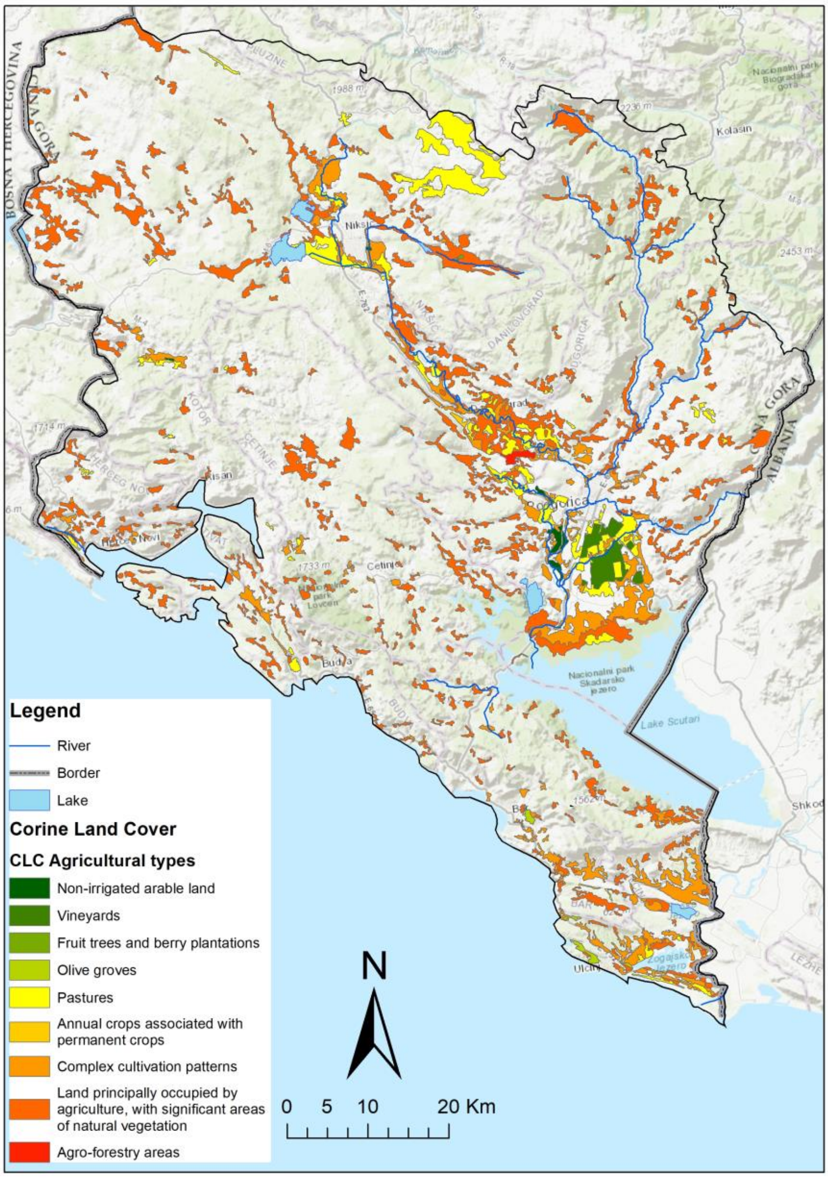
[60] Source: MONSTAT, Census 2010, Statistical Yearbook

[61] Source: Review of the state of agriculture and related activities for pollution of Skadar Lake, 2013, IPA Cross – Border Programme Albania – Montenegro, 2007 – 2013 "Economic, Environment and Social Development Grant Scheme" Reference: EuropAid/130-293/L/ACT/IPA

Using the land use pressure groups of the Corine land cover (Section 4.5.1, Table 4.2), the percentage of Group 2 "High pressure" agricultural activities were used at river segment catchments level in order to assess the catchments and water bodies under the higher level of pressures due to agriculture activities. Figure 4.7 provides an illustration of the localization and types of agricultural land use that need to be taken into account in the identification of potential pressures on the water bodies by agricultural production.

The main agriculture zones in the Adriatic River Basin are in the vicinity of lowland rivers (Figure 4.7) The highest impacts of agricultural production are as follows: Bojana (SWB 1), Gračanica_1 (SWB 22), Zeta_4 (SWB 28), Morača_6 (SWB 30) and WB 2_North (SWB 37) (Table 4.37).

### Figure 4.7 Localization and types of agricultural land uses in the Adriatic River Basin



### 4.7.2 Gravel Extraction

For many years the devastation of the riverbeds of many rivers has been a major environmental, economic and aesthetic problem in Montenegro. Illegal exploitation of gravel and sand from riverbeds and surrounding farmland caused meandering of river flows and created landscapes with huge craters from which material was extracted.

The state institutions in charge of water management have endeavored to bring order to this area by awarding concessions to individual companies, in accordance with applicable regulations. The concessions stipulated the manner in which the river sediment should be exploited, the rights and obligations of the concessionaires, as well as the amount of compensation to be paid to the State Budget. This system did not seem to produce the best results, since a large number of small dealers aim to extract as much sand and gravel as possible in as short a time as possible, without considering nature and environmental standards.

This was the reason that the state authorities took steps to permanently resolve riverbed regulation. Therefore, a decision was made to draw up technical documentation for the most vulnerable sections and to carry out works that would define the river bed and coastal fortification for large and medium-sized waters, prevent further destruction of the coasts and flood the surrounding agricultural areas. Currently, a number of river projects in Montenegro are being implemented (Moraca, Lim).

Also, the Ministry of Agriculture and Rural Development, on 04/07/2017 introduced a Moratorium on the exploitation of river beds, indefinitely. In order to continue with further activities during the Moratorium, the Government of Montenegro adopted an Action Plan for the Suppression of Illegal Exploitation of River Sediments from the 2019 - 2021 Watercourse, which will achieve more efficient monitoring of illegal exploitation activities, ensure continuous monitoring and implement criminal measures policies in sanctioning offenders. The planned measures and activities through the Action Plan elaborate the set operational objective, define activities for the implementation of key measures, their carriers, dynamics, as well as indicators of results that will monitor the degree of their realization.

Gravel extraction has a double negative impact on SWBs. On one side, the activity destroys the bottom fauna (benthos) which is of basic importance for the riverine food chain, while from the other side it changes the morphology of riverbed causing a change in the watercourse. Of all Adriatic rivers in MNE, the Morača river is under biggest pressure from gravel extraction. The following SWBs are negatively impacted by this activity: Morača_4 (SWB 14), Morača_5 (SWB 18), Gračanica_2 (SWB 24), Morača_6 (SWB 30) and Cijevna (SWB 34) (Table 4.36)

### 4.7.3 Erosion

Soil erosion is a natural process that is causing environmental concerns such as land degradation, soil loss, water pollution and ecosystem alteration. Water erosion has affected 95% of Montenegro. Alluvial accumulation characterises the remaining area, where the deposition of sediments is also affecting agricultural land. Large suspended sediment fluxes are prevalent in river catchments, which result from soil loss due to water erosion, constituting a major environmental issue. Modelling soil erosion rates under various land use and climate conditions is the key to understanding the impact of future land management and climate change on land degradation. The topography of the region is illustrated by the percentage of land slope within the basin (Figure 4.8).

The extent and the distribution of erosion depend on the specific pattern of physical and geographical factors. The major drivers of water erosion are intense rainfall, topography, low soil organic matter content, percentage and type of vegetation cover, inappropriate farming practices and land marginalisation or abandonment[62].

A study undertaken in the inland region of Montenegro[63] concluded that the condition of the vegetation cover and the land use influenced the development of erosion processes in the river basin. The net soil loss in the study area was calculated as 315 $m^3$ per $km^2$. This indicates that the belongs in “Destruction Category V”, according to the classification system of Gavrilovic[64]. However, the strength of the erosion process is regarded as medium, and according to the erosion type, it is mixed erosion. Change of the land use in structure for the period of four decades (1970-2013), in the study area, decreased the soil erosion intensity by 3.95%.

The most recent coastal studies were carried out in the coastal region of Bar[65]. Most of the study area is hilly-mountainous terrain, consisting mainly of Eocene flysch sediments in the lower and the central zone and of Triassic and Jurassic limestone, with plenty of detritus and traces of hornstones and other silicate ingredients in the central and higher zones. The dominant erosion form in this area is surface runoff, but more severe forms of erosion, such as rills, gullies and ravines, also occur frequently. The eroded soil becomes compacted and lacks a sufficient amount of nutrients and organic matter. The infiltration rates and water-storage capacity of the soil profile are reduced, and this, in turn, increases the overland flow and the erosion. The erosion activities affect a large area of agricultural and forest land, in addition to roads and various commercial facilities and settlements. The damage is vast and incalculable. The erosion has resulted in the loss of fertile land, the formation of patchy bare ground and the deposition of sterile alluvial deposits on fertile soils. It has also resulted in torrents, which have flooded roads and interrupted travel[50].

The computer-graphic IntErO model was used to calculate soil erosion intensity, resulting in real soil losses of 1,899$m^3$ per $km^2$. The Gavrilović classification indicates that the river basin belongs to the category II destruction class. The strength of the erosion process is high. The findings indicate that it is a region of strong erosion.

Soil erosion in the Adriatic River Basin ultimately result in (i) on-farm losses raising production costs and lowering farm incomes, and (ii) phosphorus enrichment of freshwater bodies, which has negative implications for water quality.

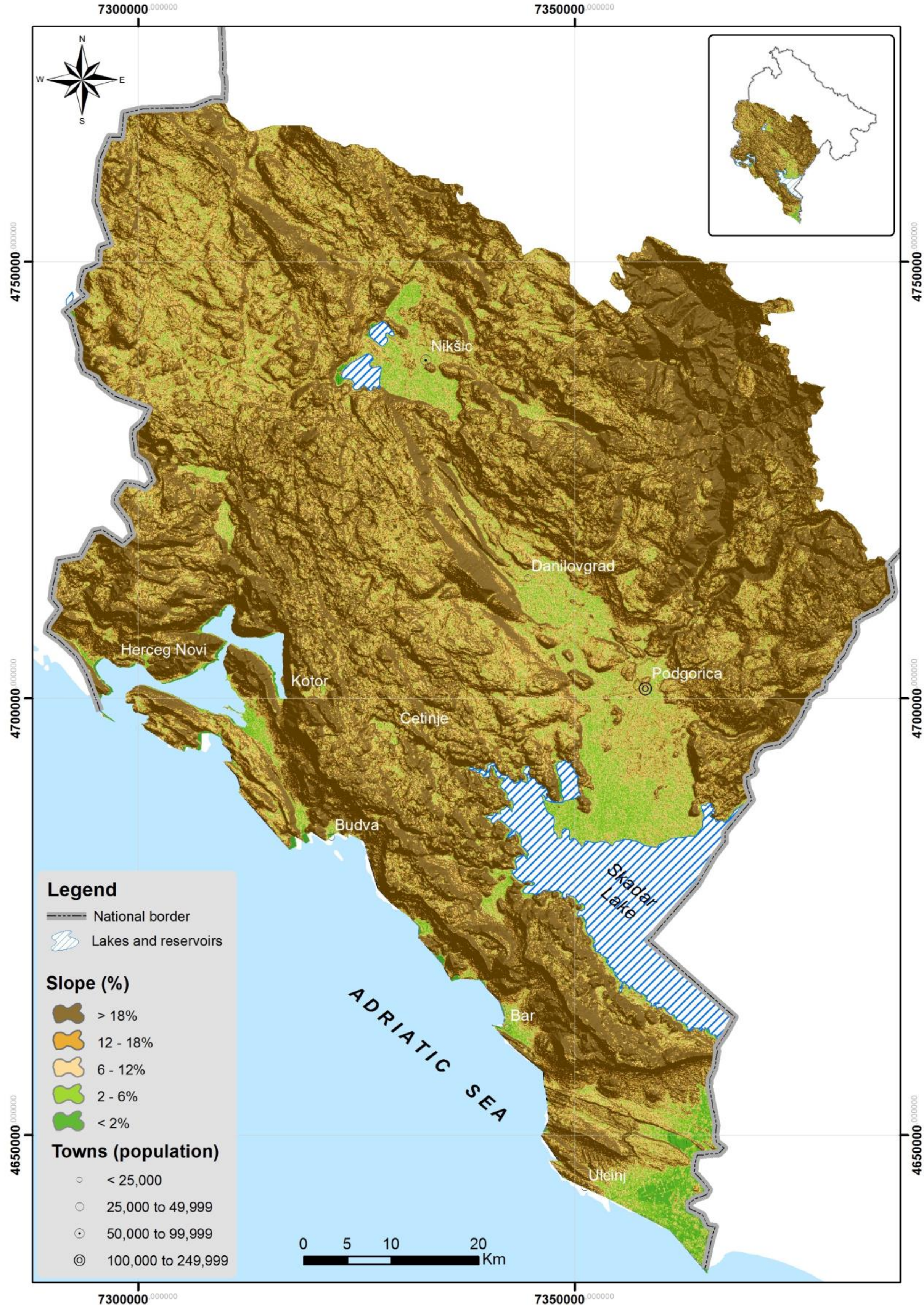
[62]Blinkov, I. (2015): The Balkans: The most erosive part of Europe? Glasnik Sumarskog fakulteta. 111: 9-20. DOI: 10.2298/GSF1511009B

[63]Spalevic, V. et.al., (2013). The impact of land use on soil erosion in the River Basin Boljanska Rijeka in Montenegro. Conference: IV International Symposium “Agrosym 2013”, At Jahorina, Sarajevo, Bosnia and Herzegovina

[64]Gavrilovic, S. (1972): Inzenjering o bujicnim tokovima i eroziji. Izgradnja. Beograd

[65] Spalevic, V. et.al., (2012) Soil erosion in the Riber Basin Zeljeznica, are of Bar, Montenegro. Agriculture & Forestry, Vol. 54 (08)(1-4): 5-24 (Podgorica).

## Figure 4.8 Land slope in the Adriatic River Basin (%)



## 4.8 Water abstraction and water demand

At the national level, data related to actual abstraction pressures is based on the official document revision and updating of the study "Projection of long-term water supply of Montenegro" from 2015. Related information helped identify potential pressures for some of the water bodies, for both surface water and ground water. For consumers, approximately 92% of water is supplied from underground sources with the remaining 8% supplied with water from surface accumulations.

Table 4.24 shows the actual water demand and the water availability from groundwater resources for all agglomerations in the Adriatic River Basin. The springs and wells designated for human consumption are shown in Figure 4.9. it is clear that there is **lack of water availability along the coastal areas of the Adriatic sub-basin, which is mitigated by a regional water supply scheme, which provides potable water from Lake Skadar to the municipalities along the Montenegrin coast of up to 130,000 m$^3$/day**. Without such a scheme and forward thinking by the Government of Montenegro there would be little or no sustainable development of the tourist sector along the coastal areas.

A summary of water from the urban, industrial and agricultural sectors in the municipalities making up the Adriatic River Basin is presented in Table 4.25. It is estimated that 112.47 Mm$^3$/year of water is necessary to cover consumption needs for the three sectors making up the municipalities in the Adriatic River Basin. These figures do not however take into account all variations in population numbers on a seasonal basis form tourism along the Adriatic coast.[66]

### Table 4.24 Water availability from springs in the Adriatic River Basin

| Agglomeration | Sub-Basin | Water Availabity (m$^3$/day) |
|---|---|---|
| Podgorica | Morača | 286,416 |
| Nikšić | Zeta | 34,560 |
| Danilovgrad | Zeta | 32,400 |
| Cetinje | Skadar lake | 18,230 |
| Ulcinj | Adriatic Sea | 28,328 |
| Bar | Adriatic Sea | 27,734 |
| Budva | Adriatic Sea | 4,579 |
| Kotor | Adriatic Sea | 35,078 |
| Herceg Novi | Adriatic Sea | 1,728 |

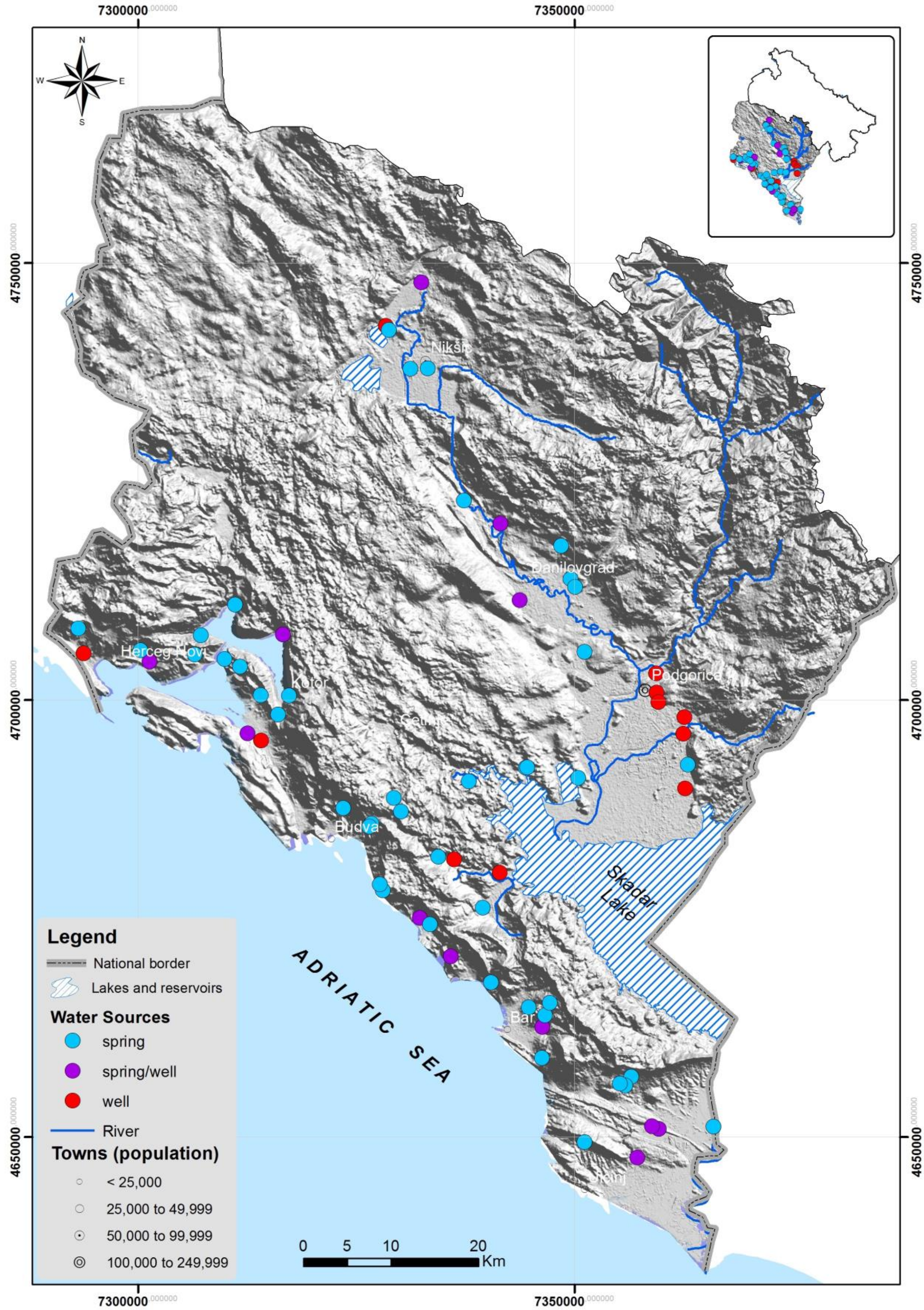
[66] IPA project Strengthening Capacities for Implementation of the EU Water Framework Directive in Montenegro, 2017-2020

**Table 4.25 Summary of water use by urban areas, industries and agriculture in the Adriatic River Basin (excluding seasonal tourism requirements[67])**

| Municipality | Urban Population (Number of Inhabitants) | Urban Domestic Use (m3/year) | Industrial Use (m3/year) | Agricultural Use – irrigation + Livestock ($m^3$/year) | Total ($m^3$/year) |
|---|---|---|---|---|---|
| **Bar** | 42,048 | 6,316,977 | 1,497,955 | 208,481 | 8,023,413 |
| **Budva** | 19,218 | 4,578,071 | 2,703,667 | 44,358 | 7,326,096 |
| **Danilovgrad** | 18,472 | 2,467,261 | 914,321 | 1,693,624 | 5,075,206 |
| **Kotor** | 22,601 | 4,679,891 | 1,432,625 | 16,235 | 6,128,751 |
| **Nikšić** | 72,443 | 5,892,857 | 649,351 | 4,406,173 | 10,948,381 |
| **Podgorica** | 185,937 | 25,324,760 | 9,377,347 | 11,670,913 | 46,373,020 |
| **Tivat** | 14,031 | 2,086,074 | 572,867 | 4,658 | 2,663,599 |
| **Ulcinj** | 19,921 | 5,027,182 | 756,472 | 548,784 | 6,332,438 |
| **Herceg Novi** | 30,864 | 10,393,471 | 3,183,828 | 28,966 | 13,606,265 |
| **Cetinje** | 16,658 | 5,073,150 | 844,076 | 76,336 | 5,993,562 |
| Total | **442,193** | **71,839,694** | **21,932,509** | **18,698,528** | **112,470,731** |

[67] No data for Tuzi available

## Figure 4.9 Springs and wells whose water is designated for human consumption



**As far as the coastal municipalities are concerned, after the commissioning of the regional water supply system, sufficient quantities of water have been provided. For the supply of sufficient quantities of water by 2025 and 2040, it will be necessary to build the second phase of the regional water supply.**

A large part of the abstracted water is discharged to the river (or reused), and in the vast majority of cases without proper or effective treatment.

Currently 18,000 ha of agricultural land is irrigated in Montenegro; over 83% in the catchment area of the Adriatic Sea. There are over 2,310 ha in Cemovsko polje in Podgorica for vines and peaches that are irrigated by the system of wells, where about 1,7 – 2.0 $m^3$ /s of groundwater is pumped during vegetation period.

Various scenarios, under assumptions of climate change have shown that it is likely that there will be more frequent periods of water restriction in the future if the demand increases[68].

Furthermore, detailed information regarding the water sources and quantitative pressure assessment in the Adriatic River Basin is provided in Section 4.13.

Although water abstraction, no matter for which purpose (irrigation, households or industry), has a negative impact on WBs, the majority of abstractions are not significant due to low population number, relatively low agriculture and industry activities. However, there are some WBs where water abstraction plays a significant negative role: Orahovštica (SWB 2), Crmnička rijeka (SWB 3), Sutorina_1 (SWB 4), Sitnica (SWB 33), Cijevna (SWB 34)(Table 4.37).

## 4.9 Physical pressures

### 4.9.1 Major hydropower plants and water supply dams

The major dams in the Adriatic River Basin constitute HMWBs since they form impenetrable barriers and act as major discontinuities on the river system. Two main dams are located in the basin:

- HPP "Perućica" is the oldest large hydropower plant in Montenegro and was put into operation in 1960. It is named after the well 'Perućica', which originates in the vicinity of hydroelectric power plant. For electricity production, HPP "Perucica" uses the water catchment of river Gornja Zeta, which flows into Nikšić field. HPP "Perucica" consist the following facilities: accumulations "Krupac" and "Slano" and retention "Vrtac" and the system of channels

  In the initial stage HPP "Perućica" had functioned with the two generators (2 x 38 Mw). In 1962 the three more were added (3 x 38 Mw), while in 1976 the 6$^{th}$, and in 1979 7$^{th}$ aggregate were also added (both of 58.8 Mw). Connection for installation of 8$^{th}$ aggregate which power should be also 58.8 Mw is left, and once installed the nominal power of HPP would raise from existing 308 Mw to 365.5 Mw, while the needed flow would accordingly raise from 68 $m^3$/s to 80.75 $m^3$/s. An assessment is that not more than 60% of the energetic potential is actually utilized. The main reason is high water losses from the reservoirs "Slano" and "Vrtac", located in highly karstified rocks. Most of lost water appears at the springs on the edge of Bjalopavlica valley in

[68] National strategy with action plan for transposition implementation and enforcement of the EU acquis on environment and climate change 2016-2020, Ministry of Sustainable Development and Tourism

GWB "Prekornica-Bjelopavlici". Discharge of Glava Zete, Obostica and Drenostica springs is over 50 $m^3/s$ in high water periods.

- Liverovići Reservoir is located at an altitude of 736 meters above sea level. The reservoir has an elongated shape of the canyon, a length of 3 km and a width of 500 meters with a total area of about one square kilometer. The total volume of water in the reservoir Liverovichi of 9 million cubic meters, which is used for industrial purposes. The lake is in contact with the area Nikšić its eastern part. It is located 10 km away from Nikšić.

Under the WFD 2106 reporting scheme, these water bodies are classed as HMWB alteration 'dams' and/or 'flow regime'. HMWB use is typically 'flood protection', 'agriculture irrigation' or 'energy hydropower'. HMWBs at dams are also subjected to point abstraction pressures agriculture, water supply, fish farms or hydropower. Physical pressure is most typically related to dam hydropower, dam irrigation, hydrology agriculture and hydrology hydropower. The typical impacts are termed as either 'altered habitat morphology' and 'altered habitat hydrology'.

### 4.9.2 Small hydropower plants

Small Hydropower Plants (SHPPs) have potentially significant impacts on downstream water bodies, which include the following[69]:

- Changes in river morphology and riverine habitat
- Barriers to migration and dispersal of protected species
- Disruption of sediment dynamics
- Changes of the ecological flow regime
- Changes of the flow regime (hydropeaking)
- Changes in seasonal flood cycles
- Water chemical and temperature changes
- Displacement and disturbance of species /loss of habitat
- Effects on terrestrial species and habitats

In recent years, intensive activities have been carried out in the Adriatic River Basin to explore the potentials for the development of SHPPs[70]. In the period from 2007 until today, hydrological measurements have been carried out on watercourses for the possibility of construction of SHPPs with an installed capacity of up to 10 MW.

As shown in Table 4.26, up to now, in the Adriatic River Basin, 2 SHPPs are under construction with 3 more in the planning phase.

Based on the implemented tender procedures, concession contracts are currently being implemented in the Morača sub-basins and on the coast near Budva, which envisage the construction SHPPs of approximately 2 MW, equating to an annual production of 6.52 MWh (Table 3.21). A further 3 SHPPs <1MW are planned in the Adriatic River Basin in the Morača sub-basin, which will produce a further 1.27 MW and an annual expected increase in energy production of just over 6.33 MWh (Table 4.26).

[69] Guidance on the requirements for hydropower in relation to Natura 2000, European Commission (2018)

[70] http://www.mek.gov.me/files/1196083302.pdf

The location of the large and small hydropower plants in the Adriatic River Basin are illustrated in Figure 4.10.

### Table 4.26 National register of SHPPs in the Adriatic River Basin

| No.[71] | SHPP Name | Design Capacity (MW)[72] | Annual Production Expected (GWh)[73] | River/ Stream | Sub-Basin | Related Surface Waterbody[74] |
|---|---|---|---|---|---|---|
| | **Under Construction** | | | | | |
| 10. | mHE "Ljeviška rijeka -izvor Morače" | 0.98 | 3.32 | Ljeviška rijeka | Morača | Morača_1 |
| 12. | mHE "Rijeka Reževića" | 0.95 | 3.20 | Rijeka Reževića | Adriatic | MNE_CW4 |
| | **Sub-Total** | **1.93** | **6.52** | | | |
| | **Planned** | | | | | |
| 21. | mHE "Raštak" | 0.62 | 2.50 | Paljevinska rijeka | Morača | Morača_2 |
| 22. | mHE "Raštak 2" | 0.62 | 2.50 | Ljevak | Morača | Morača_2 |
| 25. | mHE "Slatina" | 0.45 | 1.33 | Merica vrelo | Morača | Morača_2 |
| | **Sub-Total** | **1.27** | **6.33** | | | |
| | **Total** | **3.20** | **12.85** | | | |

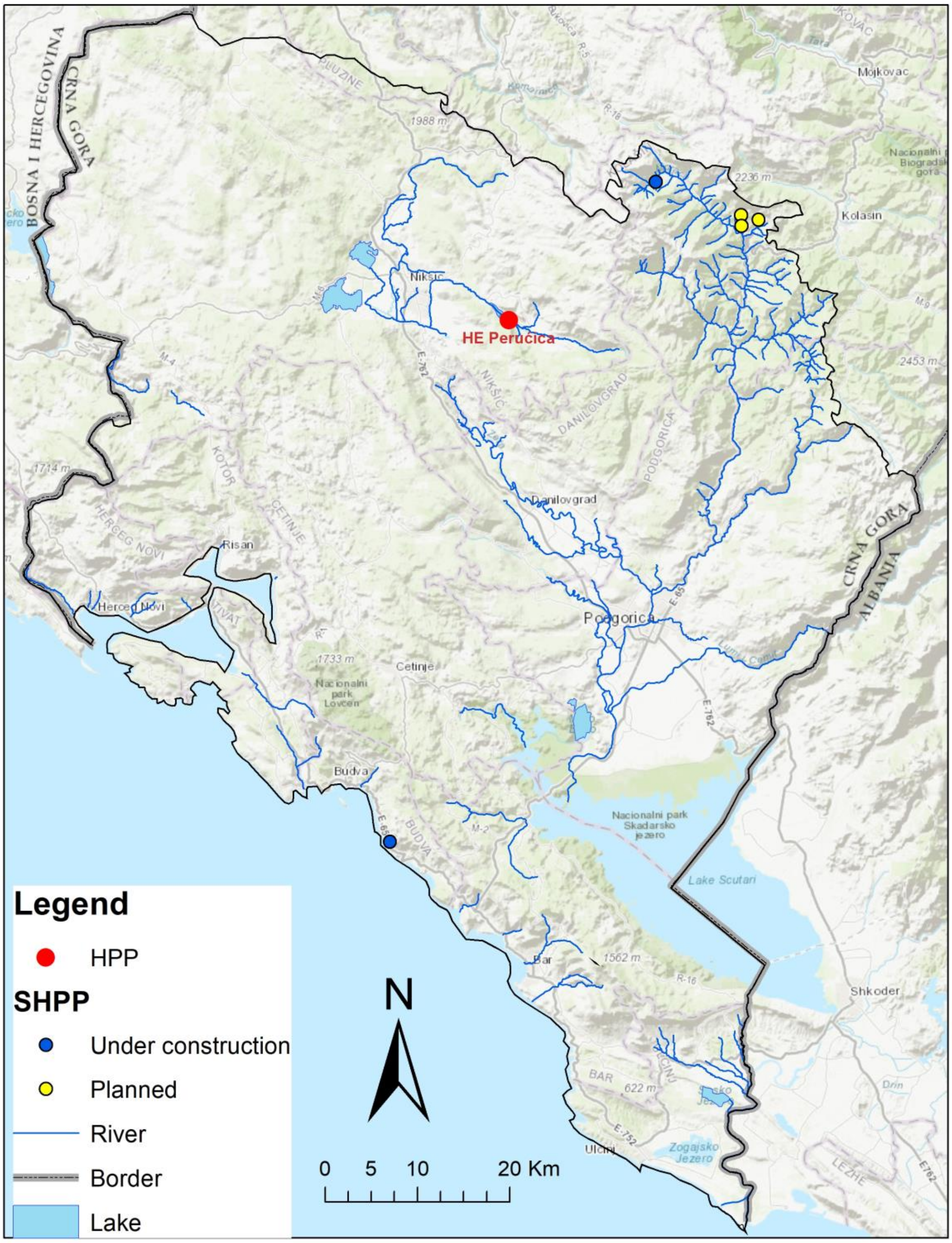
[71] Numbering according to the national register of SHPPs

[72] Values rounded up to 2 decimal points

[73] Values rounded up to 2 decimal points

[74] Rivers or streams related to surface water body designations shown in Section 2.3, Table 2.5

## Figure 4.10 The location of hydropower plants in the Adriatic River Basin




The definition of impacts (significantly adverse to significantly positive) of SHPPs on the environment are clearly outlined by the EU[75,] as shown below in Table 4.27.

[75] Guidance on the requirements for hydropower in relation to Natura 2000, European Commission (2018)

### Table 4.27 Definition of impacts to the environment based on the construction of small hydropower plants

| Term | Description | Examples |
| --- | --- | --- |
| Significant adverse impact | Significant adverse impact. Excludes plan/project implementation Significant disturbance or destructive impact on habitat or species population or its substantial part; significant disturbance of ecological demands of the habitat or species; significant impact on the habitat or natural development of a species. Under certain conditions, the impact can be lowered by mitigation measures. | Disruption of migration routes to spawning places of anadromous species Destruction of habitat by inundation because of new dam. Hydrological changes because of derivation significantly influencing population. |
| Moderately adverse impact | Limited/moderate/non-significant adverse impact. Plan/project implementation is not excluded. Moderate troublesome impact to habitat or species population; moderate disruption of ecological demands of habitat or species; marginal impact on habitat or natural development of a species. Its elimination through mitigation measures is possible but application of mitigation measures cannot be enforced, unless national legislation requires differently. | Modernization — using technology less damaging to fish, building fish passes on existing barriers. Impact on margin parts of population. Influence on habitat common in surrounding area. |
| Zero impact | The plan/project has no demonstrable impact. | Outside area of occurrence. |
| Moderately positive impact | Moderate favorable impact on habitat or species population; moderate improvement of ecological demands of the habitat or a species; moderate favorable impact on the habitat or on the natural development of a species. | Reconstruction of peaking hydropower to run-of-river hydropower without weir or dam. |
| Significantly positive impact | Significant favorable impact on habitat or species population; significant improvement of ecological demands of habitat or a species, significant favorable impact on the habitat or natural development of a species. | Demolition of hydropower plant. |

An analysis of SHPPs that are in the process of construction in the Adriatic River Basin in terms of impacts to the environment is summarized in Table 4.28. Based on the criteria use by the EU, it is clear that all SHPPs exert either a 'Significant' or 'Moderate' adverse impact to the surrounding environment for most of the criteria examined. The one clear exception is related to chemical pollution and temperature changes where a zero impact would be expected for most SHPPs.

It is important to bear in mind that the analysis carried out in Table 4.28 provides only an indication of the 'possible' impacts, which may or may not be the actual impacts to the environment following the construction of the SHPPs. The potential mitigation measures to counteract all of the 'possible' impacts are outlined in Section 10.

## Table 4.28 Assessment of potential impacts of small hydropower plants under construction in the Adriatic River Basin

**Key:**

Potential Significant Adverse Impact

Potential Moderate Adverse Impact

Potential Zero Impact

| No.[76] | SHPP Name[77] | Changes in river morphology and riverine habitat | Barriers to migration and dispersal of protected species | Disruption of sediment dynamics | Changes of the ecological flow regime | Changes of the flow regime by peaking hydropower plants | Changes in seasonal flood cycles | Water chemical and temperature changes | Displacement and disturbance of species /loss of habitat | Effects on terrestrial species and habitats |
|---|---|---|---|---|---|---|---|---|---|---|
| 10. | Ljeviška rijeka -izvor Morače | | | | | | | | | |
| 12. | Rijeka Reževića | | | | | | | | | |

[76] Numbering according to the national register of SHPPs

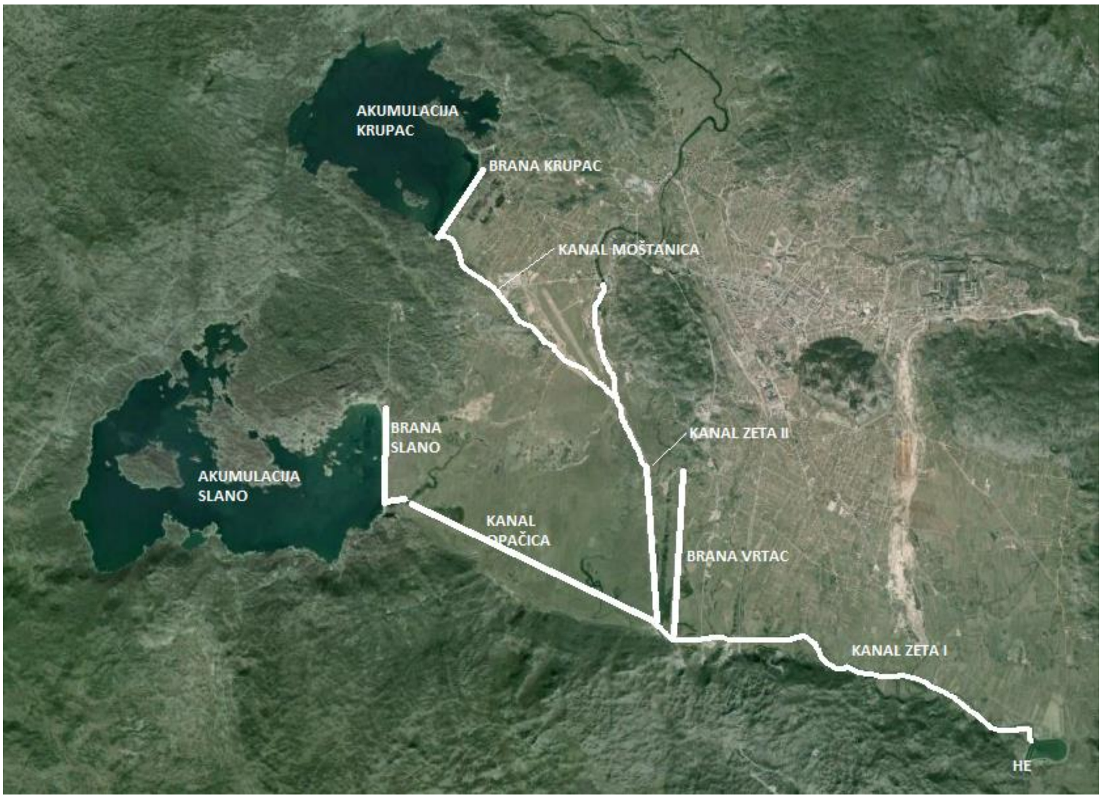
[77] SHPPs No. 10 and 12 are under construction

### 4.9.3 Canalization and altered water bodies

Heavily canalised river channels (generally through the principal urban areas) have been classed as Heavily Modified. Usually these canalizations serve the function of improved river conveyance and/or flood protection e.g. main river canalizations at River Bojana on the border between Montenegro and Albania, carried out in 1950.

Immediately downstream of all major dams and major hydropower plants it is highly likely that the natural flow regime is severely disrupted. This is best seen on the system of the Upper Zeta where the Zeta River is turned into concrete canals and pipelines that bring water from reservoirs to the Perucica hydroelectric power plant (Figure 4.11).

**Figure 4.11 The system "Upper Zeta"**




The natural flow regime will be subjected to artificial pulses ('hydro-peaking'), artificial extensions of high flows in summer, and a possible absence or attenuation of seasonal flood peaks in winter.

Under the WFD 2016 reporting classification scheme (Section 4.4.4, Table 4.6), at the Pfafstetter segment level, these are classed as HMWB alteration 'channelization', where the HMWB use is most commonly related to 'flood protection'.

Physical pressure is most typically the result of channel flood protection, and the typical impact is termed an 'altered habitat morphology'. In the urbanized areas some HMWBs are also likely subject to point source pressures and chemical pollution impacts.

The following criteria were selected to determine probable effects on the ecological potential of the water body:

- **Canalization** - Invariably river canalizations provide relatively sterile environments with regard to biological elements. Riverbanks are typically concreted (revetments), and usually the river berms are laid to grass and/or gravel with little natural flora. Frequently the berms are themselves are disconnected from the wider floodplains by flood protection levees.

  There is little work in Montenegro at present with respect to restoration of concrete/excavated rivers. These canalised rivers tend to have a uniform section, depth and velocity, and provide virtually no in-channel habitat refuges or variation. The general approach has been to allocate these segments/water bodies as Ecological Potential 5 (Bad) and the risk assessment as 'At Risk'.

- **Regime Altered Water Bodies** - Hydropower invariably operates to the full limit of the turbines, irrespective of the downstream environmental needs.

  As far as we aware there have been no assessments with regard to variable compensation flows downstream of dams, nor any implementation of environmental flow regimes. The general approach has been to allocate the segments/water bodies immediately downstream of the abstraction or discharge point as Ecological Potential 5 (Bad) and the risk assessment as 'At Risk'.

  It is more difficult to assess the ecological potential of water bodies at greater distance downstream because of a lack of data. As the downstream distance increases, the relative impact of the artificial influence decreases. However, the detrimental impact (modification) can persist for many kilometers.

  For water bodies where we suspect that the flow regime is possibly heavily modified, the general approach has been to approximate the Q50 at each water body. If the upstream turbine capacity is >50% of the Q50 value, the segment/water body is assessed as Ecological Potential 4 or 3 (Poor to moderate) and the risk assessment as 'Probably at Risk'. This is based on the premise that modification to the natural flow regime of +/-50% would be sufficient in itself to generate 'Bad' ecological potential.

  Where the upstream release schedule is not known e.g. for water supply dams, the segment/water body is assessed as Ecological Potential 4 or 3 (Poor to Moderate) and the risk assessment as 'Probably at Risk'.

- **Canalization and Regime Altered Water bodies** - Water bodies subjected to combined pressures of canalization and flow regime alteration without any obvious mitigation measures are clearly at relatively higher risk than the categories in isolation. The general approach has been to allocate these segments/water bodies as Ecological Potential 5 (Bad) and the risk assessment as 'At Risk'.

In Adriatic catchment area there are only two WBs which have the riverbed made of concrete (channelized river flow): Sutorina_2 (SWB 5) and Zeta_2 (SWB 21) (Table 4.37).

## 4.10 Assessment of Water Quality

A detailed assessment of the chemical and ecological status carried out as part of a survey in 2018 is provided in Section 7. This current section supports the initial risk assessment by providing a simple assessment of the historical water quality data undertaken by Institute for Hydrometeorology and Seismology since 2015, within its basic activity and its competence is defined by the Law on Waters.

According to the Decree on Classification of Waters in Montenegro, water to be used for drinking and the food industry is classified as follows:

1. Class A - water which, in the natural state, with possible disinfection, can be used for drinking;
2. Class A1 - water which, after a simple physical treatment process and disinfection can be used for drinking;
3. Class A2 - water that can be used for drinking after proper conditioning (coagulation, filtration and disinfection);
4. Class A3 - water that can be used for drinking after treatment requiring intensive physical, chemical and biological treatment with prolonged disinfection and chlorination, i.e. coagulation, flocculation, decantation, filtration, active carbon absorption and ozone or chlorine disinfection.

Waters that can be used for fishing and shellfish farming are classified into classes, such as:

1. Class S - water that can be used for the cultivation of precious fish species (Salmonidae);
2. Class Š - water that can be used for breeding of shells;
3. Class C - water that can be used for the cultivation of less precious fish species (cyprinids).

Waters that can be used for bathing are classified into two classes:

1. Class K1 - excellent,
2. Class K2 – satisfactory

To protect and improve the quality of water, surface waters are classified into categories that meet the following requirements:

1. Category I - fresh water of classes A1, S and K1, and salt water and class Š;
2. Category II - classes A2, C and K2;
3. Category III - class A3

Although currently not in compliance with the EU WFD requirements, according to the quality of water to be maintained or secured in Montenegro for achieving good water status, water bodies of surface waters are classified into the following classes and categories are shown in Table 4.29.

### Table 4.29 Required classes and category of surface waters

| River Reach or Lake | Class | Category |
|---|---|---|
| **Morača** | | |
| Upstream Duklja | A1, S, K1 | I |
| From Duklja to the confluence of Morača with the Skadar lake | A2, C, K2 | II |
| **Zeta** | | |
| Upstream Brezovik | A1, S, K1 | I |
| From Brezovik to the confluence of the River Zeta with the River Morača | A2, C, K2 | II |
| **Bojana** | A2, C, K2 | II |
| **Skadar lake** | A2, C, K2 | II |
| **Saško lake** | A2, C, K2 | II |
| **Artificial lakes** (Liverovici, Krupac, Slano, Vrtac, Grahovo, Gradac) | A2, C, K2 | II |
| **Coastal sea** | | |
| Water in the tourist and recreational areas outside the Boka Bay, except the port basins in Bar | A1, S, Š, K1 | I |
| The waters of the sea in the Bay of Kotor, except the archaeological waters of Tivat, Kotor and the Bijela Shipyard | A2, C, K2 | II |
| Port in Bar (a riparian boundary with breakwater), as well as a seafront from the Sailing Club "Delfin" south of the concrete beach in front of the "Mimoza" hotel in the width of 500m in the municipality of Tivat, south of the imaginary line drawn between the building of the former military the department at Peluzica and the right bank of the mouth of the Škurde II and Luka Risan in the Kotor municipality and the Bijela Shipyard in Herceg Novi. | A3 | III |

Table 4.30 shows the definition of water quality status applied to assess the quality of surface waters:

### Table 4.30 Qualification of water quality

| Qualification | Environmental Categories | | |
|---|---|---|---|
| | Drinking Water | Fish Farming | Bathing Water |
| High (H) | A | Š | I |
| Good (G) | A1 | S | I |
| Moderate (M) | A2 | C | II |
| Poor (P) | A3 | >C | >II |
| Bad (B) | >A3 | >C | >II |

The following stations in the Adriatic River Basin (Table 4.31) are monitored regularly by IHMS, which conform only to 10 out of the 41 surface water bodies designated in Section 3.3, Table 3.5.

### Table 4.31 IHMS surface water monitoring stations in the Adriatic River Basin

| IHMS Monitoring Station | SWB No. | Surface Water Body (ECRIN Code) |
|---|---|---|
| Pernica | 9 | Morača_3 |
| Zlatica | 14 | Morača_4 |
| City Beth | 18 | Morača_5 |
| Podgorica WWTP | 18 | Morača_5 |
| Grbavci | 19 | Morača_6 |
| Vukovci | 19 | Morača_6 |
| Vidrovan | 26 | Sušica |
| Duklov most | 27 | Zeta_1 |
| Danilovgrad | 34 | Zeta_3 |
| Vranjske njive | 34 | Zeta_3 |
| Trganj | 25 | Cijevna |
| Cijevna | 25 | Cijevna |
| Fraskanjel | 1 | Bojana |
| Rijeka Cnojevica | 36 | Skadar Lake Vučko blato |

The Maximum Allowable Concentrations (MAC) of the general physico-chemical quality elements, and some 'specific pollutants' (chemical oxygen demand and iron) are shown in Tables 4.32 and 4.33, respectively.

### Table 4.32 Class Thresholds of selected general physico-chemical quality elements (rivers)

| Parameter | Acronym | Unit | A - High | A1- Good | A2 - Moderate | A3 - Poor | Out of Class - Bad |
|---|---|---|---|---|---|---|---|
| **Oxygenation conditions** | | | | | | | |
| Degree of saturation of Dissolved Oxygen | DO | % $O_2$ | 75 | 80-110 | 80-120 | 50-120 | >120 |
| Biochemical Oxygen Demand | $BOD_5$ | mg $O_2$/l | 2 | 3 | 4 | 7 | >7 |
| **Nutrient conditions** | | | | | | | |
| Ammonium ion | $NH_4$ | mg N/l | 0.00 | 0.02 | 0.05 | 1 | >1 |
| Nitrate | $NO_3$ | mg N/l | 10 | 20 | 25 | 50 | >50 |
| Nitrite | $NO_2$ | mg N/l | < DL* | 0.003 | 0.005 | 0.02 | >0.02 |
| Orthophosphate | $PO_4$ | mg P/l | 0.01 | 0.02 | 0.05 | 0.10 | >0.10 |

*DL - detection limit

### Table 4.33 Environmental Quality Standards for selected specific pollutants

| Parameter | Acronym | Unit | A - High | A1- Good | A2 - Moderate | A3 - Poor | Out of Class - Bad |
|---|---|---|---|---|---|---|---|
| Chemical Oxygen Demand | $COD_{Mn}$ | mg$O_2$/l | 1 | 2 | 4 | 8 | >8 |
| Iron | Fe | mg/l | 0.05 | 0.1 | 0.3 | 1 | >1 |

Measurement of other priority substances and metals has not yet been carried out. Based on assessment of aggregated monitoring data for 2015-2017, in accordance with the draft Decree on classification of surface water bodies, a preliminary summary of classification based only on physico-chemical parameters is shown in Table 4.34. The link between the categories of pressures and the discharges from agricultural, industrial and municipal sectors is summarized in Table 4.35.

**Table 4.34 Preliminary summary of classification of physico-chemical parameters at main rivers**[78]

| Name of River | Measuring Point | Surface Water Body | Physico-Chemical Status* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | General Conditions | | | | | Specific Pollutants | |
| | | | $BOD_5$ | $NH_4$ | $NO_3$ | $NO_2$ | $PO_4$ | COD | Fe |
| Morača | Pernica | Morača_3 | H | P | H | H | P | G | H |
| | Zlatica | Morača_4 | H | P | H | M | B | G | H |
| | Gradska plaža | Morača_5 | H | P | H | M | M | M | H |
| | Ispod grad. kolektor | Morača_5 | B | B | H | B | B | G | H |
| | Grbavci | Morača_6 | G | P | H | B | B | M | H |
| | Vukovci | Morača_6 | G | B | H | B | P | G | H |
| Zeta | Vidrovan | Sušica | H | P | H | H | P | H | H |
| | Duklov Most | Zeta_1 | P | P | H | M | P | M | H |
| | Danilovgrad | Zeta_3 | G | B | H | G | B | M | H |
| | Vranjske njive | Zeta_3 | H | B | H | M | B | M | H |

*Status: H-High, G-Good, M-Moderate, P-Poor, B-Bad

[78]Quality state of water in main rivers of the Adriatic River Basin assessed for years 2015, 2016 and 2017 by the Institute for Hydrometeorology and Seismology, Podgroica, Montenegro.

### Table 4.35 Links between type of pressure and monitoring categories of parameters

| Pressures (selection) | Organic pollution | Nutrients | Salinity | Transparency | Other specific pollutants | Priority substances | Pathogens | Remarks |
|---|---|---|---|---|---|---|---|---|
| Wastewater households | X | X | - | - | (X) | (X) | X | • There are no 'other specific pollutants' or 'Priority substances' exclusively linked to households. |
| Urban wastewater | X | X | X | (X) | X | X | X | • Normally urban wastewaters are a mix from households, SMEs and 'other sources' (e.g. runoff from roads). |
| Wastewater Small and Medium Enterprises | X | X | X | (X) | X | X | (X) | • The group(s) of pollutants that are discharged depends very much on the type of enterprise (see Table 3.14).<br>• SMEs often discharge into combined sewage systems, with or without pretreatment. |
| Wastewater larger industries (often IPPC /EID) | X | X | X | (X) | X | X | (X) | • The group(s) of pollutants that are discharged depends very much on the type of industry. (See Table 3.14)<br>• Larger industries often discharge directly into the river, in principle after treatment. |
| Agriculture (generally diffuse, perhaps except for intensive animal farms (pigs, cattle, poultry) | (X) | X | - | - | - | x | (X) | • Nutrients are generally linked with application of organic and artificial fertilizers and excrements of animals walking around freely.<br>• Use of specific pesticides depends on the type of crops.<br>• Besides the usage of fertilizers and pesticides as such, also the amount is relevant. |
| Mines (incl. abandoned ones) | - | - | (X) | (X) | X | X | - | • The metals that are potentially discharged depends also on the specific mining. |
| Quarries, excavations | - | - | - | X | - | - | - | |

In order to further examine the historic surface water pollution, the content of $BOD_5$, phosphate and nitrate for the period 2009-2016 were also analyzed for the main watercourses Morača and Zeta,[79].

These data show that in general there are mainly problems with organic pollution in the Adriatic River Basin and the negative effect of municipal discharge of urban discharges are clear. This is mirrored with phosphate pollution, but to a much lesser extent with nitrate pollution, the latter being derived primarily from agricultural pollution.

## 4.11 Assessment of pressures on surface water bodies

The identification of the risk of non-achievement of the environmental objective (See Section 9) has to be carried out at 'water body' level. The reason for this is that the WFD environmental objective has to be achieved at water body level. Other levels can be considered: for instance, the different type of pressures was recorded whenever possible at 'river segment' level or groups of water bodies can be used for management purpose, especially for implementing measures to maintain high status or recover good status.

The analysis was carried out at 'river segment' level but the synthesis of the pressure and the assessment of the risk of non-achievement of the environmental objectives was performed at 'water body level'.

### 4.11.1 Preliminary assessment of pressures and identification of surface water bodies 'at risk'

Table 4.36 provides a complete analysis of all surface water bodies with respect to point source pollution. This incorporates the following: urban wastewaters, IED plants, non-IED plants, contaminated sites, waste disposal sites, mine waters, aquaculture and hydropower installations.

The analysis provided in Table 4.37 indicates the actual pressures in each water body resulting from either point or diffuse source pollution, abstraction and physical alterations. The analysis was competed for all 41 surface water bodies identified in the Adriatic River Basin.

A further assessment of the pressures on the surface water bodies is provided in Section 7, which incorporates an assessment of the biological quality elements, the chemical status and the hydromorphology to highlight the surface water bodies that are deemed 'at risk', 'possibly at risk' and 'likely not at risk'.

[79] Report on Environment in Montenegro for 2016, EPA, 2017

### Table 4.36 Point source pressures in surface water bodies in the Adriatic River Basin[80]

| SWB No. | Surface Water Body (ECRIN Code) | Condition | Urban wastewater | IED plants | non IED plants | Contaminated sites | Waste disposal | Gravel Extraction | Mine waters | Aquaculture | Hydropower[81] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bojana | Natural | √ | | | | | | | | |
| **2** | Orahovštica | Natural | | | | | | | | | |
| **3** | Crmnička rijeka | Natural | | | | | | | | | |
| **4** | Sutorina_1 | Natural | | | | | | | | | |
| **5** | Sutorina_2[82] | HMWB | | | | | | | | | |
| **6** | Bilećko Lake | AWB | | | | | | | | | |
| **7** | Morača_1 | Natural | | | | | | | | | (√) |
| **8** | Morača_2 | Natural | | | | | | | | | |
| **9** | Morača_3 | Natural | | | | | | | | | |
| **10** | Sjevernica_1 | Natural | | | | | | | | | |
| **11** | Sjevernica_2 | Natural | | | | | | | | | |
| **12** | Mrtvica_1 | Natural | | | | | | | | | |
| **13** | Mrtvica_2 | Natural | | | | | | | | | |

[80] Point sources pressures are categorized in Section 3.4, Table 3.3

[81] Ceckmark in parenthesis relates to SHPPs under construction only.

[82] River bed in concrete

| SWB No. | Surface Water Body (ECRIN Code) | Condition | Urban wastewater | IED plants | non IED plants | Contaminated sites | Waste disposal | Gravel Extraction | Mine waters | Aquaculture | Hydropower[81] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **14** | Morača_4 | Natural | | | | | | | | | |
| **15** | Nožica | Natural | | | | | | | | | |
| **16** | Mala Rijeka_1 | Natural | | | | | | | | | |
| **17** | Mala Rijeka_2 | Natural | | | | | | | | | |
| **18** | Morača_5 | Natural | √ | √ | √ | √ | √ | √ | | | |
| **19** | Sušica | Natural | | | | | | | | | |
| **20** | Zeta_1 | Natural | | | | | | | | | |
| **21** | Zeta_2[83] | HMWB | √ | √ | √ | | √ | | | | |
| **22** | Gračanica_1 | Natural | | | | | | | √ | | |
| **23** | Liverovići[84] | HMWB | | | | | | | √ | | |
| **24** | Gračanica_2[85] | HMWB | √ | | | | √ | √ | | | |
| **25** | Krupac Lake | AWB | | | | | | | | | |
| **26** | Slansko Lake | AWB | | | | | | | | | |
| **27** | Zeta_3 | Natural | | | | | | | | | |
| **28** | Zeta_4 | Natural | √ | | √ | | √ | | | √ | √ |
| **29** | Ribnica | Natural | | | | | √ | | | √ | |

[83] River connectivity lost due to hydropower plant “Salp Zete“

[84] Reservoir

[85] River substantially altered by gravel extraction

| SWB No. | Surface Water Body (ECRIN Code) | Condition | Urban wastewater | IED plants | non IED plants | Contaminated sites | Waste disposal | Gravel Extraction | Mine waters | Aquaculture | Hydropower[81] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **30** | Morača_6[86] | HMWB | | | √ | | √ | √ | | | |
| **31** | Matica_1 | Natural | | | | | | | | | |
| **32** | Matica_2 | Natural | | | | | | | | | |
| **33** | Sitnica | Natural | | | | | | | | | |
| **34** | Cijevna | Natural | | | | | | √ | | | |
| **35** | Morača_7 | Natural | √ | | | | | | | | |
| **36** | WB1_Vucko blato | Natural | √ | | | | | | | | |
| **37** | WB 2_North | Natural | √ | | √ | | √ | | | | |
| **38** | W3_South west | Natural | | | | | | | | | |
| **39** | W4_Pelagic zone | Natural | | | | | | | | | |
| **40** | Saško Lake | Natural | | | | | | | | | |
| **41** | Malo Blato Lake | Natural | | | | | | | | | |

[86] River substantially altered by gravel extraction

## Table 4.37 Pressures affecting surface water bodies in the Adriatic River Basin and identification of risk[87]

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| 1 | Bojana | 28.77 km | Urban wastewater - There are many private houses built on water in Bojana Delta (tourism) | Agriculture - relatively high intensity in Bojana river surrounding area | | | Removal of fish-Illegal fishing (poachers)[88] | Possibly at risk |
| 2 | Orahovštica | 10.32 km | | | Water abstraction for Cetinje municipality water supply | | Removal of fish-Illegal fishing (poachers) | At risk |
| 3 | Crmnička rijeka | 7.91 km | | | Water abstraction for irrigation | Small cascades related to irrigation system | | Possibly at risk |
| 4 | Sutorina_1 | 3.88 km | | Agriculture – low intensity but significant since the low waterflow regime | Water abstraction for households | | | At risk |
| 5 | Sutorina_289 | 3.15 km | | Agriculture – low intensity but significant since the low water flow regime | | Riverbed made of concrete (channelized river flow) | | At risk |

[87] Pressures on the surface water bodies are categorized in Section 4.4, Tables 4.3 to 4.7

[88] See Section 4.4, Table 4.7: Pressure No. 5.2 Exploitation of/removal of animals/plants

[89] Riverbed in concrete

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| **6** | Bilećko  Lake | | | | | | Introduction of invasive rainbow trout and several cyprinid species | Likely not at risk |
| **7** | Morača_1 | 5.34 km | | | | | | Likely not at risk |
| **8** | Morača_2 | 15.08 km | | | | | | Likely not at risk |
| **9** | Morača_3 | 14.52 km | | | | | Removal of fish-Illegal fishing (poachers) | Likely not at risk |
| **10** | Sjevernica_1 | 4.87 km | | | | | | Likely not at risk |
| **11** | Sjevernica_2 | 5.44 km | | | | | | Likely not at risk |
| **12** | Mrtvica_1 | 5.41 km | | | | | | Likely not at risk |
| **13** | Mrtvica_2 | 9.51 km | | | | | | Likely not at risk |
| **14** | Morača_4 | 31.95 km | | | | | Removal of fish-Illegal fishing (poachers) | Likely not at risk |
| **15** | Nožica | 14.44 km | | | | | | Likely not at risk |
| **16** | Mala Rijeka_1 | 12.72 km | | | | | | Likely not at risk |
| **17** | Mala Rijeka_2 | 5.66 km | | | | | | Likely not at risk |
| **18** | Morača_5 | 9.99 km | Urban wastewater from Podgorica municipality;<br>Discharge from non-IED plants<br>Discharge from IED plants | Overflows and discharges in urbanized and non-urbanized areas and organic matter loading | | Intensive gravel extraction | Removal of fish-Illegal fishing (poachers) | At risk |

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| | | | Waste disposal;<br>Sludge dumping site from aluminum plant | Diffuse pollution from road and train traffic | | | | |
| **19** | Sušica | 6.47 km | | | | | | Likely not at risk |
| **20** | Zeta_1 | 9.13 km | | | | | Removal of fish-Illegal fishing (poachers) | Likely not at risk |
| **21** | Zeta_2[90] | 11.09 km | Urban wastewater from Nikšić municipality;<br>Discharge from non-IED plants<br>Discharge from IED plants;<br>Waste disposal | Overflows and discharges in urbanized and non-urbanized areas and organic matter loading;<br>Diffuse pollution from road and train traffic | | Riverbed made of concrete (channelized river flow) | | At risk |
| **22** | Gračanica_1 | 12.66 km | Discharge from bauxite mine | Agriculture – low intensity but significant since the low waterflow regime | | | | At risk |
| **23** | Liverovići[91] | | Discharge from bauxite mine | | | | | Likely not at risk |

[90] River connectivity lost due to hydropower plant “Salp Zete“

[91] Reservoir

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| **24** | Gračanica_2[92] | 13.05 km | Urban wastewater from Nikšić municipality<br>Waste disposal | | | Gravel extraction; Riverbed in some parts almost destroyed | | At risk |
| **25** | Krupac Lake | 9 km2 | | | | | Introduction of invasive rainbow trout and several cyprinid species | Likely not at risk |
| **26** | Slansko Lake | | | | | | Introduction of invasive rainbow trout and several cyprinid species | Likely not at risk |
| **27** | Zeta_3 | 10.15 km | | Agriculture – low intensity | | Hydropeaking on daily basis (changing of flow several times during one daily cycle) | | Possibly at risk |
| **28** | Zeta_4 | 36.70 km | Urban wastewater from Danilovgrad municipality;<br>Discharge from non-IED plants;<br>Waste disposal;<br>Fish-farms (cage farming);<br>River connectivity lost due to | Agriculture – medium to high intensity | | | Removal of fish-Illegal fishing (poachers) | At risk |

[92] River substantially altered by gravel extraction

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| | | | hydropower plant “Salp Zete“ | | | | | |
| **29** | Ribnica | 8.09 km | Fish farm;<br>Waste disposal | Overflows and discharges in urbanized and non-urbanized areas | | Small barriers on river flow and one part of riverbed made of concrete | | At risk |
| **30** | Morača_6[93] | 16.82 km | Discharge from non-IED plants<br>Waste disposal | Agriculture<br>Overflows and discharges in urbanized and non-urbanized areas and organic matter loading;<br>Diffuse pollution from road and train traffic | | Due to intensive gravel extraction riverbed and river flow completely changed and destroyed;<br>Dam constructed for water extraction purpose | Removal of fish-Illegal fishing (poachers) | At risk |
| **31** | Matica_1 | 2.73 km | | | | | | Likely not at risk |
| **32** | Matica_2 | 6.14 km | | | | | Removal of fish-Illegal fishing (poachers) | Likely not at risk |
| **33** | Sitnica | 9.29 km | | | Water abstraction for irrigation | Small cascades related to irrigation system | | Possibly at risk |

[93] River substantially altered by gravel extraction

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| **34** | Cijevna | 31.77 km | | Agriculture<br>Diffuse pollution from road and train traffic | Water abstraction for irrigation<br>Water abstraction for households | Intensive gravel extraction | Removal of fish-Illegal fishing (poachers) | Possibly at risk |
| **35** | Morača_7 | 9.17 km | Urban wastewater from Podgorica and Golubovci municipality | Agriculture<br>Overflows and discharges in urbanized and non-urbanized areas and organic matter loading;<br>Diffuse pollution from road and train traffic | | | Removal of fish-Illegal fishing (poachers) | Possibly at risk |
| **36** | WB1_Vucko blato | | Urban wastewater from Cetinje municipality | | | | Removal of fish-Illegal fishing (poachers);<br>Introduction of invasive cyprinid species | Likely not at risk |
| **37** | WB 2_North | | Urban wastewater from Podgorica and Golubovci municipality;<br>Discharge from non-IED plants | Agriculture<br>Overflows and discharges in urbanized and non-urbanized areas | | | Removal of fish-Illegal fishing (poachers)<br>Introduction of invasive cyprinid species | Possibly at risk |

| No. | SWB Name | Length Or Area | identification of Pressure | | | | | Assessment of Status |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | Abstraction | Physical | Other | |
| | | | Waste disposal | and organic matter loading | | | | |
| **38** | W3_South west | | | | | | Removal of fish-Illegal fishing (poachers);<br>Introduction of invasive cyprinid species | Likely not at risk |
| **39** | W4_Pelagic zone | | | | | | Removal of fish-Illegal fishing (poachers);<br>Introduction of invasive cyprinid species | Likely not at risk |
| **40** | Saško Lake | | | | | | Removal of fish-Illegal fishing (poachers);<br>Introduction of invasive cyprinid species | Likely not at risk |
| **41** | Malo Blato Lake | | | | | | Removal of fish-Illegal fishing (poachers);<br>Introduction of invasive cyprinid species | Likely not at risk |

## 4.12 Assessment of quantitative pressures on groundwater bodies

At global scales, several initiatives aim at developing water resources assessments and water budgets (balances), such as the activities of the UNESCO-IHP programme. Under this programme, an Atlas of World Water Resources was developed already in the 1970s including guidelines for conducting water resources assessment. By support of UNESCO-IHP and IGRAC, Margat & Gun van der published *Groundwater around the World* (2013)[94] which includes groundwater budgeting. A compilation of water budgets has also been produced by FAO/AQUASTAT and the World Meteorological Organization (WMO) Commission for Hydrology (CHy). At the EU scale, the European Environment Agency has worked in recent years on physical water budgets at catchment scale.

In order to support creation of River Basin Management Plans including planning processes and the implementation of the WFD in the EU, the European Commission (EC) develops the Guidance for Water Budgeting (2015). This document focuses on the application of water budgets (balances) as a "coherent framework to cross-evaluate the information on drivers, pressures and impacts on water quantity (including the coherence between water extraction and water recharge, water flows between water bodies/catchments, storage changes over time, etc.) and providing a sound basis to the quantitative management of water resources."

After EC (2015)[95] "water balances are usually linked to models for simulating different components of the balance and different water management scenarios in order to assess (*ex-ante*) their potential impact on water use, demand and availability, or to learn (*ex-post*) from the effectiveness of past efforts and applied measures to respond to drought and water scarcity."

Therefore, water budgeting should be systematically applied as an integrated component of sustainable water resources management in individual river basins and catchments. Based on results of water budget the quantitative management of water resources enables to mitigate negative consequences of the imbalance between water availability and water demand and of water scarcity and drought, both in ecological and economic terms.

The water budget describes the pressure on the quantitative status in relation to the water extraction and the artificial recharge. In case of the latter no any such structure exists in Montenegro. According to Annex V, item 2.1.1 of the WFD good quantitative status is identified when the groundwater level in the groundwater body is such that the available groundwater resources are not exceeded by the long-term annual average rate of extraction. The parameters of risk assessment of the quantitative status are either the groundwater level or the estimated water balance of the groundwater body. However, the EU Guidance for Water Budgeting (2015) does not fully recognizes specificity of karstic aquifers and water budget methodology needed for this kind of aquifer system, which is dominant in Montenegro, but also in other Alpine and Dinaric countries of SE Europe.

During the examination of the anthropogenic impact on the quantitative status of the groundwater bodies according to the WFD, the quantitative status identified for the initial characterization is based on data related to water bodies which are used for water extraction for human consumption,

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[94] Margat J. Gun van der J., 2013: Groundwater around the World: A Geographic Synopsis. CRC Press, Taylor & Francis Group, Boca Raton, pp. 348

[95] European Commission, 2015: Guidance document on the application of water balances for supporting the implementation of the WFD, Final – Version 6.1 – 18/05/2015, Technical report 2015/090

“providing more than 10 $m^3$ a day as an average or serving more than fifty persons as well as water bodies intended for such future use and to places of direct water discharge”. However, the water budget in this report has been applied only on 17 delineated groundwater bodies (GWB) and group of groundwater bodies (GGWB) because in case of Montenegro consequential respect of above criteria would have result with several thousand of such water bodies.

In order to assess quantitative status, the climatic and hydrological parameters, registered during the initial characterization of GWBs and GGWBs and their catchments, are compared with the average annual rate of water extraction (springs and wells) of these GWBs and GGWBs. Data on the groundwater levels of dug or drilled wells are very rarely measured in entire Montenegro, while sporadically collected data of spring discharges have used from available literature and funds (see List of References in Annex 1). Data of climatic and hydrological parameters are taken from the database of the Hydrometeorological Institute of Montenegro (IHMS). The next chapter of this report indicates all previous and actual GW monitoring points and periods of their observation. Some other references, published articles, studies, dissertations, data base of the Geological Survey of MNE responsible for preparation of the national Basic Hydrogeological Map 1:100.000, has also been consulted and its data evaluated.

Although some general information on the springs’ discharges is indeed available (Qmin/av/max), such data has been systematically collected for very few springs. Similarly, only a few waterworks continually measure and provide data on the regime of tapped water sources. Consequently, the situation concerning the elements required for proper water budgeting is as follows:

- Relatively satisfactory data and historical records on precipitation (rainfall) and several other climatic elements (air temperature, humidity, winds) collected at the stations of the national network maintained by IHMS;
- Absence of evapotranspiration data (no lysimeter stations), and only some data from three stations where evaporation was temporarily monitored (pan class A);
- Relatively satisfactory data and historical records collected for hydrological stations of the national network maintained by IHMS, which are rarely located close to the river sources (upper catchments where springs exist);
- Incomplete historical records on the springs’ discharge regime;
- Almost no data on groundwater level measurements; and
- Very limited data on pumped water amounts or utilized spring flow, collected by local waterworks.

Consequently, the levels of certainty should also be presented in each characterization table for evaluated GWBs or GGWBs. In accordance with the standards used in these types of studies, we advise five levels of certainty of estimated GW budget parameters and obtained results, depending on the quality of collected data: RA – Rough Assessment; LL - Low Level (Uncertain), ML – Medium Level (Probable); HL – High Level (Most Probable) and CT – Certain (Confirmed after long-term observation). Unfortunately, all the evaluated GWBs and GGWBs were classified as RA – Rough Assessment; with transition between RA and LL - Low Level for just three GGWBs, namely: Southern Rim of the Skadar Lake and Zeta Valley, as well as Nikšićko polje, which contains some more information on the GW regime but is nevertheless lacking results of continual monitoring of the groundwater regime.

### 4.12.1 Groundwater utilization and protection

The groundwater in Montenegro is mostly used for the water supply, but also for irrigation, industry and bottling.

Around 92% of population in Montenegro obtain the drinking water from groundwater sources (77% from karst aquifers, and 15% from intergranular aquifers)[96]. The annual extraction of groundwater for the **public water supply** in Montenegro is around 100 MCM (millions cubic meters). There are 53 groundwater sources located in karst aquifers and 13 sources in intergranular aquifers in the Adriatic River Basin as shown in Table 4.38. The karst springs are mostly tapped by the water intake, but in few cases also by the horizontal and vertical underground structures (shafts, drilling wells and tunnels). The groundwater from the intergranular aquifer is pumped from extraction wells. The list of all groundwater sources used for water supply is presented in the Table 4.38.

**Table 4.38 Groundwater Sources used for water Supply in the Adriatic River Basin**

| Municipality | Location | Type of Source | Type of Aquifer | Quantity of water (l/sec) | Population [97] |
|---|---|---|---|---|---|
| **Bar** | Zaljevo | spring | karst | 20 | 42,048 |
| | Kajnak | spring/well | karst | 70 | |
| | Brca | spring | karst | 60 | |
| | Sustaš | spring | karst | 2 | |
| | Turčin I | spring | karst | 0.5 | |
| | Turčin II | spring | karst | 0.5 | |
| | Vrelo (Čanj) | spring/well | karst | 8 | |
| | Velje Oko | spring | karst | 40 | |
| | Orahovsko polje | well | inter-granular | 150 | |
| **Budva** | Reževića Rijeka | spring | karst | 80 | 19,218 |
| | Dobra Voda (Buljarica) | spring/well | karst | 10 | |
| | Zagradac | spring | karst | 2 | |
| | Piratac | spring | karst | 2 | |
| | Loznica | spring | karst | 5 | |
| | Spring “under Pyramid” | spring | karst | 5 | |
| | Sjenokos | well | inter-granular | 100 | |
| | Smokovijenac | spring | karst | 5 | |
| **Cetinje** | Podgor Springs | spring | karst | 200 | 16,657 |
| | Obzovica | spring | karst | 1 | |
| | Uganjska Springs | spring | karst | 10 | |

[96] SWMM, 2017: Strategy for water management in Montenegro. MARD, Government of Montenegro,

[97] MontStat data for 2011

| Municipality | Location | Type of Source | Type of Aquifer | Quantity of water (l/sec) | Population [97] |
|---|---|---|---|---|---|
| | Struge (Rijeka Crnojevića) | spring | karst | 1 | |
| | Karuč[1] | spring | karst | 1000 | |
| | Volač[1] | spring | karst | 30 | |
| **Danilovgrad** | Oraška Jama | spring/well | karst | 120 | 18,472 |
| | Slatinski Springs | spring | karst | 15 | |
| | Brajovića Jama | spring | karst | 40 | |
| | Žarića Jama | spring | karst | 50 | |
| | Miojevića Vrelo | spring | karst | 60 | |
| | Viško Vrelo | spring/well | karst | 20 | |
| | Mareza | spring | karst | 70 | |
| **Herceg Novi** | Opačica | spring/well | karst | 35 | 30,854 |
| | Pijavica | spring | karst | 2 | |
| | Springs in Sasovići | spring | karst | 3 | |
| | Sutorina | well | inter-granular | 30 | |
| | Lovac | spring | karst | 7 | |
| **Kotor** | Vrmac | spring | karst | 20 | 22,601 |
| | Orahovački Springs (Ercegovina and Cicanova Kuća) | spring/well | karst | 120 | |
| | Škurda | spring | karst | 200 | |
| | Risanska Spilja | spring | karst | 20 | |
| | Morinjski Springs | spring | karst | 500 | |
| **Nikšić** | Vidrovan | spring/well | karst | 200 | 72,443 |
| | Trebjesa[1] | spring | karst | | |
| | Poklonci | well | karst | 200 | |
| | Blaca[1] | spring | karst | 50 | |
| | Studenačka Springs[1] | | karst | 30 | |
| **Podgorica + Tuzi** | Mareza | spring | karst | 2070 | 198,033 |
| | Zagorič | well | inter-granular | 545 | |
| | Konik | well | inter-granular | | |
| | Ćemovsko Polje | well | inter-granular | 410 | |
| | Tuzi | well | inter-granular | 12 | |
| | Dinoša | well | inter-granular | 70 | |
| | Milješ | well | inter-granular | 78 | |
| | Vuksan Lekići | well | inter-granular | 130 | |
| | Bioče | well | inter-granular | 100 | |
| | Bolje Sestre[2] | spring | karst | 1500 | |
| **Tivat** | Topliš | spring/well | karst | 20 | 14,031 |
| | Plavda | spring | karst | 20 | |

| Municipality | Location | Type of Source | Type of Aquifer | Quantity of water (l/sec) | Population [97] |
|---|---|---|---|---|---|
| | Brštin | spring | karst | 2 | |
| | Češljar | spring | karst | 3 | |
| | Grbaljsko polje | well | inter-granular | 30 | |
| **Ulcinj** | Lisna Bori | well | inter-granular | 250 | 19,921 |
| | Salč | spring | karst | 2 | |
| | Gač | spring/well | karst | 20 | |
| | Klezna I and II | spring/well | karst | 23 | |
| | Mide | spring | karst | 5 | |
| | Kaliman I and II | spring | karst | 2 | |
| **Regional water supply system for costal region** | Bolje sestre | | | 1,500 | |

[1] Potential sources for water supply designated in accordance with Official Gazete MNE 36/08

[2] Source "Bolje sestre" is located in territory of Podgorica Municipality whereas water is derived to supply Montenegrin Coast.

The groundwater extraction for the purposes of the industry in the Adriatic River Basin ranges from around 10,000 to 23,000 m$^3$/year[98]. The main consumers are Aluminium Plant Podgorica (APP) and brewery "Nikšić". The Aluminium plant uses water from Morača River, but there is also groundwater pumping from wells drilled or dug out in intergranular aquifer of Lower Zeta Valley. The brewery "Nikšić" has own wells for the extraction of groundwater from the intergranular aquifer of Nikšić polje.

The largest groundwater use for the irrigation occurs in the Lower Zeta Valley. For the irrigation of the vineyards of company "Plantaže" the groundwater of intergranular aquifer is abstracted by more than 20 wells in quantity of around 2 m$^3$/s. The estimated extraction of groundwater for the irrigation of agriculture areas in Montenegro ranges from 1.6 to 8.8 MCM/year[99].

As regard the average volume of water resulting from precipitation, in Montenegro out of 24.9 x 10$^9$ m$^3$ which is estimated average total annual volume of water from precipitation (1805 mm/year)[100] some 13.6 x 10$^9$ m$^3$ are total annual internally renewable resources. Out of this amount around 62% represent groundwater. Data depicting water availability per capita are more illustrative. In an average hydrological year, each inhabitant of Montenegro has 21,395 m$^3$ of water available but utilizes just 1.18 % of this volume[101].

[98] SWMM, 2017: Strategy for water management in Montenegro. MARD, Government of Montenegro

[99] SWMM, 2017: Strategy for water management in Montenegro. MARD, Government of Montenegro

[100] FAO, Rome: www.fao.org/nr/aquastat

[101] FAO, Rome: www.fao.org/nr/aquastat

### 4.12.2 Applied Groundwater Budgeting Methodology and Assessment of Quantitative Status

The lack of monitoring data on most water budget parameters limits seasonal or monthly water parametrization and budgeting, and the general analysis mostly refers to averaged input and output values. However, the distinction between the average and minimal flows, which is essential to the analyses made in karst, has been thoroughly introduced and evaluated.

Due to the lack of data, even the above condensed GW budget formula has not been systematically applied, and therefore additional simplification is required in some cases. Groundwater modelling and the use of GIS to approximate some values regarding spatial distribution should be implemented in the next stages, when RBMPs will be developed for major internal basins.

The balance equation is applied to historical (and approximated) data and considers only the actual stage: "present climate – present demands". However, some increased water demands are also taken into consideration and included in our analyses. For future scenarios, including the climate change impact, input parameters for precipitation, temperature, evapotranspiration etc. could be gleaned from some of the Regional Climate models, usually available in the 25 x 25 km scale.

The analysis considers the amount of water that regularly replenishes an aquifer or GWB and also considers both the *dynamic reserves* and the earlier-accumulated waters i.e. *static reserves*, which exist below the minimal water table. Although some authors use the term *non-renewable* to describe *static reserves*, this is incorrect because in case of their extensive pumping, in addition to the dynamic reserves, they could be replenished (compensated), at least in part, during the later periods of flooding.

For GWBs that consist of intergranular aquifers, a combination of methods was applied. The estimation considers the geometry of aquifers (cross sectional area of the saturated zone) as well as effective porosity, but potential extraction per kilometer of length of alluvial aquifer along the riverside has also been estimated. However, the latter cannot be applied to sediments of Tertiary basins as parts of concerned GWB or GGWB. The effective porosity, along with the transmissivity values, has been derived from rare pumping tests performed in unsteady conditions; on the other hand, once a steady flow is confirmed, the obtained capacity of a well, or a group of wells, has been found to be a relevant parameter for the estimation of the dynamic reserves in the area of interest. In certain cases of non-tested areas, the analogy method has proven to be the only solution. Thus, in case of similar hydrogeology, a comparison has been made of the existing data from a relatively known GWB with those of an unexplored GWB. Such rough estimation seems to be satisfactory in case of regional RBMPs, while plans that should be prepared for smaller, internal river basins require more detailed studies.

The analysis has considered that $I_{ef}$ (effective infiltration of rainfall into the ground, as aquifer's recharge) fluctuates throughout the year. Its value depends on numerous factors, such as vegetation season (interception intensity), snow and ice cover, actual deficit of soil moisture, groundwater depth, rainfall intensity, air temperature, winds and similar; however, for analysis it was necessary to average the $I_{ef}$ at the annual level (LTA or long-term annual recharge).[102,103,]

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[102] Radulović MM., Stevanović Z., Radulović M., 2012: A new approach in assessing recharge of highly karstified terrains–Montenegro case studies. Environ Earth Sci 65(8):2221–2230

[103] Stevanović Z. et.al. 2016: Dinaric Karst Aquifer – One of the world's largest transboundary systems and an ideal location for applying innovative and integrated water management. In: Karst Without Boundaries, Stevanović Z., Kresic N., Kukuric N. (eds.), CRC Press/Balkema, Taylor & Francis Group, London, 3-25

In general, dynamic groundwater reserves could be roughly equalized to $I_{ef}$, but for analysis reference to the total average springs' discharge as the more accurate value. In intergranular aquifers, a potential extraction per kilometer of length of alluvial aquifer along the riverside was also considered. To determine the exploitable groundwater reserves, the water needed for dependent ecosystems was considered and subtracted from the ecological flows as the total minimal springs' discharge from dynamic reserves. Therefore, the total minimal discharge of springs of one GWB could be considered as the above demanded ecological flow, while the average total discharge via springs could be approximated as dynamic groundwater reserves.

**Exploitable GW reserves = (Dynamic GW reserves) – (Ecological flows)**

In order to verify the correctness of such an assessment, we may also compare the results obtained from the separation of hydrographs, in which river baseflow supposedly corresponds relatively well with dynamic reserves. However, one of the prerequisites for such equivalency is a properly determined catchment, which is not an easy task in karst terrains.

In terms of pressure, relevance should be given to these exploitable GW reserves and the relation between them and the total of demanded (extracted) waters.

**Quantitative pressure on GWB = Exploitable GW reserves Vs. Totally demanded waters**

Such an approach is adequate for two reasons: first, it considers ecological demands, and second, in relatively water-rich countries with a small extraction of groundwater such as Montenegro there is no need to use static water reserves, except in very rare cases (during extreme droughts) and when their quick replenishment during the flooding periods is ensured.

When assessing quantitative pressure on GWB by comparing exploitable and demanded resources, it is important to consider that most utilized waters will be returned to water recipients. The only exception is the transfer of water over long distances. This means that if the return flow is in the same GWB, the ecological flow could be supported by infiltrated re-used waters, either from the municipal sewage system or from irrigation. For instance, water used for extensive irrigation of vineyards and various crops is actually a return flow (recharge) of a local GWB. The quality of these waters is an additional aspect that requires attention.

In order to obtain a more realistic view of the pressure placed on aquifer systems (GWBs), and also "to be safe", projected water demands have been used and not the actual extraction, i.e. the actual demands for potable, irrigation and industry water were increased by 20% and these values were compared with the exploitable reserves.

There are two possible approaches to defining the pressure categories ('at risk 'or 'not at risk'): by comparing Water Demands with Exploitable Water Reserves (Approach 1), or GW Demands with Dynamic (renewable) Reserves (Approach 2). The criterion "percentage of" was adapted to local water resources and the water management situation in Montenegro.

The following risk categories have been introduced (Approach 1):

- *Not at risk*, when GW demands < 20 % of GW exploitable reserves;
- *Not at risk (but potentially at risk*[104]*)*, when GW demands = 20 – 33 % of GW exploitable reserves;

[104] The category '*Potentially at Risk*' is not recognized in WFD or EU reference application documents (CIS).

- *At risk*, when GW demands > 33 % of GW exploitable reserves.

Considering the fact that Guidance for GW status[105] as well as some EU countries' reports compare *GW Extraction* i.e. *Demands* with *Dynamic (renewable) Reserves*, ($I_{ef}$), a different approach (Approach 2) was tested on several examples by using criterion "12-25%", as follows:

- *Not at risk*, when GW demands < 12 % of GW dynamic (renewable) reserves;
- *Not at risk (Potentially at risk),* when GW demands = 12–25 % of dynamic (renewable) reserves;
- *At risk*, when GW demands > 25 % of dynamic (renewable) reserves.

Considering that there were almost no differences regardless of which approach we applied in the risk assessment of GWB, we proceeded with Approach (1); the results presented in Tables 4.39 and 4.40 refer to the comparison between GW Demands and GW Exploitable Reserves.

Table 4.39 contains input parameters for all 17 delineated GWBs and GGWBs in the Adriatic River Basin. These parameters are also included in the characterization tables and refer to the catchment size (total, autogenic and allogenic), average effective infiltration, specific discharge, average and minimal springs' discharge, actual GW extraction for various purposes, and projected water demands.

Table 4.40 contains a review of input parameters and their comparison. According to the proposed Approach (1), the main factor for pressure assessment is the relation between Projected Water Demands and Exploitable Reserves.

However, this category has been introduced in some prepared RBMPs and basic technical documents for WFD implementation in the region (Bosnia and Herzegovina, Serbia), for a pragmatic reason: to warn the decision makers and local populations that groundwater pumping has to be applied with caution, coupled with the systematic monitoring of its effects.

[105] WFD CIS Guidance Document No. 18 (2009), *Guidance on Groundwater Status and Trend Assessment*

### Table 4.39 Characterization of groundwater bodies or groups of groundwater bodies – inputs for quantitative pressure assessment

| No. of GWB / GGWB | Code | Character N (inner) TBA (transboundary) | Name | River basin | Linked to SWBs | F (km²) | Av. annual rainfall (mm / $10^6 m^3$ $P_{total}$ | Effect. infiltr. on karst in aver. ($I_{ef}$ in %; m³/s) | Specif. discharge of GWB Q (l/s/km²) | Total average disch. of register. Springs Qav (m³/s) | Total minimal discharge of register. springs /ecological flows in dry season (m³/sec) | Actual GW extraction Assessed (m³/sec) | Project. of water demands during drought (m³/sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | ME_AB_GGW_K_1 | N | Southern Rim of the Skadar Lake | Skadar Lake | WB 3_South west<br>WB 4_pelagic zone | 243.3 | 2,461 / 599 | 68 / 12.9 | 53 | 11.5 | 0.6 | 0.04 | 0.048 |
| **2** | ME_AB_GW_I_1 | TBA | Ulcinjsko polje | Bojana | Bojana TW_5 MNE_CW5<br>Saško | 111.1 | 1,253 / 139 | 30 / 1.33 | 12 | 1 | 0.1 | 0.25 | 0.3 |
| **3** | ME_AB_GGW_K_2 | N | Možura - Paštrovići | Adriat. | MNE_CW3 MNE_CW4<br>MNE_CW5 | 399.0 | 1,669 / 439 | 60 / 8.35 | 21 | 8 | 0.5 | 0.326 | 0.39 |
| **4** | ME_AB_GGW_K_3 | N | Grbalj - Luštica | Adriat. | TW_3 TW_4 MNE_CW1 MNE_CW2<br>MNE_CW4 | 225.9 | 1,866 / 362 | 60 / 6.9 | 30 | 7 | 0.4 | 0.065 | 0.078 |
| **5** | ME_AB_GW_K_4 | TBA | Opačica - Morinj | Adriat. | TW_1 TW_3 TW_4<br>MNE_CW1 | 136.0 | 2,800 / 381 | 70 / 8.5 | 62 | 8 | 1.4 | 0.08 | 0.096 |
| **6** | ME_AB_GW_K_5 | TBA | Orjen | Adriat. | TW_1 | 409.6 | 3,510 / 1,430 | 80 / 36.2 | 88 | 35 | 0.03 | 0.025 | 0.03 |

| No. of GWB / GGWB | Code | Character N (inner) TBA (transboundary) | Name | River basin | Linked to SWBs | F (km²) | Av. annual rainfall (mm / $10^6 m^3$ $P_{total}$ | Effect. infiltr. on karst in aver. ($I_{ef}$ in %; m³/s) | Specif. discharge of GWB Q (l/s/km²) | Total average disch. of register. Springs Qav (m³/s) | Total minimal discharge of register. springs /ecological flows in dry season (m³/sec) | Actual GW extraction Assessed (m³/sec) | Project. of water demands during drought (m³/sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **7** | ME_AB_GW_K_6 | N | Lovćen (Njeguši) | Adriat. | TW_2 TW_3 | 330.2 | 2,370 / 730 | 70 / 16 | 66 | 10 | 0.5 | 0.36 | 0.432 |
| **8** | ME_AB_GGW_C_1 | N | Orahovštica – Rijeka Crnojevića | Skadar Lake | WB 1_Vucko blato WB 3_South west Orahovštica Crnojevica | 241.3 | 2,853 / 688 | 75 / 16.4 | 68 | 8.4 | 1.4 | 0.5 | 0.6 |
| **9** | ME_AB_GGW_K_7 | N | Karuč - Sinjac | Skadar lake | Malo blato | 277.2 | 2,700 / 748 | 70 / 16.6 | 59.9 | 19 | 7.5 | 1.52 | 1.82 |
| **10** | ME_AB_GGW_I_2 | N | Zeta Valley | Zeta | WB 3_South west WB 4_Pelagic zone Morača_3 Zeta_2 | 248.5 | 1,569 / 390 | 50 / 6.2 + av river loss 5 | 25 | 12 | 7 | 4.2 | 5 |
| **11** | ME_AB_GGW_C_2 | N | Prekornica - Bjelopavlići | Zeta | Zeta_3 Zeta_4 | 418.0 | 2,200 / 702 | 70 / 15.6 | 37.3 | 15 | 3 | 2.2 | 2.64 |
| **12** | ME_AB_GGW_K_8 | N | Garač | Zeta | Zeta_3 Zeta_4 | 338.4 | 2,246 / 760 | 70 / 16.9 | 50 | 17 | 1 | 0.2 | 0.24 |
| **13** | ME_AB_GGW_K_9 | N | Vojnik | Zeta | Sušica | 448.5 | 2,054 / 921 | 70 / 20.5 | 46 | 18.4 | 0.3 | 0.2 | 0.24 |

| No. of GWB / GGWB | Code | Character N (inner) TBA (transboundary) | Name | River basin | Linked to SWBs | F ($km^2$) | Av. annual rainfall (mm / $10^6 m^3$ $P_{total}$ | Effect. infiltr. on karst in aver. ($I_{ef}$ in %; $m^3/s$) | Specif. discharge of GWB Q ($l/s/km^2$) | Total average disch. of register. Springs Qav ($m^3/s$) | Total minimal discharge of register. springs /ecological flows in dry season ($m^3/sec$) | Actual GW extraction Assessed ($m^3/sec$) | Project. of water demands during drought ($m^3/sec$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **14** | ME_AB_GGW_C_3 | N | Nikšićko polje | Zeta | Zeta_1<br>Zeta_2<br>Zeta_3<br>Slansko Lake<br>Krupačko Lake<br>Gračanica_1<br>Gračanica_2<br>Liverovići Reservoir | 990.2 | 1,941 / 1,922 | 70 / 43 | 43.4 | 40 | 1.5 | 0.2 | 0.24 |
| **15** | ME_AB_GGW_K_10 | TBA | Trebišnjica (Bilećko Lake) | Trebišnjica | Bilecko Lake | 575.5 | 1,578 / 908 | 70 / 20.2 | 35 | 20 | 0.76 | 0.051 | 0.061 |
| **16** | ME_AB_GGW_C_4 | TBA | Kuči | Cijevna/ Skad. Lake | Cijevna<br>WB 2_North<br>Morača_4<br>Nožica<br>Mala Rijeka_1<br>Mala Rijeka_2 | 430.8 | 2,344 / 1010 | 70 / 22.4 | 52 | 20 | 2.2 | 0.18 | 0.22 |
| **17** | ME_AB_GGW_K_11 | N | Morača | Morača | Morača_1<br>Morača_2<br>Morača_3<br>Morača_4<br>Mrtvica_1<br>Mrtvica_2 | 355.2 | 1,925 / 684 | 70 / 15.2 | 43 | 15 | 0.74 | 0 | 0.01 |

***Legend**:* ME – Montenegro; AB – Adriatic River Basin; GW – Groundwater body; GGW – Group of groundwater bodies; K- karst aquifer; I – Intergranular aquifer; C- Complex aquifer; TBA – Transboundary GWB

***Input parameters:***

GW- groundwater; F – catchment area; P – Precipitations (rainfall); I – infiltration; q – Specific discharge; Q – Yield, discharge; Wd – Water demands;

IRR- Water demands for irrigation (roughly assessed); IND- Water demands for (small) industry (roughly assessed)

Projected water demands (required water extraction during Low water season) = Total water extraction + 20% (due to extended irrigation and tourism)

*Notice:* The level of confidence for collected and evaluated data of all GWB and GGWBs are: RA – Rough Assessment, with transition between RA and LL - Low

**Table 4.40 Characterization of groundwater bodies or group of groundwater bodies – quantitative pressure assessment**

| No. GWB / GGWBS | Code | Character N (inner) TBA (transboundary) | Name | River Basin | Total average disch. of registered springs = Dynamic reserves Qav (Qdyn) ($m^3/s$) | Total minimal discharge of register. Springs = Ecological flows WDES in dry season Qmin ($m^3/s$) | Exploitable reserves: Dynamic reserves – WDES Qexpl ($m^3/s$) | Actual GW extraction assessed Qextr. ($m^3/s$) | Project. of water demand during drought ($m^3/s$) | Project Water demand Vs. Q expl | Water demand as % of Q expl (%) | GWB under quant. Pressure Y – yes N – no P – potential | Project Water demand Vs. Qav (Dyn. reserve) for most exploit. GWB (>10% ) | Need aquifer regulat. Measure Y – yes N- not necessary | Remarks / Measure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | ME_AB_GGW_K_1 | N | Southern Rim of the Skadar Lake | Skadar Lake | 11.5 | 0.6 | 10.9 | 0.04 | 0.048 | 0.0044 | <1 | **N** | | | |
| **2** | ME_AB_GW_I_1 | TBA | Ulcinjsko polje | Bojana | 1 | 0.1 | 0.9 | 0.25 | 0.3 | 0.33 | 33 | **Y** | 30% | N | To attach to Regional w-works |
| **3** | ME_AB_GGW_K_2 | N | Možura - Paštrovići | Adriat. | 8 | 0.5 | 7.5 | 0.326 | 0.39 | 0.052 | 5 | **N** | | | |
| **4** | ME_AB_GGW_K_3 | N | Grbalj - Luštica | Adriat. | 7 | 0.4 | 6.6 | 0.065 | 0.078 | 0.012 | 1 | **N** | | | |
| **5** | ME_AB_GW_K_4 | TBA | Opačica - Morinj | Adriat. | 8 | 1.4 | 6.6 | 0.08 | 0.096 | 0.015 | 1.5 | **N** | | | |
| **6** | ME_AB_GW_K_5 | TBA | Orjen | Adriat. | 35 | 0.03 | 34.9 | 0.025 | 0.03 | 0.0009 | <1 | **N** | | | |
| **7** | ME_AB_GW_K_6 | N | Lovćen (Njeguši) | Adriat. | 10 | 0.5 | 9.5 | 0.36 | 0.432 | 0.045 | 4.5 | **N** | | | |

| No. GWB / GGWBS | Code | Character N (inner) TBA (transboundary) | Name | River Basin | Total average disch. of registered springs = Dynamic reserves Qav (Qdyn) (m³/s) | Total minimal discharge of register. Springs = Ecological flows WDES in dry season Qmin (m³/s) | Exploitable reserves: Dynamic reserves – WDES Qexpl (m³/s) | Actual GW extraction assessed Qextr. (m³/s) | Project. of water demand during drought (m³/s) | Project Water demand Vs. Q expl | Water demand as % of Q expl (%) | GWB under quant. Pressure Y – yes N – no P – potential | Project Water demand Vs. Qav (Dyn. reserve) for most exploit. GWB (>10% ) | Need aquifer regulat. Measure Y – yes N- not necessary | Remarks / Measure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **8** | ME_AB_G GW_C_1 | N | Orahovštica – Rijeka Crnojevića | Skadar Lake | 8.4 | 1.4 | 7 | 0.5 | 0.6 | 0.085 | 8.5 | **N** | | | |
| **9** | ME_AB_G GW_K_7 | N | Karuč - Sinjac | Skadar lake | 19 | 7.5 | 11.5 | 1.52 | 1.82 | 0.16 | 16 | **N** | 9.5% | N | Water export / Reg w-works |
| **10** | ME_AB_G GW_I_2 | N | Zeta Valley | Zeta | 12 + 5 | 7 | 10 | 4.2 | 5 | 0.5 | 50 | **Y** | 30% | Y | Connect adjacent GWB; Control irrigation |
| **11** | ME_AB_G GW_C_2 | N | Prekornica - Bjelopavlići | Zeta | 15 | 3 | 12 | 2.2 | 2.64 | 0.22 | 22 | **N/P** | 18% | N | Control irrigation |
| **12** | ME_AB_G GW_K_8 | N | Garač | Zeta | 17 | 1 | 16 | 0.2 | 0.24 | 0.015 | 1.5 | **N** | | | |
| **13** | ME_AB_G GW_K_9 | N | Vojnik | Zeta | 18.4 | 0.3 | 18.1 | 0.2 | 0.24 | 0.013 | 1 | **N** | | | |
| **14** | ME_AB_G GW_C_3 | N | Nikšićko polje | Zeta | 40 | 1.5 | 38.5 | 0.2 | 0.24 | 0.006 | <1 | **N** | | | |

| No. GWB / GGWBS | Code | Character N (inner) TBA (transboundary) | Name | River Basin | Total average disch. of registered springs = Dynamic reserves Qav (Qdyn) ($m^3/s$) | Total minimal discharge of register. Springs = Ecological flows WDES in dry season Qmin ($m^3/s$) | Exploitable reserves: Dynamic reserves – WDES Qexpl ($m^3/s$) | Actual GW extraction assessed Qextr. ($m^3/s$) | Project. of water demand during drought ($m^3/s$) | Project Water demand Vs. Q expl | Water demand as % of Q expl (%) | GWB under quant. Pressure Y – yes N – no P – potential | Project Water demand Vs. Qav (Dyn. reserve) for most exploit. GWB (>10% ) | Need aquifer regulat. Measure Y – yes N- not necessary | Remarks / Measure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **15** | ME_AB_G GW_K_10 | TBA | Trebišnjica (Bilećko Lake) | Trebišnjica | 20 | 0.76 | 19.2 | 0.051 | 0.061 | 0.003 | <1 | **N** | | | |
| **16** | ME_AB_G GW_C_4 | TBA | Kuči | Cijevna/ Skad. Lake | 20 | 2.2 | 17.8 | 0.18 | 0.22 | 0.012 | 1 | **N** | | | |
| **17** | ME_AB_G GW_K_11 | N | Morača | Morača | 15 | 0.74 | 14.2 | 0 | 0.01 | 0.0007 | <1 | **N** | | | |

**Legend**: ME – Montenegro; AB - Adriatic River Basin; GW – Groundwater body; GGW – Group of groundwater bodies; K- karst aquifer; I – Intergranular aquifer; C- Complex aquifer; TBA – Transboundary GWB; WDES – Water for Dependent Ecosystems

The following conclusions were reached based on the data presented in Tables 4.39 and 4.40, and the performed evaluation:

1. The analysis confirms the richness in water availability and groundwater resources in Montenegro. This is mostly due to a high rainfall rate, much higher than in the rest of Europe, and the extensive presence of highly karstified rocks and developed karst aquifers. The average specific groundwater discharge of 17 evaluated GWBs and GGWBs is 46.5l/s/km$^2$. The highest rate of 88 l/s/km$^2$ is at the Orjen GWB, which is also characterized by the highest rainfall rate. The minimal specific discharge of 12 l/s/km$^2$ is at the GWB Ulcinjsko polje.

2. The total dynamic GW reserves of studied GWBs and GGWBs as an equivalent of average springs discharge (plus dynamic reserves of intergranular alluvial aquifers) are estimated at 265 m$^3$/s. Nikšićko polje is characterized by the largest reserves of c. 40 m$^3$/s, while minimal reserves were found in the intergranular aquifers of GWB Ulcinjsko polje: 1 m$^3$/s.

3. The total minimal discharge of all the springs is estimated to be 29 m$^3$/s, which is still two times larger than the projected water demands for all GWBs and GGWBs of the Adriatic River Basin. However, the Qav: Qmin ratio shows a large disproportion - 1:9, typical for karst regions and aquifers

4. As regards minimal springs' discharge as an equivalent of ecological flow (required for a dependent ecosystem – WDES), the situation is quite different. The GWB with the largest dynamic reserves - Nikšićko polje - is now in the middle of the list, with the total Qmin of 1.5 m$^3$/s. The GWB with the largest total Qmin of 7.5 m$^3$/s is Karuč-Sinjac, where the intake for the Regional Waterworks of Montenegrin Coast has been constructed. The GWB Ulcinjsko polje is characterized by a minimal ecological flow of only 0.1 m$^3$/s, which is less than the actual GW extraction.

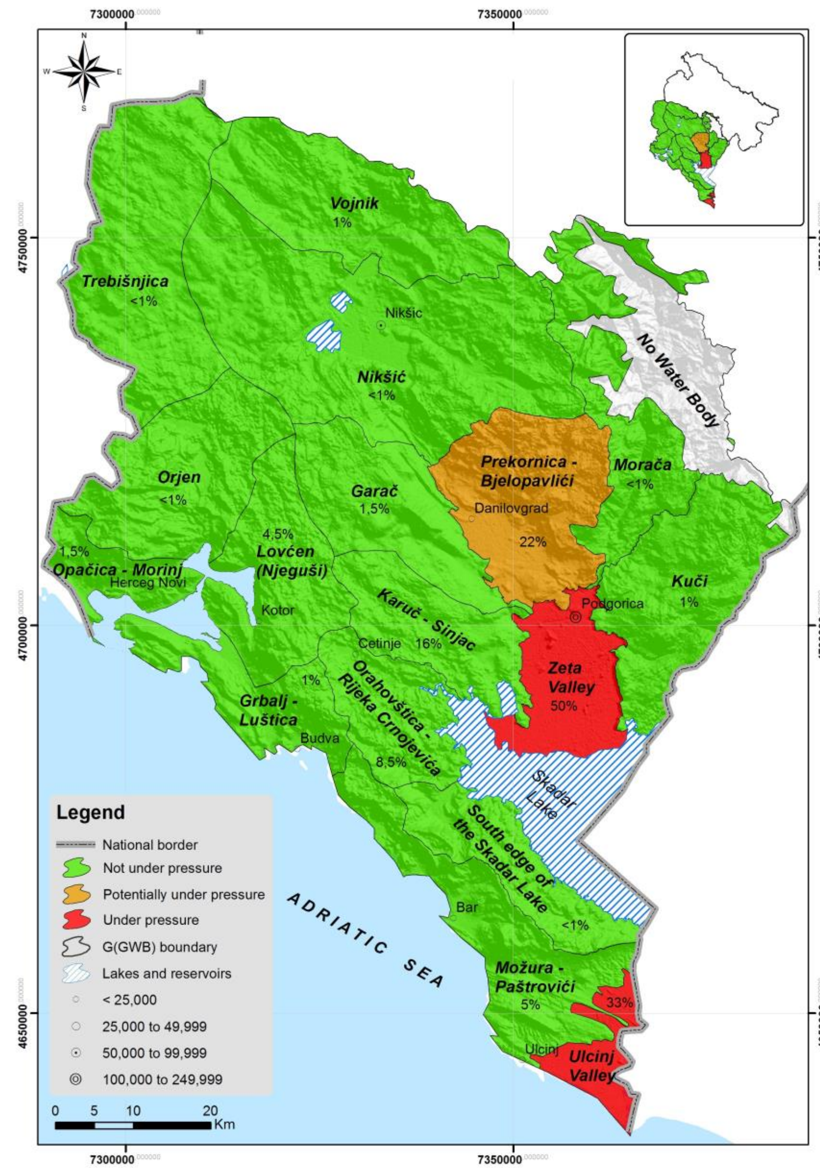
5. Due to the water supply of the Regional Waterworks, the GWB Karuč-Sinjac is also highly positioned on the list of GWBs with actual extraction and projected water demands, with 1.52 and 1.82 m$^3$/s, respectively. Only two GWBs are more exploited: Zeta Valley with 4.2 m$^3$/s (projected demands: 5 m$^3$/s) and Prekornica-Bjelopavlići with 2.2 m$^3$/s (2.64 m$^3$/s). Actually, all other GWBs and GGWBs consume water (or provide extracted water to other areas) in the amounts lower than 1 m$^3$/s.

6. The comparison of water demands (actual extraction + 20%) and exploitable GW reserves shows that the largest percentage of GW reserves is demanded in GGWBs Zeta Valley (50%) and Ulcinjsko polje (33%). Therefore, these two GGWBS are under quantitative pressure i.e. risk of over-extraction (Figure 4.12). No other GGWBs are at risk, with the exception of GGWB Prekornica-Bjelopavlići, which, with the projected use of 22% of exploitable reserves, could potentially find itself at risk in the near future if GW extraction continues to rise. One other GGWB, Karuč-Sinjac (16%) should also exploit their groundwater reserves with caution.

7. Consumers of all other GWBs and GGWBs demanded less than 10% of exploitable GW reserves, which confirms low pressure on GW quantity and available water resources. In addition to the above, the population, irrigation and small industry sectors of the 8 GWBs and GGWBs require less than 1% of their available water reserves, which fully complies with the general assessment that was presented in the introductory part of this chapter.

8. Artificial recharge and regulation of the regimes of karst aquifers of GWB Zeta Valley may improve the water situation and lessen the pressure on local aquifers. Some other measures, such as conversion of the irrigation system to use surface water, are also possible. In the case of Ulcinj polje, connection to the Regional Waterworks of the Montenegrin Coast and continual water supply from this system, instead of over-pumping the Lisna-Bori alluvial aquifer, would decrease pressure on this local aquifer.

### Figure 4.12 Levels of quantitative pressures on GWBs and GGWBS in the Adriatic River Basin[106]




[106] Map indicating levels of quantitative pressures on GWBs and GGWBs of the Adriatic River Basin (% is ratio between projected water demands (enlarged actual use by 20%) and exploitable groundwater reserves (total average springs discharge minus ecological flow)

## 4.13 Assessment of qualitative pressures on groundwater bodies

### 4.13.1 Groundwater chemical analysis

When considering the monitoring of groundwater quality as a base for chemical status assessment, the situation is as follows:

- Each water supply system should perform own measurements of abstracted water and water quality according to the existing national Rulebooks[107]. However, this data is often impracticable for the assessment of the qualitative characteristics of aquifers. The samples for the analyses of water quality are most often taken from taps, after the chlorination, so they cannot represent the real chemical and microbiological status of groundwater.
- The examination of groundwater quality is done by the Institute for Hydrometeorology and Seismology of Montenegro (IHMS). This programme contains the network stations for water quality, as well as scope, kind and frequency of analysis of water quality. The parameters include temperature, pH, electrical conductivity, dissolved matter, % oxygen saturation, biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, bicarbonates, hardness, calcium, magnesium, sodium, potassium, chlorides, sulphates, phenols, detergents, phosphates, nitrates, nitrites, faecal bacteria, coliform bacteria, aerobic mesophilic bacteria
- The analyses of water quality from the water supply systems are also carried out by the Institute for Public Health. Specific priority pollutants are analysed by the Centre for Eco-Toxicological Research in Podgorica (CETI).

According to collected and interpreted data the chemistry of groundwater could be considered as generally satisfactory. Although most of aquifers are vulnerable to pollution, lack of large industrial pollutants caused that water out of urbanized areas is still of good quality and following national standards most of regularly analysed chemical parameters (major ions, but also micro constituents) are below maximal permitted level for potable water.

When it comes to microbiological quality situation is quite different, many tested samples of natural water show presence of bacteria, often faecal, but with regular chlorination, which is systematically applied at all waterworks no evidences of pollution accidents or hydric epidemical cases in the country.

Untreated wastewater and solid waste disposal along with diffuse source of pollution and minimal spring-flows during lean (recession) periods can be considered as the major issues of concern in most of GWBs and GGWBs.

The worst groundwater quality is in Zeta Valley (towards Golubovci) as result of pollution by industrial waters from Alumina Plant in vicinity of Podgorica, then in Nikšićko polje as result of many inappropriate landfills or abandoned, but still not cleaned solid waste dump sites.

[107] The Rulebook on procedure and scope of water quality analyses (Official Gazette of Montenegro, No. 68/15, 8 December 2015; and No. 17/16, 11 March 2015)

Some general characteristics of karst waters are identified from two major geographical units of the Adriatic River Basin.[108]

- **Karst aquifers of plains, plateaus and high mountains** (including the Skadar basin). In this typical karst region, the chemical composition of the source waters completely reflects the karst aquifer chemistry with prevailing content of $Ca\text{-}HCO_3$ ions.
- **Coastal karst**. Source water in the coastal karst, can be directly influenced by the sea. Such the case is in the Boka Kotorska Bay, and the parts of Barsko and Ulcinjsko polje, closest to shoreline. There, Cl content is dominant cation, followed by Mg. The fresh groundwater samples away from the coast, characterised by TDS which is usually within the range of 500-1000 mg/l, while in the Boka Kotorska Bay some tested samples show TDS higher than 20,000 mg/l.

The pH value of the analysed water of karst aquifers mostly varies from 6.8 to 8.5, they thus belong to neutral and slightly alkaline waters. The TDS of these waters is within the limits of 200-600 mg/l. General hardness mostly varies in the range of 4-25 °dH (from soft to hard water, expressed in German degrees).

### 4.13.2 Methodology applied for assessment of groundwater chemical status

The proposed methodology for assessment of groundwater chemical status is based on the WFD Guidance Document GW4 'Pressures and Impacts Assessment Methodology', together with methodologies applied in several technical documents[109,110] and experiences obtained from several River Basin Management Plans and several projects conducted in the region (ICPDR, Sava Commission, Croatia, Bosnia & Herzegovina, Serbia).

The main human pressures that can influence a groundwater body chemical status are divided into two groups:

- Diffuse sources of pollution
- Point sources of pollution.

The ICPDR[111] indicates the main components of the methodologies for assessing the risk of failure to achieve good chemical status. These are: the available monitoring data on water quality, data on existing pressures and possible impacts, data on the overlying strata of the groundwater bodies, and the corresponding vulnerability of the aquifer. It is highlighted that risk assessment methods are rather country-specific and range from using combinations of the above-mentioned data sets to focusing on interpreting water quality data.

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[108] Radulović M., 2000: Karst hydrogeology of Montenegro. Sep. issue of Geological Bulletin, vol. XVIII, Spec. ed. Geol. Survey of Montenegro, Podgorica, 271 p.

[109] IGWWG (Ireland GW Working Group), 2005: WFD - River Basin District Management Systems, Advice on the implementation of guidance on monitoring groundwater, Guidance document no. GW6, Dublin

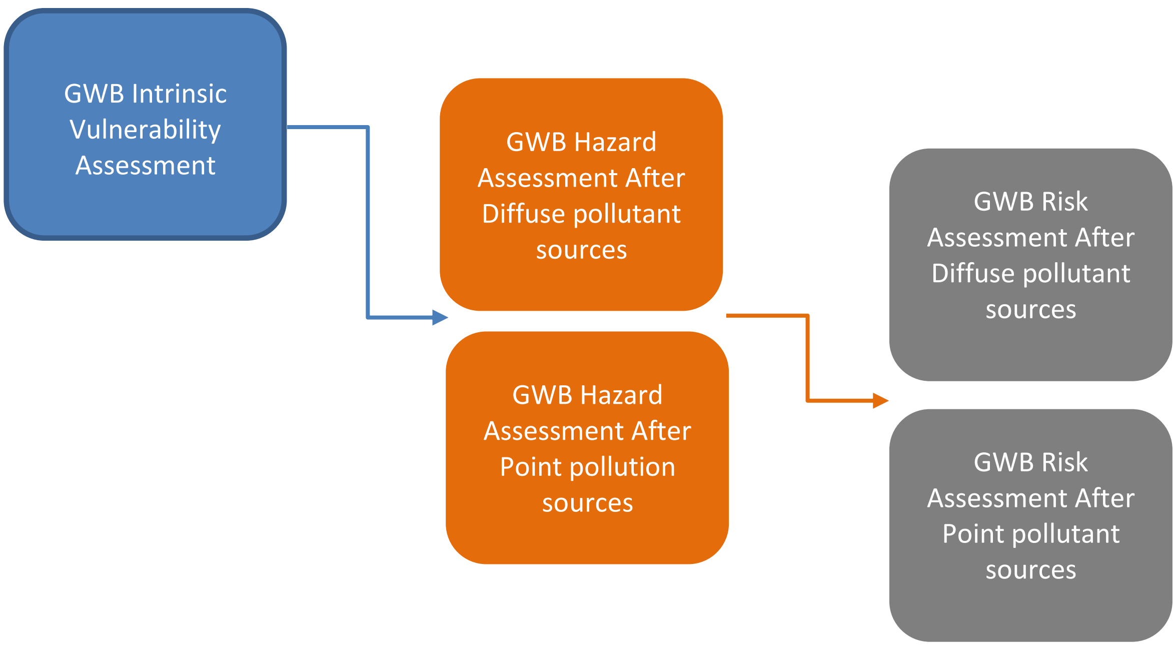
[110] United Kingdom Technical Advisory Group, 2005b: Methodology for Risk Characterization of Ireland's Groundwater, Paper by the Working Group on Groundwater, Guidance document no. GW8

[111] ICPDR 2014: Danube River Basin Management Plan, Vienna Austria, www.icpdr.org

In many national reports data gaps and inconsistencies have become apparent, resulting in uncertainties in the interpretation of the data. It is therefore common to establish a level of confidence: High - Medium – Low, for the assessment of groundwater status. However, in case of Montenegro. lack of continual and systematic monitoring of groundwater quality results that level of confidence for most of delineated GWBs and GGWBs can be considered as Low.

For the purpose of this RBMP, the pressures on water quality of each of the Receptors (delineated Groundwater Bodies (GWB) and Group of Groundwater Bodies (GGWB)) in this report have been estimated based on the following matrices, outlined Figure 4.13.

## Figure 4.13 The method applied for assessing pressures on groundwater quality



The following groups were determined considering risk assessment analysis based on diffuse pollution sources are shown in Table 4.41:

**Table 4.41 Categories of risk assessment analysis for diffuse source pollution for groundwaters**

| Risk assessment | Index of risk on the map |
|---|---|
| No risk | < 1 |
| Low risk | 1 – 10 |
| Moderate risk | 10 – 30 |
| Medium risk | 30 – 50 |
| High risk | 50 – 70 |
| Very high risk | 70 - 93 |

In general, the two first categories would be considered as a "Not at risk" (Good chemical status), next two as a "Potentially at risk", and last two as "Conditionally at risk" or "At risk". "Conditionally" is applied just in case that no sufficient data regarding pollutants and their load is collected and evaluated, and preliminary assessment is thus considered as a probable and not certain - requires confirmation through operational monitoring.

A similar approach has been applied in risk assessment analysis based on point pollution sources, where PE load[112] was compared with intrinsic vulnerability of groundwater. The following risk groups were determined considering this approach which will be explained in more detail hereafter:

| | |
|---|---|
| PE load vs. Vulnerability < 10 | No Risk |
| < 10 PE load vs. Vulnerability < 40 | Conditionally at Risk |
| PE load vs. Vulnerability > 40 | At Risk |

### 4.13.3 Applied Methodology for GWB intrinsic vulnerability assessment

During last several decades the vulnerability assessment of groundwater and aquifers becomes necessary tool for planning and management of groundwater resources. Vulnerability maps in combination with hazard and risk maps point out endangered areas of special importance (springs, quality water reservoirs, national and nature parks, etc.) that need to be preventively protected. Those endangered areas and preventive measures for protection need to be considered in spatial planning and development of water management plans.

[112] PE – Population Equivalent, also abbreviated as p.e.

Term "Groundwater vulnerability" has been in use since 1960s, following an idea to assess and describe impact of potential pollution of groundwater based mainly on:

- Geological pattern (lithology, tectonics);
- Hydrology (surface water distribution and streams net);
- Hydrogeological characteristics (aquifer distribution, recharge and discharge, catchment areas, permeability).

One of the tasks is to demonstrate that natural protection is varying from site to another, and there are especially vulnerable places even within the same aquifer system or groundwater body. The results are to be shown on Vulnerability maps. Development of the method and wide introduction of GIS caused number of evaluation parameters to be increased, such as surface slope, inclination of aquifer layers, groundwater depths, groundwater flow velocity, vegetation and soil cover, etc.

There are the two types of aquifer vulnerability:

- General (intrinsic) vulnerability
- Specific vulnerability

When assessing General (intrinsic) vulnerability we are taking into account primarily natural factors such as geology, hydrology, hydrogeology etc., but neither scenario of possible pollution, nor character of the pollutants.

When assessing Specific vulnerability, we are taking into account what kind of pollutants we could have in the area and what kind of migration, absorption, self-purification we could facing in case of real (accidental) pollution.

The definition of vulnerability classes which is commonly used in hydrogeological practice[113] is shown in Table 4.42.

### Table 4.42 Practical definition of classes of aquifer pollution vulnerability

| Vulnerability class | Corresponding Definition |
|---|---|
| Extreme | Vulnerable to most water pollutants with rapid impact in many pollution scenarios |
| High | Vulnerable to many pollutants (except those strongly absorbed or readily transformed) in many pollution scenarios |
| Moderate | Vulnerable to some pollutants but only when continuously discharged or leached |
| Low | Only vulnerable to conservative pollutants in the long term when continuously and widely discharged or leached |

[113] Foster S., McDonald, A., 2014: The 'water security' dialogue: why it needs to be better informed about groundwater. Hydrogeology Journal, November 2014, 22/7: 1489-1492

| Vulnerability class | Corresponding Definition |
|---|---|
| Negligible | Confining beds present with no significant vertical groundwater flow (leakage) |

Vulnerability mapping and presentation of results in GIS is applicable for all kind of rocks / aquifers, but it is especially important application in karst terrains, due to their non-homogenous and anisotropic properties. Therefore, we can distinguish the following:

- Methods, designed for karstic aquifers (e.g. EPIK method[114])
- Methods, applicable for other aquifers with special emphasis on karst (e.g. PI method[115])

The regional vulnerability maps for the river basin of the Sava in Bosnia & Herzegovina have been made and presented in associated River Basin Management Plans[116]. The authors of these maps and originally applied the SODA method and as such suggest their application for vulnerability mapping in Montenegro is valid for the Adriatic River Basin for two reasons:

1. Similarity in geological and hydrogeological settings of Montenegro and Bosnia & Herzegovina, with distribution prevalence of karstic rocks and aquifers;
2. Simplification of mapping process adapted to regional scaling and locally available data.

The acronym SODA consists of the following parameters:

- Parameter S  - (Slope) inclination of terrain,
- Parameter O – (Overlying strata) soil, surficial strata and cover of underlying aquifer,
- Parameter D – (Depth) to the groundwater table,
- Parameter A – (Aquifer) type of locally present aquifer.

For each of the parameter there are weight factors which consider the local specific circumstances and characteristics. The factors are in range from 1 to 10, and they are shown for each parameter (S,O, D and A) in Tables 4.43 to 4.46. The smaller weight factors are corresponding with appropriate conditions, favourable for water protection, while where the larger number exists the aquifer vulnerability is correspondingly raising.  By combination of these factors, a vulnerability index for each pixel on the map can be obtained.

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[114] Doerfliger N., Zwahlen F., 1995: EPIK: A new method for outlining of protection areas in karstic environment, Karst Waters and Environmental Impacts, Gunay and Johnson (eds), Balkema, Rotterdam

[115] Goldscheider N., 2005: Karst groundwater vulnerability mapping: application of a new method in the Swabian Alb, Germany, Hydrogeology Journal, 13, 4: 555-565

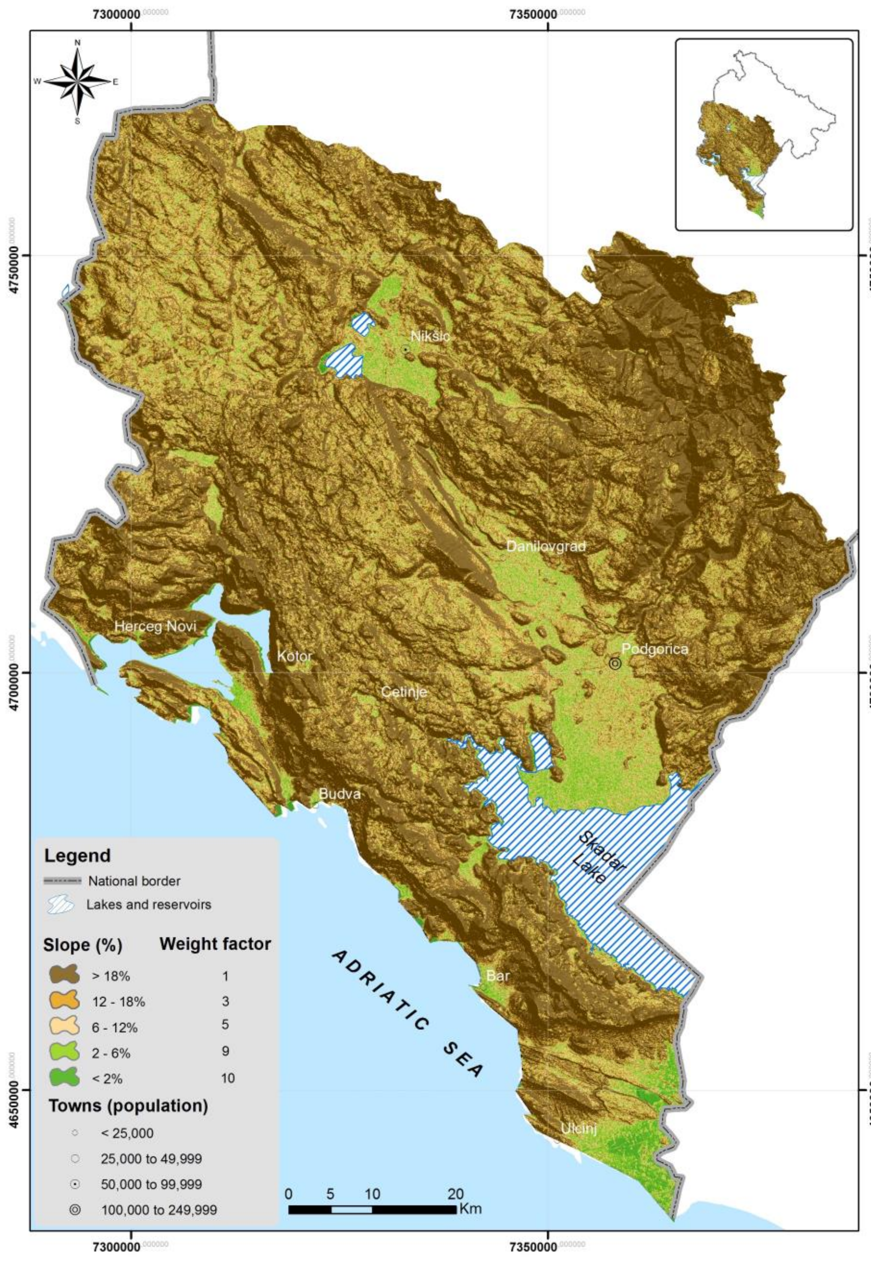
[116] Stevanović Z., Marinović V., Merdan S., Skopljak F., Jolović B., 2015:  Koncept izrade hidrogeoloških podloga za planove upravljanja rečnim slivovima / Conception of creating basic documents in hydrogeology for river basin management plans, Zbornik radova I Kongresa geologa Bosne i Hercegovine sa medjunarodnim učešćem, Udr. geologa BiH, p. 150-151

Slope layer (Figure 4.14) resulted from available digital elevation model (DEM) of resolution 30 x 30 m. By use of ArcGIS platform and Spatial Analyst Tools with option Surface/Slope from ArcToolbox, DEM is transformed into polygons showing slope in %. The weight factors are the following:

### Table 4.43 Weight factor (S) - Slope and inclination

| Slope / Inclination (%) | Weight factor (S) |
|---|---|
| over 18 | 1 |
| Between 12 - 18 | 3 |
| Between 6 - 12 | 5 |
| Between 2 - 6 | 9 |
| Less than 2 | 10 |

**Figure 4.14 Base layers created for Final Vulnerability Map of the Adriatic River Basin according the SODA method: SLOPE layer**




The creation of an overlying strata layer (Figure 4.15) (layer O) is based on combination of three maps: DIKTAS Map[117] Hydrogeological Map of Montenegro 1: 200,000[118] and the Soil Map for the territory of Montenegro (Pedological Map of Montenegro in scale 1:50.000, 1969/70).

[117] https://apps.geodan.nl/igrac/ggis-viewer/viewer/diktas/public/default) contains just six hydrogeological units as

[118] Radulović V., 1995: Hydrogeology Map of Montenegro, 1:200.000, Geological Survey of Montenegro, Podgorica.

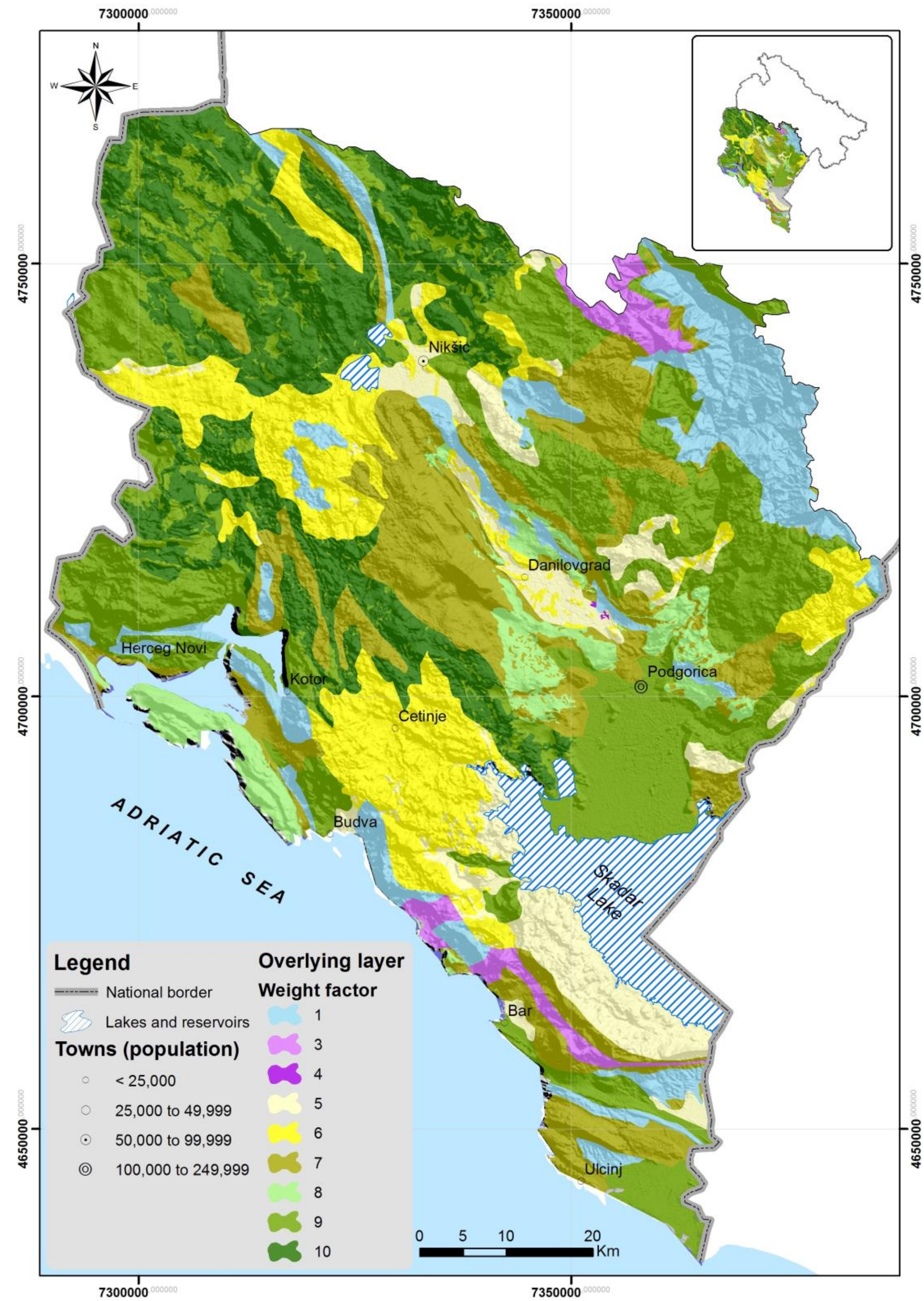
While the DIKTAS map contains just six members, as the following: AT (aquitards, with no or low groundwater content), FA (fissured aquifers), IA 1,2 (intergranular aquifers with various groundwater resources) and KA 1,2 (karstic aquifers with various groundwater resources), several other units are also delineated and included in the evaluation. For this reason, the DIKTAS Hydrogeological Map of Dinaric Region in scale 1:500,000 was updated by Hydrogeological Map of Montenegro in larger scale (1:200,000).

Although the permeability of overburden layer based on lithology and type of soil can be easily determined this is not the case with its thickness. It is due to fact that even determined in one point there is no guarantee that same or similar depth (thickness) is present in an another. However, some approximation and generalization have been applied by comparison of several layers including those from soil map of Montenegro, DIKTAS map and the Basic Geological map of SFRY.

### Table 4.44 Weight factor (O) – Overlying strata

| HG Units – Aquifer systems | Thickness of Overlying Strata | Weight Factor (O) |
|---|---|---|
| 1. Alluvial, glacial, and terrace sediments with dominant clay content and thick soil cover - AT<br>2. Neogene – clay and soil cover - AT | 1. H > 10 m<br>2. H > 20 m | 1-2 |
| 1. Fissured aquifer - FA<br>2. Alluvial, glacial, and terrace sediments with clay content and residual soil cover – IA2<br>3. Neogene – clay, sands IA2 | 1. H > 10 m<br>2. H = 8-12 m<br>3. H = 15-20 m | 3-4 |
| 1. Karstic and karstic fissured aquifer with thick epikarst KA2<br>2. Alluvial, glacial, and terrace sediments of moderate permeability with soil cover IA2<br>3. Neogene – sands, gravel, clay with soil cover IA2 | 1. H = 5-10 m<br>2. H = 3-8 m<br>3. H = 10-15 m | 5 |
| 1. Karstic and karstic fissured aquifer with thin epikarst KA2<br>2. Alluvial, glacial, and terrace sediments of moderate permeability with thin soil cover IA2 | 1. H = 2-5 m<br>2. H = 2-3 m | 6 |
| 1. Karstic aquifer with thin epikarst KA1<br>2. Alluvial and fluvioglacial sediments of moderate to high permeability with thin soil cover IA1 | 1. H = 1-2 m<br>2. H = 1-2 m | 7 |
| 1. Karstic aquifer well karstified with cavities KA1<br>2. Alluvial and fluvioglacial sediments of high permeability without soil cover IA1 | 1. H < 1 m<br>2. H < 1 m | 8 |
| 1. Karstic aquifer highly karstified with large caverns KA1<br>2. Alluvial and fluvioglacial sediments of very high permeability, unconfined IA1 | 0 | 9 |
| 1. Karstic aquifer, highly karstified carbonates with caves, potholes, all classical karstic features and very large springs KA1 | 0 | 10 |

**Figure 4.15 Base layers created for Final Vulnerability Map of the Adriatic River Basin according the SODA method: OVERLYING layer**



The parameter Depth to the groundwater table (Figure 4.16) is also problematic, because there are no sufficient data for the most of territory of Montenegro. In order to obtain some information for the terrains in the Adriatic River Basin, some approximation based on DEM, topographic maps in scale 1:25000 and Hydrogeological map in scale 1:200.000 has been made. The estimate is based on altitude of main springs and discharge points (registered or estimated). The conception is analogical as that applied in RBMPs for Sava basin in Bosnia & Herzegovina[119], [120].

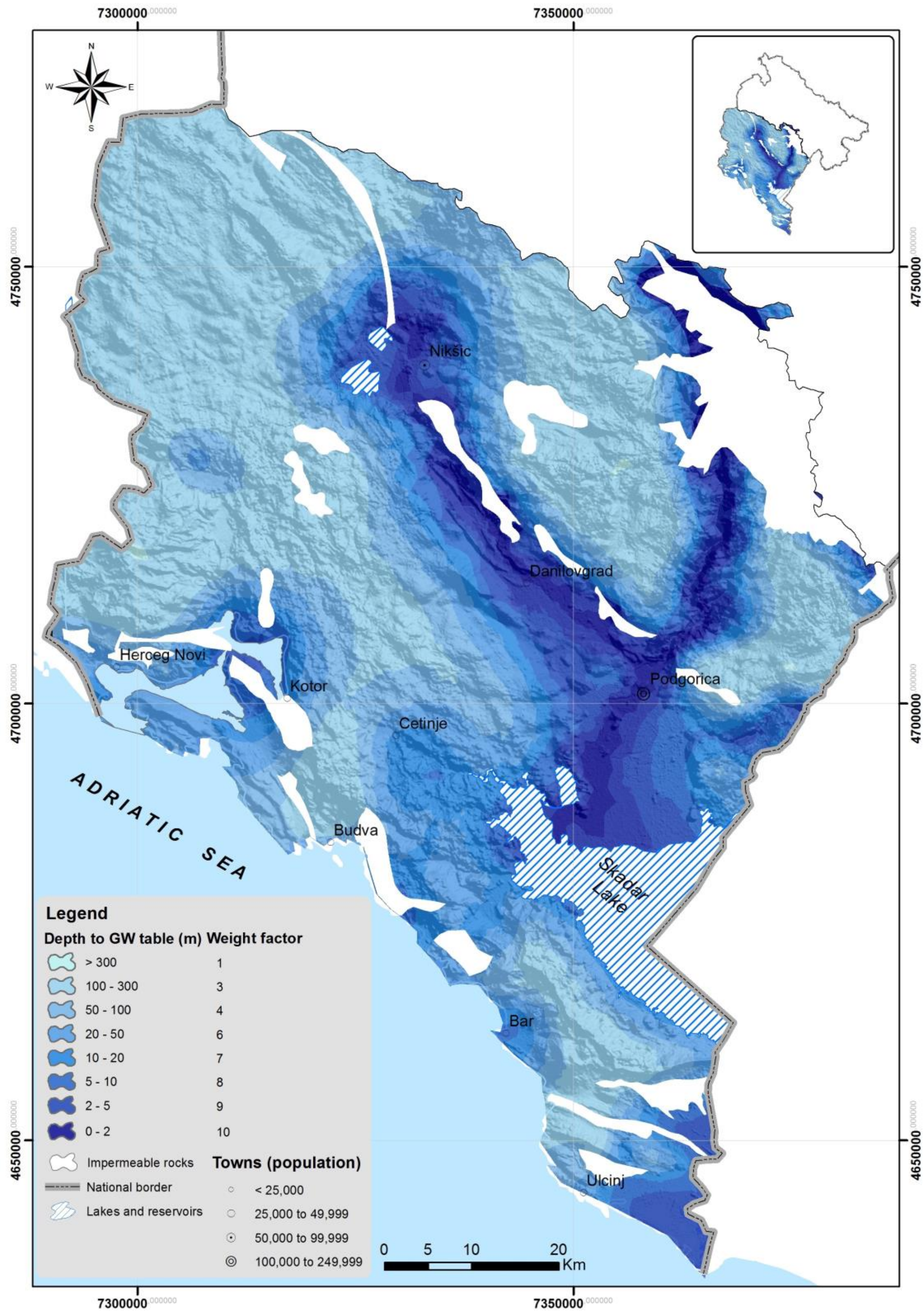
### Table 4.45 Weight factor (D) - Depth to the groundwater table

| Depth to Groundwater Table (m) | Weight Factor (D) |
|---|---|
| Over 300 | 1 |
| 100 - 300 | 3 |
| 50 - 100 | 4 |
| 20 - 50 | 6 |
| 10 - 20 | 7 |
| 5 - 10 | 8 |
| 2 - 5 | 9 |
| 0 - 2 | 10 |

113 Agency for Sava River Basin (ASRB), 2016: Sava River Basin Management Plan in Federation of B&H, draft version, Sarajevo (Available at: www.voda.ba)

120 Stevanović Z., Marinović V., Merdan S., Skopljak F., Jolović B., 2015: Koncept izrade hidrogeoloških podloga za planove upravljanja rečnim slivovima / Conception of creating basic documents in hydrogeology for river basin management plans, Zbornik radova I Kongresa geologa Bosne i Hercegovine sa medjunarodnim učešćem, Udr. geologa BiH, p. 150-151

**Figure 4.16 Base layers created for Final Vulnerability Map of the Adriatic River Basin according the SODA method: DEPTH to groundwater table**



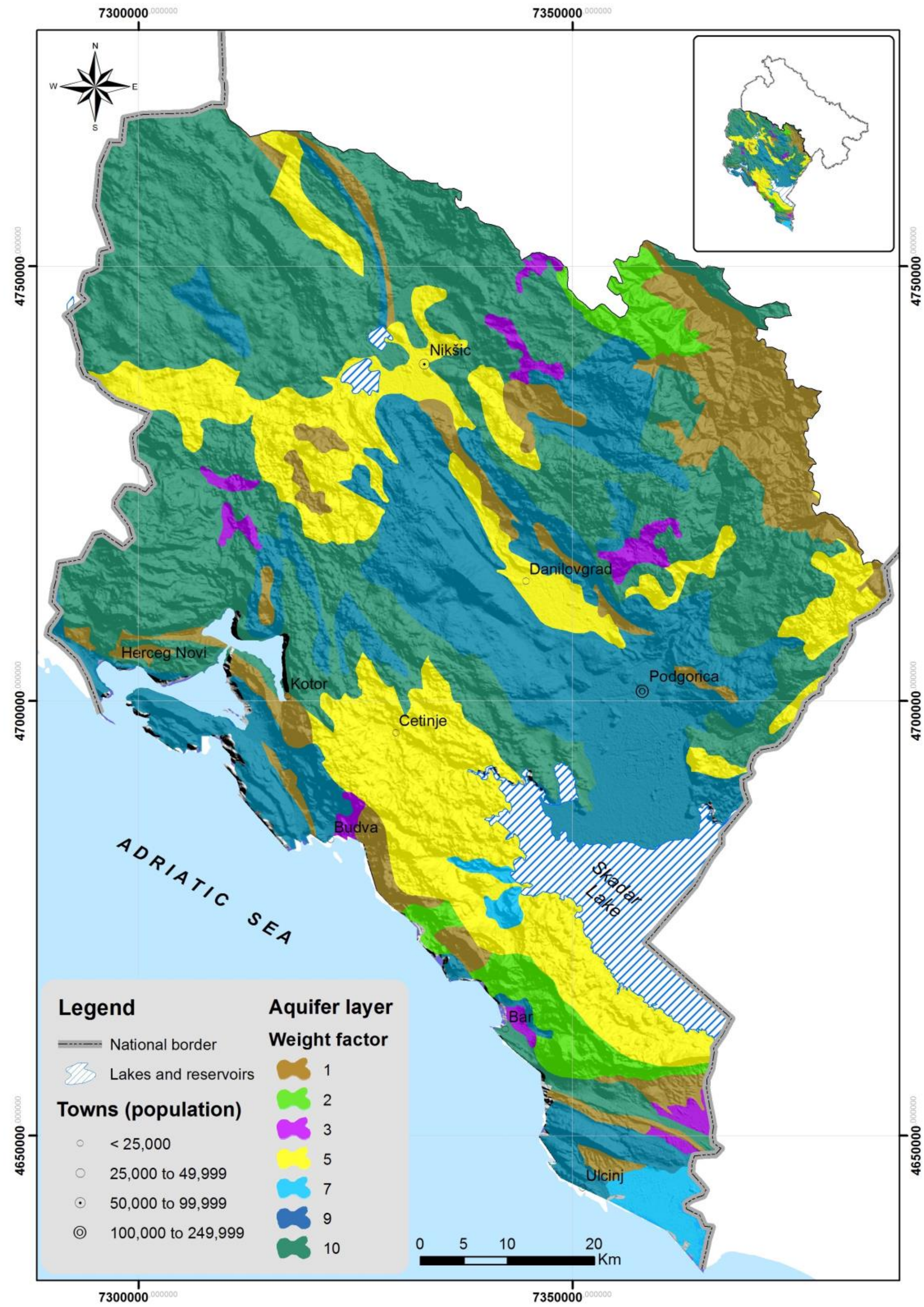
The parameter for aquifers type (Figure 4.17) is based on polygons obtained from DIKTAS map, Hydrogeological map of Montenegro in scale 1:200.000 and Basic Geological map of SFRY and is accordingly modified to include all distinguished 9 aquifer types shown in Table 4.46.

### Table 4.46 Weight factor (A) – Aquifer types

| Aquifers[121] | Weight factor | Typical TF |
|---|---|---|
| AT – Impervious rocks | 0-1 | 1 |
| FA – Fissured aquifers | 2 | 2 |
| IA2 – Neogene, alluvial and terrace aquifers of low to moderate permeability | 2-4 | 3 |
| IA2 – Neogene, alluvial and terrace aquifers of moderate permeability | 4-6 | 5 |
| KA2 – karst and karstic fissured aquifer of moderate permeability | 4-6 | 5 |
| IA1 – alluvial, fluvioglacial and terrace aquifers of moderate to high permeability | 6-8 | 7 |
| KA1 – karst aquifer of high permeability | 8-9 | 9 |
| IA1 – alluvial aquifers along major rivers, fluvioglacial aquifers, highly permeable, unconfined | 8-9 | 9 |
| KA1 – karst aquifer, highly karstified, with large features and strong springs | 10 | 10 |

[121] AT, FA, IA, KA units as per DIKTAS Map (Stevanović et al. 2016, modified);
https://apps.geodan.nl/igrac/ggis-viewer/viewer/diktas/public/default

**Figure 4.17 Base layers created for Final Vulnerability Map of the Adriatic River Basin according the SODA method: AQUIFER layer**



After creation of all 4 base layers for vulnerability assessment according SODA method, the map is finally created based on following algorithm:

$$iU = (S \times 1) + (O \times 3) + (D \times 2) + (A \times 4)$$

After creating a conceptual model and calibrating the results, the entire vulnerability map (Figure 4.18) is classified according to the given vulnerability classes given in Table 4.47.

### Table 4.47 Categorization of intrinsic vulnerability of groundwater according to the SODA method

| Vulnerability aquifer classes | Index |
|---|---|
| Terrains with no aquifers – impervious rocks | **0 - 10** |
| Very low vulnerability | **10 - 30** |
| Low vulnerability | **30 - 50** |
| Moderate vulnerability | **50 - 60** |
| Moderate to high vulnerability | **60 -80** |
| High vulnerability | **80 - 92** |
| Very high vulnerability | **92 -100** |

### 4.13.4 Results of Aquifer Vulnerability Assessment

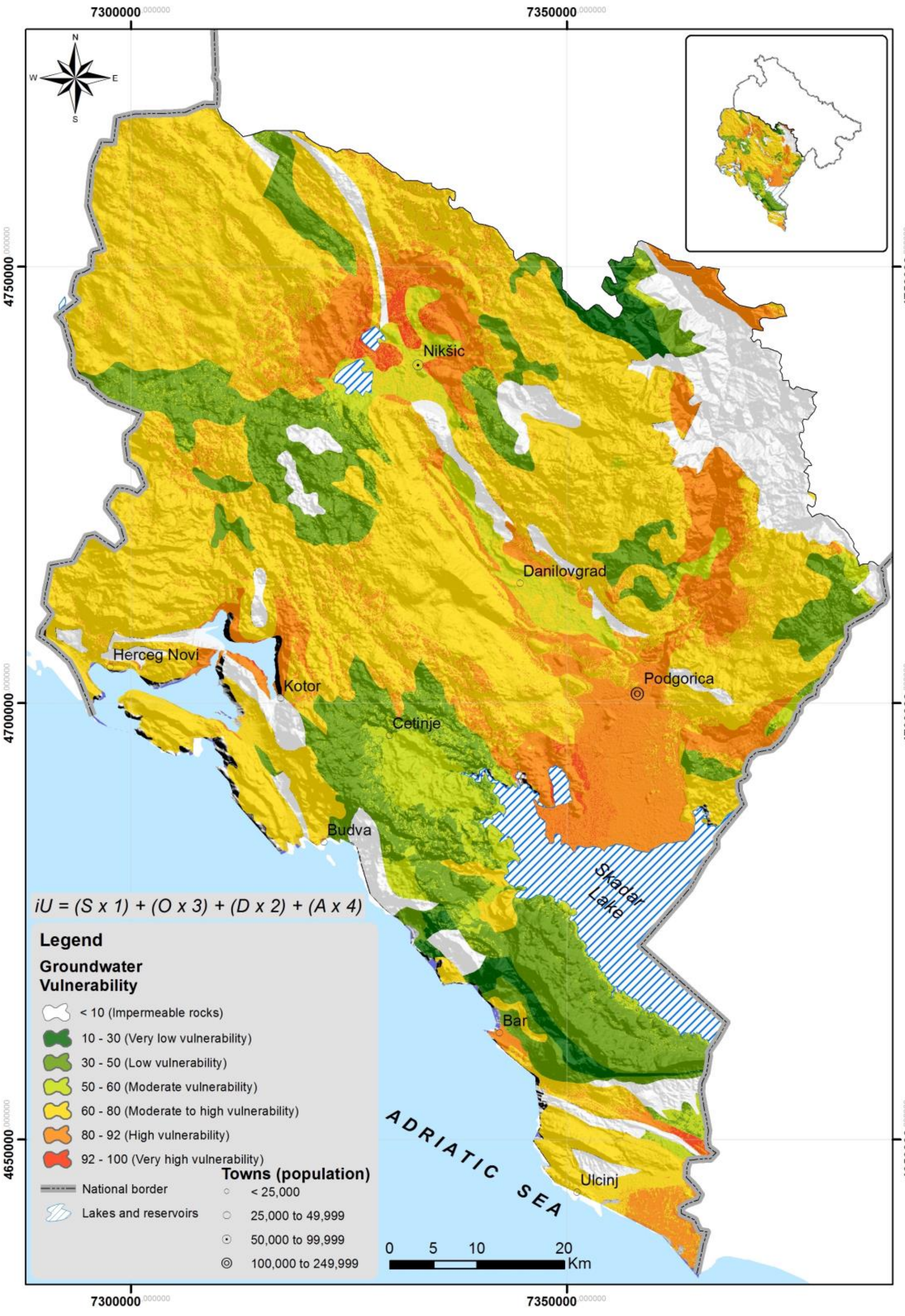
Using the SODA methodology for assessing the intrinsic vulnerability of groundwater, as presented in chapter above and the input parameters, vulnerability categories presented on the final map have been obtained. Fig. 3.20 shows final groundwater vulnerability map of the Adriatic River Basin. The vulnerability classes (in percentage) are also presented in Table 4.48.

The most widespread vulnerability category is **Moderate to high vulnerability** with 45.19% of total area belonging to the Adriatic River Basin. That high percent of intrinsic vulnerable area is mostly due to a wide distribution of karst terrains which have very low auto-purification (attenuation) capacities.

**Table 4.48 Vulnerability classes of the Adriatic Basin according the SODA method for groundwater vulnerability assessment**

| Montenegro - Vulnerability Classes | | | |
|---|---|---|---|
| | **Class** | **Km$^2$** | **%** |
| **Terrains with no aquifers – impervious rocks** | 0 - 10 | 1,182.47 | 17.06 |
| **Very low vulnerability** | 10 - 30 | 103.45 | 1.49 |
| **Low vulnerability** | 30 - 50 | 1,010.92 | 14.59 |
| **Moderate vulnerability** | 50 - 60 | 394.86 | 5.70 |
| **Moderate to high vulnerability** | 60 - 80 | 3,131.53 | 45.19 |
| **Very high vulnerability** | 80 - 92 | 1,061.51 | 15.32 |
| **Extremely high vulnerability** | 92 - 100 | 45.60 | 0.66 |

**Figure 4.18 Final groundwater vulnerability Map of the Adriatic River Basin according the SODA method**



### 4.13.5 Applied Methodology for hazard assessment

As it can be seen on the Vulnerability Map of groundwater, the aquifers are mainly in the category Moderate to High vulnerability with 45.19% of total area belonging to the Adriatic River Basin, which generally defines the intrinsic vulnerability of groundwater in this area. High groundwater intrinsic vulnerability is even more pronounced if we bear in mind all existing and potential pollutions in this area. The aforementioned pollutants can be presented on a Groundwater Hazard Map (from pollution).

The methodology for preparing hazard maps (the result of possible pollution from the present pollutants) and risks (combination of present pollutants and Intrinsic (natural) vulnerability of the terrain) of groundwater in the Adriatic River Basin were created separately after actual diffuse and point pollutants. In fact, these maps make practically one whole, but they had to be made separately because of the impossibility of performing common mathematical calculations of vector and raster data in the GIS environment. In this way, diffuse and point pollutants are separated, represented either by pixels in raster form (diffuser pollutants), or by points in the vector form (point pollutants). Thus, in the following text the methodology for creating Hazard and Risk maps after diffuse and point pollutants is presented.

Groundwater Hazard Map of the Adriatic River Basin after diffuse pollution sources is derived from a Corine 2012 land use map, created by European Environment Agency[122]. In accordance with the legend that is official part of Corine 2012 map, each pixel on the map is assigned a value in the range from 1 to 255, which indicates the type of land cover (Table 4.49).

Since land use can be one of the most important indicators of the sensitivity of water quality to pollution, each pixel has a load coefficient of 0 to 1 depending on the potential pollution hazard. That assigned values are empirical and accepted as standard and, in this case, taken from the European project CCWARE[123] However, some of these established values are slightly modified in order to increase and emphasize impact of specific unit they represent. That was the case for instance with mines, dump sites and irrigated areas, which may have high impact on groundwater quality deterioration as diffuse pollution sources.

[122] https://www.eea.europa.eu/data-and-maps/data/clc-2012-raster

[123] https://www.ccware.eu

## Table 4.49 CORINE 2012 land use units and weight factors[124]

Note: Only CORINE 2012 land use units located in Montenegro are shaded

| CORINE unit | Land Use (Corine map 2012) | Load Coefficient | CORINE unit | Land Use (Corine map 2012) | Load Coefficient |
|---|---|---|---|---|---|
| 1 | Continuous urban fabric | 0.500 | **23** | Broad-leaved forest | 0.240 |
| 2 | Discontinuous urban fabric | 0.367 | **24** | Coniferous forest | 0.167 |
| 3 | Industrial or commercial units | 0.500 | **25** | Mixed forest | 0.187 |
| 4 | Road and rail networks and associated land | 0.500 | **26** | Natural grasslands | 0.167 |
| 5 | Port areas | 0.467 | **27** | Moors and heathland | 0.180 |
| 6 | Airports | 0.467 | **28** | Sclerophyllous vegetation | 0.167 |
| 7 | Mineral extraction sites | 0.800 | **29** | Transitional woodland-shrub | 0.173 |
| 8 | Dump sites | 1.000 | **30** | Beaches, dunes, sands | 0.200 |
| 9 | Construction sites | 0.467 | **31** | Bare rocks | 0.150 |
| 10 | Green urban areas | 0.233 | **32** | Sparsely vegetated areas | 0.133 |
| 11 | Sport and leisure facilities | 0.267 | **33** | Burnt areas | 0.333 |
| 12 | Non-irrigated arable land | 0.800 | **34** | Perpetual snow | 0.007 |
| 13 | Permanently irrigated land | 0.900 | **35** | Inland marshes | 0.153 |
| 14 | Rice fields | 0.900 | **36** | Peat bogs | 0.153 |
| 15 | Vineyards | 0.400 | **37** | Salt marshes | 0.300 |
| 16 | Fruit trees and berry plantations | 0.333 | **38** | Salines | 0.400 |
| 17 | Olive groves | 0.300 | **39** | Intertidal flats | 0.200 |

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| CORINE unit | Land Use (Corine map 2012) | Load Coefficient | CORINE unit | Land Use (Corine map 2012) | Load Coefficient |
|---|---|---|---|---|---|
| 18 | Pastures | 0.233 | **40** | Water courses | 0.200 |
| 19 | Annual crops associated with permanent crops | 0.600 | **41** | Water bodies | 0.200 |
| 20 | Complex cultivation patterns | 0.553 | **42** | Coastal lagoons | 0.200 |
| 21 | Land principally occupied by agriculture, with significant areas of natural vegetation | 0.367 | **43** | Estuaries | 0.200 |
| 22 | Agro-forestry areas | 0.200 | **44** | Sea and ocean | 0.200 |

After transformation of the CORINE 2012 Land Use map into a Hazard map for diffuse pollution, by using above stated weight coefficients, the entire Hazard classification has been made (Table 4.50).

### Table 4.50 Hazard classes used for groundwater hazard assessment

| Hazard | Class |
|---|---|
| **No Hazard – impervious rocks** | 0 – 0.1 |
| **Very Low Hazard** | 0.1 – 0.15 |
| **Low Hazard** | 0.15 – 0.35 |
| **Medium Hazard** | 0.35 – 0.55 |
| **High Hazard** | 0.55 – 0.75 |
| **Very High Hazard** | 0.75 – 1.0 |

The hazard maps on point source pollutants enable visualization of most problematic zones from groundwater protection point of view. The main input for Hazard map point pollutants is the current Population Equivalent (PE) load. Each point pollutant is expressed by a population equivalent load (PE load) and, depending on the size of PE load, and according to the ratio of the minimum and maximum calculated loads, to each point pollutant a circle was attributed of a determined radius (Table 4.51). In that way, each point pollutant has been represented by a circle of a certain surface (depending on the size of the load in 13 classes of diameter in an appropriate scale from 2,000 meters to 8,000 meters), and which completely or partly covers certain surfaces of (group) of groundwater body in which the pollutant is located. The semi-radius of each circle is approximated to express differences between small and large PE loads. As such, the scale of 1:850.000 for the Danube River basin is respected.

It should also be stated that population equivalent (PE) load data were not available, but only the location of potential point pollutants. PE load was determined based on data stated in draft version of Master plan for sewage and wastewater in the central and northern region of Montenegro (Serbia and Montenegro)[125] where only PE load data for Montenegrin municipalities and some main rivers were evaluated. Another applied approach for the groundwater hazard assessment is the analogy with the equivalent point pollutants in RBMP for Sava River basin of Bosnia & Herzegovina considering very similar level of industrial development in both countries.

### Table 4.51 Radius of circle based on PE load in creation of GW Hazard map for point pollutants adapted to scale 1:850,000

| PE load | Radius of circle (m) | PE load | Radius of circle (m) |
|---|---|---|---|
| 0 - 1000 | 2000 | 6000 - 7000 | 5000 |
| 1000 - 2000 | 2500 | 7000 - 8000 | 5500 |
| 2000 - 3000 | 3000 | 8000 - 9000 | 6000 |
| 3000 - 4000 | 3500 | 9000 - 10000 | 6500 |
| 4000 - 5000 | 4000 | 10000 - 11000 | 7000 |

[125] Master plan for sewage and wastewater in the central and northern region of Montenegro (Serbia and Montenegro), draft version; source: http://www.procon.me/index.php/mne/ (visited on 03 July 2018)

| PE load | Radius of circle (m) | PE load | Radius of circle (m) |
|---|---|---|---|
| 5000 - 6000 | 4500 | 11000 - 12000 | 7500 |
| | | > 12000 | 8000 |

Finally, this map represents the distribution of registered but still not fully confirmed point pollutants depending on their PE load. Their assigned circles were not taken into consideration for the groundwater risk assessment for point pollutions, since there is a certain subjectivity in determining the radius of the circle, which directly affects the degree of risk. Therefore, the circles which are attributed to each hazard class aiming to show their relationship and enable relative comparison. The methodology of risk assessment based on point pollution is explained in following text in more detail.

### 4.13.6 Applied Methodology and Risk Assessment

In general, the groundwater risk assessment can be expressed by relation:

**Groundwater Risk = Groundwater Vulnerability x Groundwater Hazard**

Methodology of groundwater risk assessment after diffuse pollution sources included combination of Groundwater Vulnerability map and Groundwater Hazard map after diffuse pollution sources: Groundwater hazard map after diffuse potential pollutants based on CORINE 2012 Land Use Map is overlapped with the Groundwater Intrinsic Vulnerability Map in order to estimate the risk of pollution. In other words, the risk of pollution will depend on both, the potential diffuse pollutant and the vulnerability of aquifers and groundwater. For example, the low degree of intrinsic groundwater vulnerability can be exaggerated by the high degree of hazard after diffuse pollution caused by inadequate land use. In contrast, if no any activities in the vulnerable catchment, the risk can be low.

The risk mapping methodology implied the multiplication of each pixel from vulnerability map with the corresponding hazard map pixel having the above-mentioned weight coefficients. This was possible using the ArcGIS software package and its Map Algebra / Raster Calculator tool. The first prerequisite that had to be fulfilled is that both maps (i.e. raster files) that enter into calculations are of the same resolutions, i.e. of the same pixel size, so that each pixel from one raster is multiplied with one corresponding pixel of the same size. This methodology at the end, proposed risk classes after diffuse pollution sources, which are given in Table 4.52 below.

**Table 4.52 Risk classes based on methodology applied in order to assess groundwater risk for diffuse pollution sources**

| Risk | Class |
|---|---|
| **No Risk – impervious rocks** | 0 - 1 |
| **Very Low Risk** | 1 - 10 |
| **Low Risk** | 10 - 25 |
| **Medium Risk** | 25 40 |
| **High Risk** | 40 - 60 |
| **Very High Risk** | 60 - 100 |

Similarly, as in the case of the methodology for determination of groundwater hazard maps, groundwater risk maps had to be created separately for diffuse and point sources. Groundwater risk assessment for point pollution sources were based on the comparison of PE load and vulnerability classes of each of groundwater body in the Adriatic River Basin. The assessment concept included summarizing of PE load in every GWB and comparison with sum of vulnerability classes in the same GWB. To do so, vulnerability classes are compared with corresponding PE loads. Thus, values in percentage of vulnerability classes were multiplied with new weight factor which depends on vulnerability degree (Table 4.53).

### Table 4.53 Vulnerability classes with appropriate empirical weight factor

| Vulnerability Class | Weight Factor |
|---|---|
| **Terrains with no aquifers – impervious rocks** | 35 |
| **Very low vulnerability** | 25 |
| **Low vulnerability** | 15 |
| **Moderate vulnerability** | 10 |
| **Moderate to high vulnerability** | 8 |
| **Very high vulnerability** | 6 |
| **Extremely high vulnerability** | 1 |

Therefore, total sum of PE load for each GWB or GGWB is divided with obtained values for vulnerability (class x weight factor). Ratio PE load vs. Vulnerability results with the Risk category in following way:

| | |
|---|---|
| PE load / Vulnerability < 10 | No Risk |
| PE load / Vulnerability < 10-40 | Conditionally at Risk |
| PE load /Vulnerability > 40 | At Risk |

## 4.13.7 Results of Groundwater Hazard and Risk Assessment

### Hazard Assessment

The entire territory of the Adriatic River Basin was classified into 6 categories based on groundwater hazard assessment after diffuse pollutions (Table 4.54). The categorization of the values of pollution hazard is determined based on the potential hazard of certain elements. Thus, the least hazardous area has a coefficient of 0.007 (areas of perpetual snow), while in the category of the most dangerous are: Landfills with a coefficient of 1.0, or permanently irrigated area with weight factor of 0.9. From the above-mentioned, the greater danger of pollution is where the greater coefficient is 0.1 at least to 1.0 as the most dangerous.

### Table 4.54 Groundwater hazard classes of the Adriatic River Basin based on groundwater hazard assessment method

| Montenegro - Hazard classes | | | |
|---|---|---|---|
| | **Class** | **Km²** | **%** |
| **No hazard – impervious rocks** | 0 – 0.1 | 1,182.47 | 17.06 |
| **Very Low Hazard** | 0.1 – 0.15 | 558.92 | 8.06 |
| **Low Hazard** | 0.15 – 0.35 | 4,351.64 | 62.79 |
| **Medium Hazard** | 0.35 – 0.55 | 623.14 | 8.99 |
| **High Hazard** | 0.55 – 0.75 | 195.81 | 2.83 |
| **Very High Hazard** | 0.75 – 1.0 | 18.67 | 0.27 |

Table 4.54 shows that the most extensive hazard class in the Adriatic River Basin is Low Hazard that covers 62.79% of total territory. That is the case mostly because large areas are not or are rarely inhabited and belong to hilly-mountainous terrains. Moreover, the industrial development was generally not developed to such extent to have significant impact on environment. On the other hand, medium and high hazard after diffuse pollution is only significant in most populated and developed municipalities of Nikšić and Podgorica, where the biggest industrial zones are also located (mines, breweries, etc.). This situation is presented on Figure 4.19 which shows Groundwater hazard map of Adriatic River Basin after diffuse pollution.

Similar results were obtained by creating the Groundwater Hazard map after point pollution sources. By creating this map, the locations of main industrial facilities have been taken in consideration (Figure 4.20), which are also listed in the risk assessment for surface waters (Section 4.6.2, Table 4.16).

The groundwater Hazard Map of the Adriatic River Basin for point source pollutants is shown in Figure 4.21.

## Figure 4.19 Groundwater Hazard Map of the Adriatic River Basin for diffuse pollution

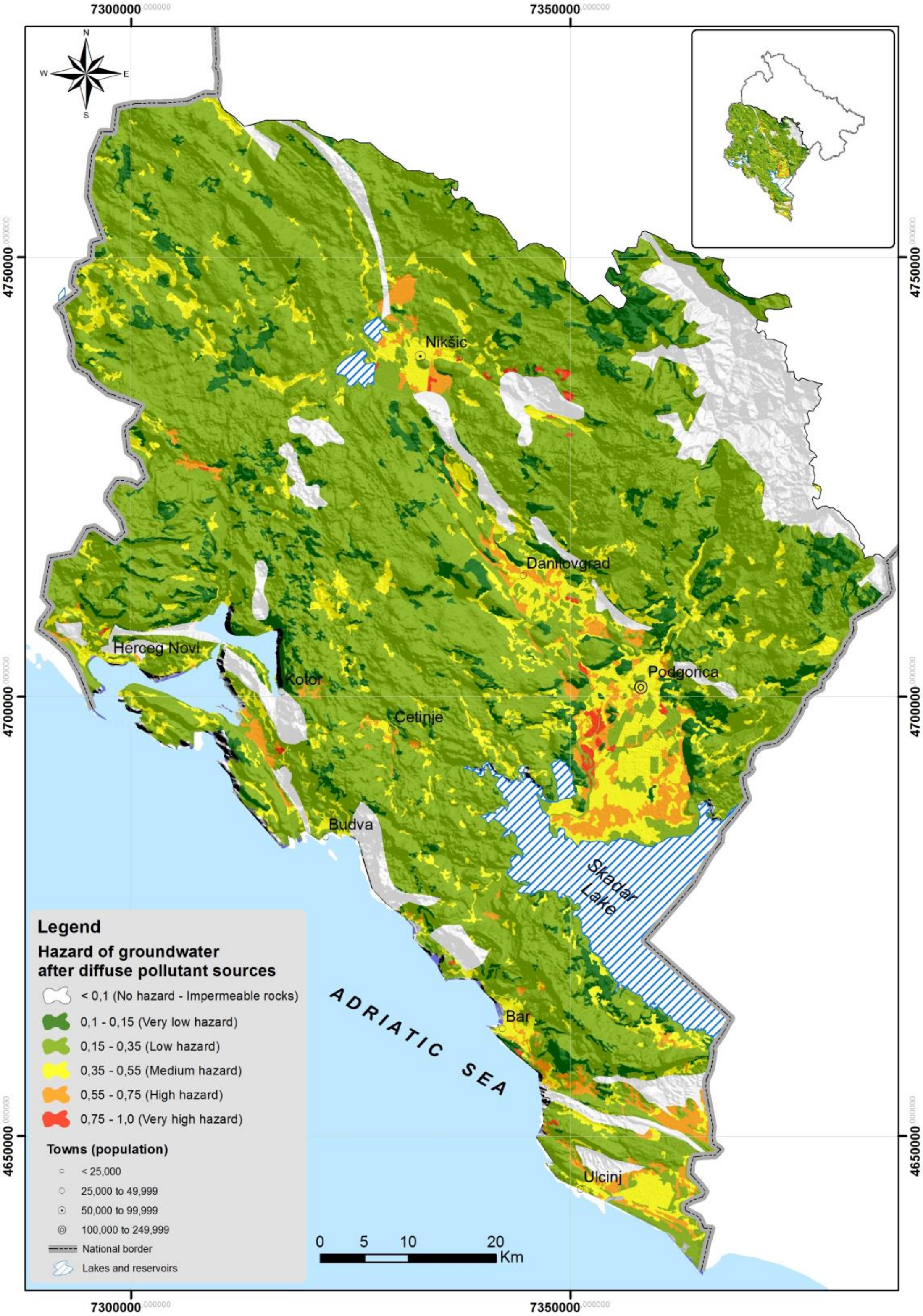
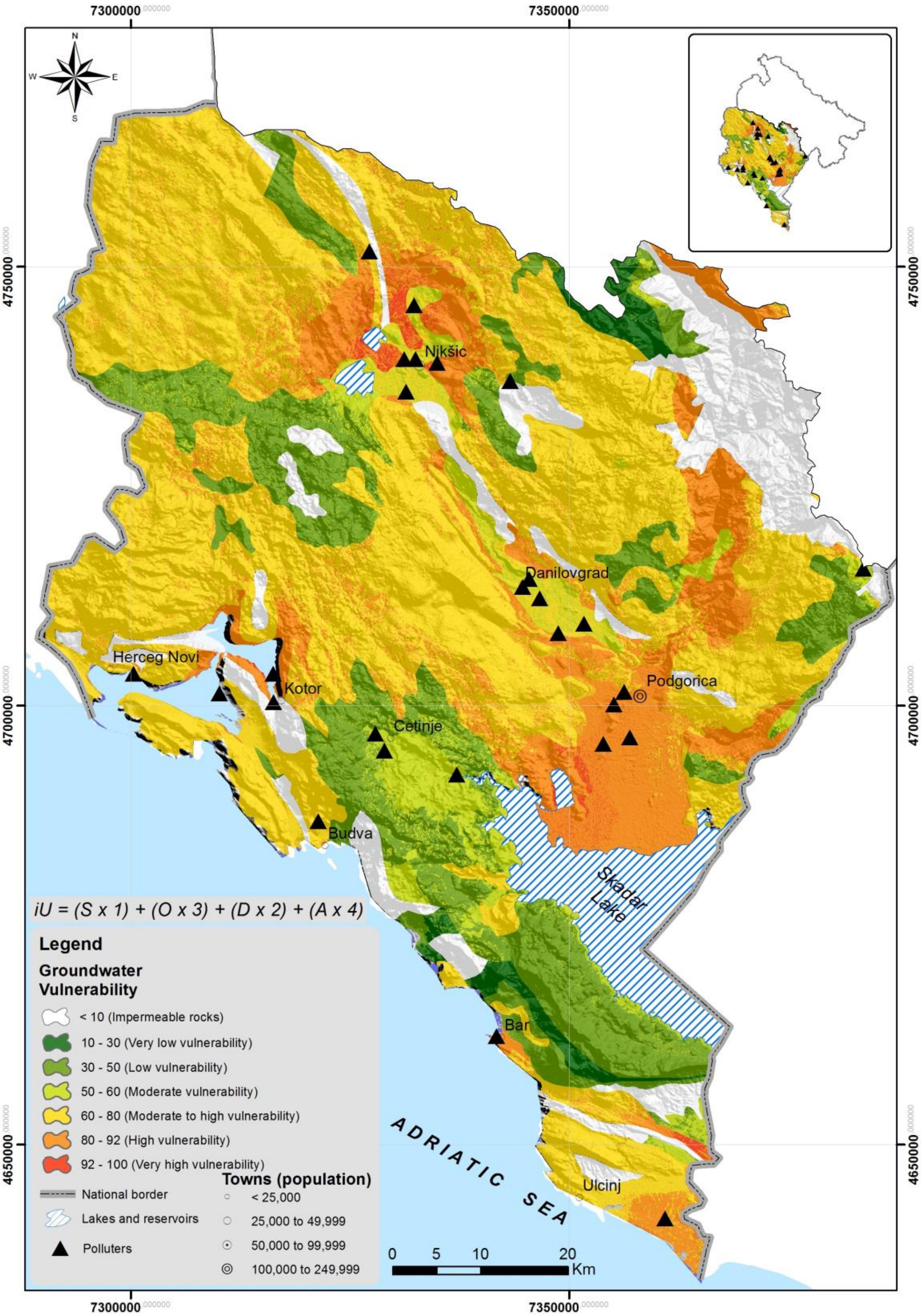
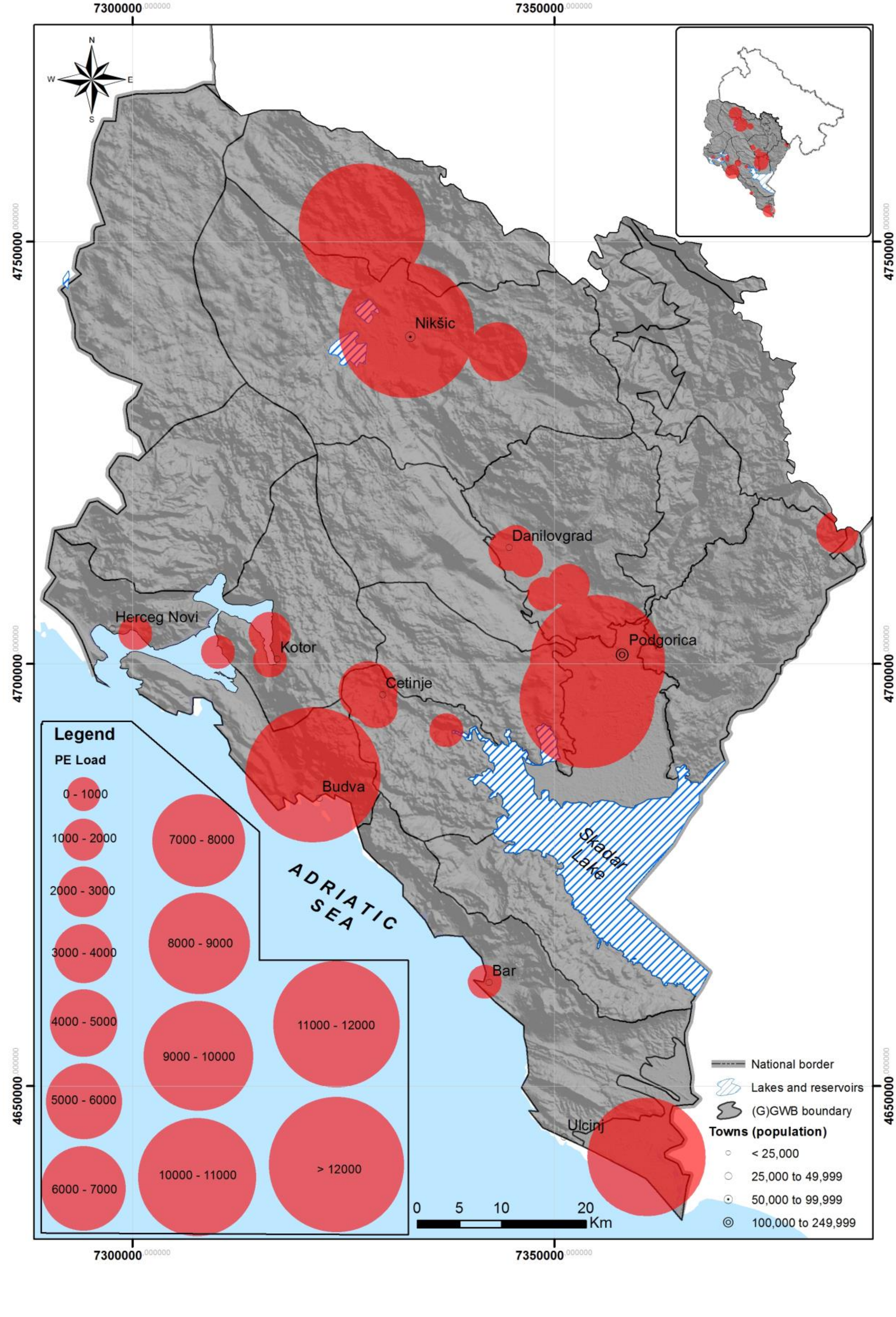


**Figure 4.20 Locations of main industrial facilities in the Adriatic River Basin – potential water polluters**



## Figure 4.21 Groundwater Hazard Map of the Adriatic River Basin for point source pollutants



## Risk Assessment

The graphical presentation of groundwater risk for diffuse pollution is shown in Figure 4.22. The map also indicates so-called hotspots when it comes to the groundwater Risk – Bar, Danilovgrad, Herceg Novi, Kotor, Nikšić, Podgorica, Tivat and Ulcinj. As it can be seen on the map (Figure 4.23), risk categories Medium, High and Very High risk are located in these areas. The associated groundwater bodies are: Grbalj – Luštica, Orahovstica-Rijeka Crnojevica, Nikšićko polje, Ulcinjsko polje and Zeta Valley.

The applied methodology for groundwater Risk assessment for diffuse pollution sources shows that the category of Low Risk is the most widespread category in entire territory of the Adriatic River Basin. This risk category covers 58.18% of the total basin (Table 4.55).

### Table 4.55 Groundwater Risk assessment of Montenegro after diffuse pollution sources

| Montenegro - Risk Classes | | | |
|---|---|---|---|
| | Class | Km$^2$ | % |
| No Risk – impervious rocks | 0 - 1 | 1,182,47 | 17.07 |
| Very Low Risk | 1 - 10 | 1,063.04 | 15.35 |
| Low Risk | 10 - 25 | 4,029.97 | 58.18 |
| Medium Risk | 25 40 | 493.45 | 7.12 |
| High Risk | 40 - 60 | 147.03 | 2.12 |
| Very High Risk | 60 - 100 | 11.18 | 0.16 |

Risk assessment based on point pollution sources practically shows the very similar situation. By applying the methodology presented for vulnerability analysis (shown above in Table 4.48), a risk category for each of groundwater body has been calculated as shown in Table 4.56. This table shows that two GWBs are risk due to the impact of point pollution sources Nikšićko polje and Zeta Valley while four GGWB are potentially at risk (Ulcinjsko polje, Grbalj-Lustica, Orahovštica – Rijeka Crnojevića and Karuc-Sinjac). A graphical presentation of risk assessment for point pollution sources is shown in Fig. 3.25.

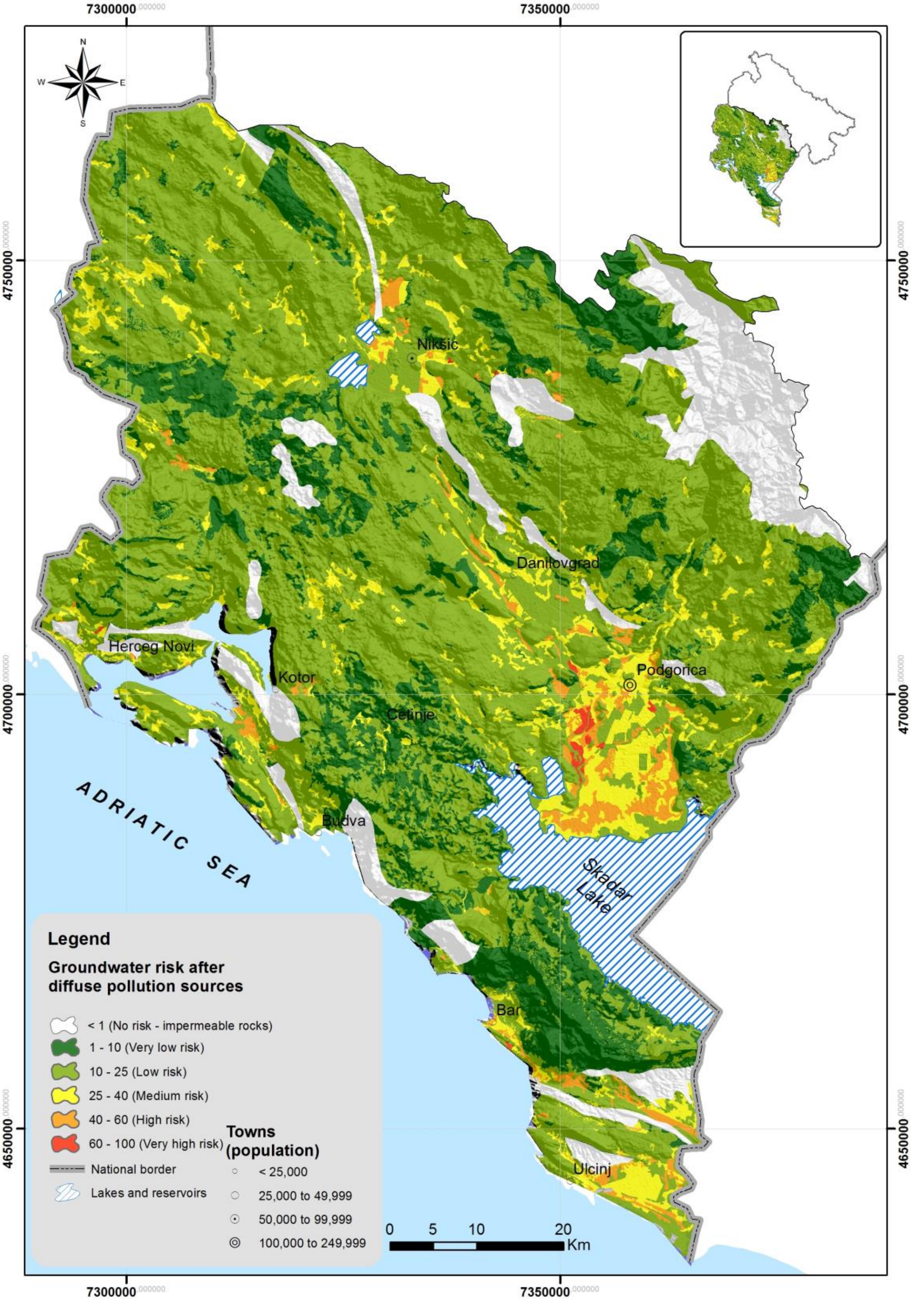
### Table 4.56 Risk Assessment after comparison of PE load and summarized vulnerability classes based on point pollution sources

| No. | GWB Name | PE Load | Vulnerability | PE Load / Vulnerability | Risk Assessment |
|---|---|---|---|---|---|
| 1 | South Edge of Skadar Lake | No PE load | | 0 | No Risk |
| 2 | Ulcinj Valley | 10 707 | 909.88 | 11.77 | Potentially at Risk |
| 3 | Mažura Paštrovići | 2 000 | 1856.34 | 1.08 | No Risk |
| 4 | Grbalj Luštica | 15 874 | 1264.97 | 12.55 | Potentially at Risk |

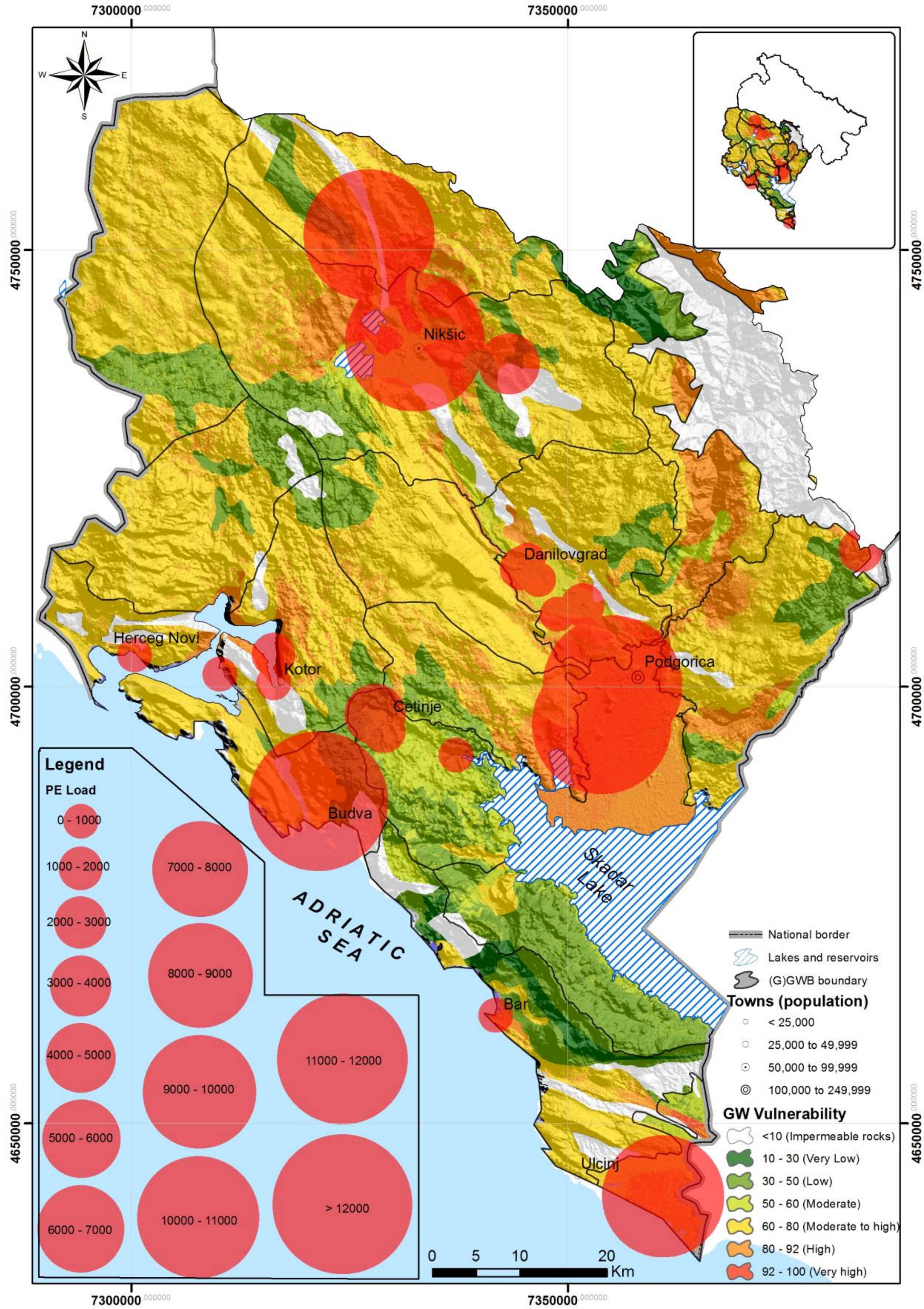
| No. | GWB Name | PE Load | Vulnerability | PE Load / Vulnerability | Risk Assessment |
|---|---|---|---|---|---|
| **5** | Opačica Morinj | 500 | 1332.38 | 0.37 | No Risk |
| **6** | Orjen | No PE load | | 0 | No Risk |
| **7** | Lovćen Njeguši | 2 500 | 1316.59 | 1.89 | No Risk |
| **8** | Orahovštica – Rijeka Crnojevića | 17 650 | 1194.04 | 14.78 | Potentially at Risk |
| **9** | Karuč Sinjac | No PE load | | 0 | Potentially at Risk[126] |
| **10** | Zeta Valley | 120 750 | 589.17 | 204.95 | At Risk |
| **11** | Prekornica Bjelopavlići | 4 000 | 991.52 | 4.03 | No Risk |
| **12** | Garač | No PE load | | 0 | No Risk |
| **13** | Vojnik | No PE load | | 0 | No Risk |
| **14** | Nikšićko polje | 73 000 | 1110.86 | 65.72 | At Risk |
| **15** | Trebišnjica (Bilećko Lake) | No PE load | | 0 | No Risk |
| **16** | Kuči | 1 600 | 965.32 | 1.65 | No Risk |
| **17** | Morača | No PE load | | 0 | No Risk |

[126] Potential risk is due to hydraulic connection with adjacent GWB Zeta Valley which is classified to be at risk

## Figure 4.22 Groundwater Risk Map of the Adriatic River Basin for diffuse pollution



## Figure 4.23 Groundwater Risk Map of the Adriatic River Basin for point source pollutants



### 4.13.8 Summary of pressures on groundwaters and groundwater status

A summary of the quantitative and qualitative pressures on groundwaters, which were derived from the vulnerability and hazard/risk assessments, are presented in Table 4.57. The summary provides the key potential sources of pollution together with the assessed groundwater status. Further information regarding the monitoring of quantity and quality is outlined in Section 6.3, and in Annex 1 of this RBMP.

## Table 4.57 Summary of Pressures and Status of Groundwater bodies in the Adriatic River Basin

| No. | GWB Name | GW Code | Assessment of Pressure | | Vulnerability & Assessment of Risk | GW status | | Dependent ecosystems |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | | Quality | Quantity | |
| **1** | Southern Rim of the Skadar Lake | ME_AB_GGW_K_1 | No registered significant point pollutants | Wastewater of smaller settlements which are not connected to sewage system; Local landfills; Agriculture; Main road Podgorica-Bar with tunnel "Sozina" | According to the Vulnerability map, the classes Very High and High are not present while Low vulnerability occupy around 77% of GGWB area.<br><br>Population Equivalent, PE load is practically zero. | Good status | Good status | Skadar Lake, Crmnička River |
| **2** | Ulcinjsko polje | ME_AB_GW_I_1 | PE Load: 10,707 | Sea water intrusion; Wastewater of settlements which are not connected to sewage system; local landfills; tourism: agriculture; road network | The class Very High vulnerability occupies 39% while High vulnerability around 4% of GWB area<br><br>In accordance with established criteria PE Load / Vulnerability resulted with 11.77 and "Potentially at Risk" | Poor status due to natural quality / Potentially at risk due to anthropogenic impact | At risk | Bojana River, Šasko Lake, Porta Milena, Kodra Wetland, Adriatic Sea |

| No. | GWB Name | GW Code | Assessment of Pressure | | Vulnerability & Assessment of Risk | GW status | | Dependent ecosystems |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | | Quality | Quantity | |
| **3** | Možura - Paštrovići | ME_AB_GGW_K_2 | Port Bar, PE Load c. 2 000 | Wastewater of settlements which are not connected to sewage system; septic tanks: Local landfills; Agriculture; Local road network; Main road Ulcinj-Budva where wastewater from road is not collected and treated. | According to the Vulnerability map, the class Very High vulnerability occupies around 4% of GGWB area.<br>There are no large point sources of pollution in this area except of port "Bar"(according to the map of industrial polluters) | Good status<br>Not at Risk, (to be verified by future monitoring) | Good status | Adriatic Sea, small streams |
| **4** | Grbalj - Luštica | ME_AB_GGW_K_3 | PE Load estimated on 15,874 | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network; Main road Petrovac-Tivat | 77% of Moderate and <1% of High Vulnerability<br>PE Load vs. Vulnerability is at risk level, i.e. 12.55 | Potentially at risk | Good status | Adriatic Sea |
| **5** | Opačica - Morinj | ME_AB_GW_K_4 | Port "Zelenika", PE Load 500 | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network; | Relatively high; To the class Moderate to High Vulnerability belong 72.7%, and to class Very High 6.8%<br>Not at risk; PE Load / Vulnerability 0.37 | Good status | Good status | Adriatic Sea (Herceg Novi Bay); Sutorina River |
| **6** | Orjen | ME_AB_GW_K_5 | PE Load : none registered | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network; the main road Risan-Vilusi (Grahovo) | Moderate to High Class 74.3%, High Class 7%, but not densely populate away from the Coast<br>No PE Load/No risk | Not at risk from pollution / High salinity during the summer on water source Risanska Spilja | Good status | Adriatic Sea; Grahovo Lake (reservoir) |

| No. | GWB Name | GW Code | Assessment of Pressure | | Vulnerability & Assessment of Risk | GW status | | Dependent ecosystems |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | | Quality | Quantity | |
| **7** | Lovćen (Njeguši) | ME_AB_GW_K_6 | Meat processing "Niksen Cavor", port Kotor, large marina Tivat – Porto Montenegro, meat processing in Njeguši, PE Load 2500 | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network; Tunnel Vrmac | To the class Moderate to High Vulnerability belong 52% and to class High 15.7%<br>Not at Risk, need verification through monitoring | Good status except for high salinity during the summer on Plavda, Škurda and Orahovac water sources | Good status | Adriatic Sea (Kotor Bay) |
| **8** | Orahovštica – Rijeka Crnojevića | ME_AB_GGW_C_1 | Wastewater from Cetinje polje is discharging into the swallow hole and further to karst aquifer; factory of paper "Kartonaža", meat processing "Interproduct", fish processing "Ribarstvo Rijeka" | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Main road Podgorica-Budva | Low and Moderate Vulnerability classes account for 96%.<br>Potentially at risk, Due to high PE Load of 17,650. Ratio PE Load vs. Vulnerability 14.78 | Potentially at risk | Good status | Skadar Lake, Crnojevića River, Orahovštica River |
| **9** | Karuč - Sinjac | ME_AB_GGW_K_7 | PE Load : none registered | Wastewater of settlements which are not connected to sewage system – Grbavci and few others; Local landfills; Intensive gravel extraction from alluvial aquifer along Moraca River: Agriculture; Main road Podgorica-Budva< Potential threats are planned Waste Water Treatment Plant and highway. | 79% of the GWB belongs to “Moderate to High” vulnerability classes<br>No PE Load, thus PE Load vs. Vulnerability is 0, means actually no risk, but precaution measures are required due to importance of GGWB for regional water supply (Adriatic Coast), especially due to connection to adjacent GWB Zeta Valley | Potentially at risk due to connection to adjacent GWB Zeta Valley | Good status | Skadar Lake, Malo Blato |

| No. | GWB Name | GW Code | Assessment of Pressure | | Vulnerability & Assessment of Risk | GW status | | Dependent ecosystems |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | | Quality | Quantity | |
| **10** | Zeta Valley | ME_AB_GGW_I_2 | Factory of wine and vineyards "Plantaže", Processing of fruits and vegetables "Plodovi Crne Gore", chemical industry "Hemko", Aluminium Plant, many small factories and workshops. Intensive gravel extraction from alluvial aquifer of Moraca is threat for Karuc-Sinjac GWB. | Wastewater of settlements which are not connected to sewage system in Golubovci area and other villages; red mud flotation lake of Aluminium Plant; local landfills; intensive agriculture; road network | Very high; 90% of the GWB belongs to “High and Extremely HIgh” vulnerability classes<br>GGWBs is at risk, PE Load is assessed at 120 750, while ratio PE Load vs. Vulnerability is 204.95 | Poor status<br>Under pressure from various point and diffuse pollutant sources, although its part along Cijevna River is protected natural monument | Poor status, >50% of exploitable resources is utilised, and pressure likely to further increase | Skadar Lake, Morača River, Cijevna, smaller streams |
| **11** | Prekornica - Bjelopavlići | ME_AB_GGW_C_2 | Stone processing "Mermer", juice factory "Pirella", factory of coffee "Crnagoracoop", factory of animal feed in Spuž, milk factory "Lazine" | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Secondary road Podgorica-Glava Zete | 79% of the GWB belongs to “Moderate to High” vulnerability classes<br>GGWBs is not at risk, PE Load is assessed at 4000, while ratio PE Load vs. Vulnerability is 4.03 | Good status | Not at risk, but operational monitoring is needed due to fact that water demands are 18% of exploitable reserves | Zeta River |
| **12** | Garač | ME_AB_GGW_K_8 | PE Load : none registered | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Main road Podgorica-Nikšić | 89% of the GWB belongs to “Moderate to High” vulnerability classes<br>No PE Load, thus PE Load vs. Vulnerability is 0, means actually no risk | Good status | Good status | Zeta River, Sitnica (Matica) River |
| **13** | Vojnik | ME_AB_GGW_K_9 | PE Load : none registered | Wastewater of settlements which are not connected to | 77% of the GWB belongs to “Moderate | Good status | Good status | Sušica River and |

| No. | GWB Name | GW Code | Assessment of Pressure | | Vulnerability & Assessment of Risk | GW status | | Dependent ecosystems |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | | Quality | Quantity | |
| | | | | sewage system; Local landfills; Agriculture; The main roads Nikšić-Plužine and Nikšić-Šavnik-Žabljak | to High" vulnerability classes<br>No PE Load, thus PE Load vs. Vulnerability is 0, means actually no risk | | | Rastovac River, i.e. Zeta River |
| **14** | Nikšićko polje | ME_AB_GGW_C_3 | Iron Factory, Brewery "Nikšić", Hospital "Brezovik", Bauxite Mine in Župa, Fishpond in Rastovac, Mill "Nikšić", Meat factory "Goranović", smaller industrial workshops | Wastewater of settlements which are not connected to sewage system; Local municipal landfill and many "wild" landfills across the polje; Agriculture; The main road Podgorica-Nikšić. Pressure reduced due to operational WWTP since 2018 | High; 69% of the GWB belongs to "Moderate" to "High" vulnerability classes<br>GGWBs is at risk, PE Load is assessed at 73000, while ratio PE Load vs. Vulnerability is 65.72 | Poor status<br>Under pressure from various point and diffuse pollutant sources | Good status | Zeta River, Gračanica River, Slano Lake, Krupac Lake, Liverovići Lake |
| **15** | Trebišnjica (Bilećko Lake) | ME_AB_GGW_K_10 | PE Load : none registered | Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; The main roads Nikšić-Trebinje, Vilusi-Bileća and Nikšić-Gacko | 83% of the GWB belongs to "Moderate to High" vulnerability classes | No PE Load, thus PE Load vs. Vulnerability is 0, means actually no risk | Good status | Bilećko Lake (Trebišnjica River), Zaslapnica River |
| **16** | Kuči | ME_AB_GGW_C_4 | No large point sources registered | Wastewater of settlements which are not connected to sewage system; Local landfills and septic tanks; Agriculture; The road s Gusinje-Dinosa and Dinoša-Šumica; Local road network | 74% of the GWB belongs to "Moderate" to "High" vulnerability classes<br>GGWBs is actually not at risk, PE Load is assessed at 1600, while ratio PE Load vs. Vulnerability is 1. 65 | Good status | Good status | Skadar Lake, Cijevna River, Ribnica, Morača and Mala River |
| **17** | Morača | ME_AB_GGW_K_11 | PE Load : none registered | Wastewater of settlements which are not connected to | 70% of the GWB belongs to "Moderate" | Good status | Good status | Morača River, Mala |

| No. | GWB Name | GW Code | Assessment of Pressure | | Vulnerability & Assessment of Risk | GW status | | Dependent ecosystems |
|---|---|---|---|---|---|---|---|---|
| | | | Point | Diffuse | | Quality | Quantity | |
| | | | | sewage system; Local landfills; Agriculture; The main road Podgorica-Kolašin, secondary road Bioče-Mateševo and Highway section Smokovac-Mateševo (under construction) | to “High” vulnerability classes<br><br>No PE Load, thus PE Load vs. Vulnerability is 0, means no risk | | | River and Mrtvica River |

### 4.13.9 Areas of special concern and protection

The Water Framework Directive of the EU specifies that areas requiring special protection under other EC Directives and waters used for the abstraction of drinking water are identified as protected areas. These areas have their own objectives, standards and demands for water protection. Some areas may require special protection under more than one EC Directive or may have additional (surface water and/or groundwater) objectives. In these cases, all the objectives and standards must be met. Article 6 requires the establishment of a register of protected areas. Concerning groundwater status, the types of protected areas that must be included in the register are:

- Areas designated for the abstraction of water for human consumption (Drinking Water Protected Areas);
- Nutrient-sensitive areas, including areas identified as Nitrate Vulnerable Zones under the Nitrates Directive or areas designated as sensitive under Urban Waste Water Treatment Directive (UWWTD);
- Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection including relevant designated EMERALD network areas and Natura 2000 sites.

The locations of springs and wells utilized for water supply have been included in Section 4.9, Table 4.25 and Figure 4.10. The contours of the registered protected areas and the proposed EMERALD network are shown in Section 5, Figures 5.2 and 5.3, respectively. These locations and areas at certain points correspond clearly with GWBs and GGWBs which are at risk or potentially at risk considering diffuse or point pollution sources e.g. Skadar Lake Basin. These areas require special attention and systematic monitoring of local groundwater.

# 5 PROTECTED AREAS

## 5.1 Overview of protected Areas according to the WFD

The basic precondition for ensuring preparation of the proper register of protected areas and setting the associated objectives is transposition of related EU legislation into the national legislation.

WFD and other related legal documents consider separately protected areas because they need extra protection for conservation of habitats and/or species, or they are distinguished as important to be protected based on other reasons covered by the Community legislation (e.g., abstraction of drinking water, bathing waters etc. – the WFD Article 6).

In Montenegro the related national legislation is not fully harmonized with the EU standards. Thus, the modified approach in dealing with protected areas should be used, having in mind the different national standards for the delineation of protected areas.

The National Biodiversity Strategy with Action Plan (NSBAP) for the period 2016-2020 has been adopted and it established a strategic framework for the implementation of the Convention on Biodiversity, including the measures and actions to reach Aichi targets[127] in accordance with the Strategic Plan for Conservation of Biodiversity 2011-2020 and the EU 2020 Biodiversity Strategy.

As for the identification of natural areas of interest for conservation under international treaties, in the period 2005-2007, the project (funded by Council of Europe for all Balkan countries) of providing support to the establishment of EMERALD network was implemented in the framework of implementation of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). The proposal was given for 32 localities of special conservation interest (ASCI) in Montenegro. The proposed EMERALD sites in Montenegro were adopted by the Standing Committee of the Bern Convention in December 2011 following discussion at the Biogeographic Seminar which was held in Bar in November 2011. These areas serve as a basis for identifying the proposed areas for the future environmental network Natura 2000 in the context of implementing national legislation previously harmonized with Directive 2009/147/EC concerning the protection of wild birds and Directive 92/43/EEC concerning the conservation of natural habitats and wild flora and fauna. In April 2019 the implementation of the IPA project "Establishment of the NATURA 2000 network in Montenegro" was concluded. The project covered only part of the terrestrial territory of Montenegro based on the proposed EMERALD locations.

As a Party to the Bern Convention on the Conservation of European Wildlife and Natural Habitats, Montenegro has developed a list of 32 candidate EMERALD Ecologic Network sites (also defined as Areas of Special Conservation Interest at the European level - ASCIs), 14 of which are proposed in the Adriatic River Basin. According to the degree of harmonization, the EMERALD Network consists of the following areas in the Adriatic River Basin:

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[127] The 'Aichi Targets' were adopted by the Convention on Biological Diversity (CBD) at its Nagoya conference. It is a short-term plan provides a set of 20 ambitious yet achievable targets, collectively known as the Aichi Targets, which realte to Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use.

**A. Completely harmonized and accepted areas of importance for protection:** 1. Skadarsko jezero, 2. Ostrvo Katići sa Donkova i Velja seka, 3. Plaža Pećin, 4. Brdo Spas, 5. Platamuni, 6. Tivatska solana, 7. Kanjon Cijevne sa dijelom Ćemovskog polja, 8. Kotorsko-Risanski zaliv, 9. Vojnik i 11. Lovćen

**B. Areas of significance for protection that are harmonized in a high degree, but with the need for further harmonization**: 1. Rumija, 2. Kanjon Male rijeke, 3. Orjen, 4. Velika plaža i Solana, 5. Buljarica

The implementation of Montenegro's international obligations arising from CITES Convention and requirements stemming from the EU legislation governing the implementation of the CITES convention is not entirely governed in adequate manner by the national legislation.

Montenegro has made progress in transposing the international and EU legislation related to protected areas included also in WFD (Table 5.1). However, the country is having difficulties in implementing them, which is translated in practice in lack of designation of protected areas and of the register of the protected areas in Adriatic River Basin.

### Table 5.1 International and bilateral Conventions and Agreements signed by the Montenegrin Government on Species and habitat protection

| No. | International Conventions/Protocols | No of "Official Gazette" |
|---|---|---|
| **1** | Convention on Biological Diversity, 1992 | Off. Gaz. of SRY, No.011/01-28 |
| **2** | The Cartagena Protocol on Biosafety , 2003 | Off. Gaz. of S&MNE, No.016/05-40 |
| **3** | Convention on the Conservation of Migratory Species of Wild Animals (Bon), 2012 | Off. Gaz. of MNE, No.006/08-147 |
| **4** | Bern Convention on the Conservation of European Wildlife and Natural Habitats, 1994 | Off. Gaz. of MNE, No. 7/2008 |
| **5** | The Convention on Wetlands (the RAMSAR Convention), 1971 | Off. Gaz. of SRY, No.009/77-675 |
| **6** | Convention concerning the Protection of the World Cultural and Natural Heritage | Off. Gaz. of SRY, No 056/74-1771 |
| **7** | European Landscape Convention | Off. Gaz. of MNE, No.006/08-135 |
| **8** | Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES Convention), 1973 | Off. Gaz. of SRY, No.011/01-3 |
| **9** | United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, 1994 | Off. Gaz. of MNE", No.017/07-12 |
| **10** | Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) | Off. Gaz. of MNE, No.7/2008. |
| **11** | Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean | Off. Gaz. of RoMNE, No.64/07 |
| **12** | Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) | Off. Gaz. of MNE, No. 01/2011 |
| **13** | Agreement on the Conservation of Populations of European Bats (EUROBATS) | Off. Gaz. of MNE, No 16/10 |

The WFD is a fundamental tool for implementation of all water-related EU Directives, as well as a platform for coordination of activities on the realization of other Community legal instruments and global initiatives. Beside other issues, the WFD considers protected areas, as areas that need extra protection.

According to the WFD Guidance Document No. 1 (2003), the river basin management plan for each river basin district should include the map showing any protected areas, map of the results of the monitoring programmes showing the status of all water bodies and protected areas.

The WFD requires the establishment of a register of protected areas, including the details on related water bodies. The register of protected areas required by the WFD under Article 6 must include the following:

i. Areas designated for the abstraction of water intended for human consumption under Article 7;
ii. Areas designated for the protection of economically significant aquatic species;
iii. Bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC;
iv. Nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC; and
v. Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites designated under Directive 92/43/EEC(1) and Directive 79/409/EEC(2).

## 5.2 Drinking water protected areas

Waters used for abstraction of drinking water are specially identified in the WFD as one of the major target of protection. When such waters are identified, Environmental Quality Standards (EQS) for each pollutant must be established.

Drinking Water Protected Areas are:

- Bodies of water used for the abstraction of water for human consumption which provide more than an average of 10 $m^3$ a day in total or which serve more than 50 persons;
- Bodies of water intended for such level of use in the future.

Under the Drinking Water Directive (98/83/EC), water for human consumption means all water either in its original state or after treatment which is:

- Intended for drinking, cooking and food preparation or other domestic purposes; or
- Used in any food production business for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the competent national authorities in relation to drinking water quality are satisfied that the quality of water has no influence, directly or indirectly, on the health of consumers concerned.

The groundwater extraction for the purposes of the industry in the Adriatic River Basin ranges from around 10,000 to 23,000 $m^3$/year. The Aluminium Plant Podgorica uses water from Morača River, but there is also groundwater pumping from wells drilled or dug out in intergranular aquifer of Lower Zeta

Valley. The brewery "Nikšić" has own wells for the extraction of groundwater from the intergranular aquifer of Nikšić polje.

The largest groundwater use for the irrigation occurs in the Lower Zeta Valley. For the irrigation of the vineyards of company "Plantaže" the groundwater of intergranular aquifer is abstracted by more than 20 wells in quantity of around 2 $m^3/s$.

In accordance with Article 53 of the Law on Waters and the by-law[128] the sources for regional and public water supply in Montenegro are determined. Article 57 of the Law on Waters and the by-law prescribes the method of determining and maintaining the zones and sanitary protection zones (termed Drinking Water Protected Areas or DrWPAs in the WFD) of sources used or which may be used for the supply of drinking water and restrictions in such zones. The Water Supply Companies at municipalities are responsible for designation of the sanitary protected areas.

The list of springs in the Adriatic River Basin and the current status of protection of the drinking water is shown in Table 5.2. Figure 5.1 shows sanitary protection zones which are delineated around groundwater sources. The majority of these zones in Montenegro are located in the Adriatic River Basin.

Future safeguard Zones will also be delineated for all water sources and any raw water sources that are 'at risk' of deterioration will result in the need for additional treatment. Action will be targeted in these zones to address any potential pollution so that extra treatment of raw water can be avoided.

### Table 5.2 Overview of the springs and water protection zones in the Adriatic River Basin

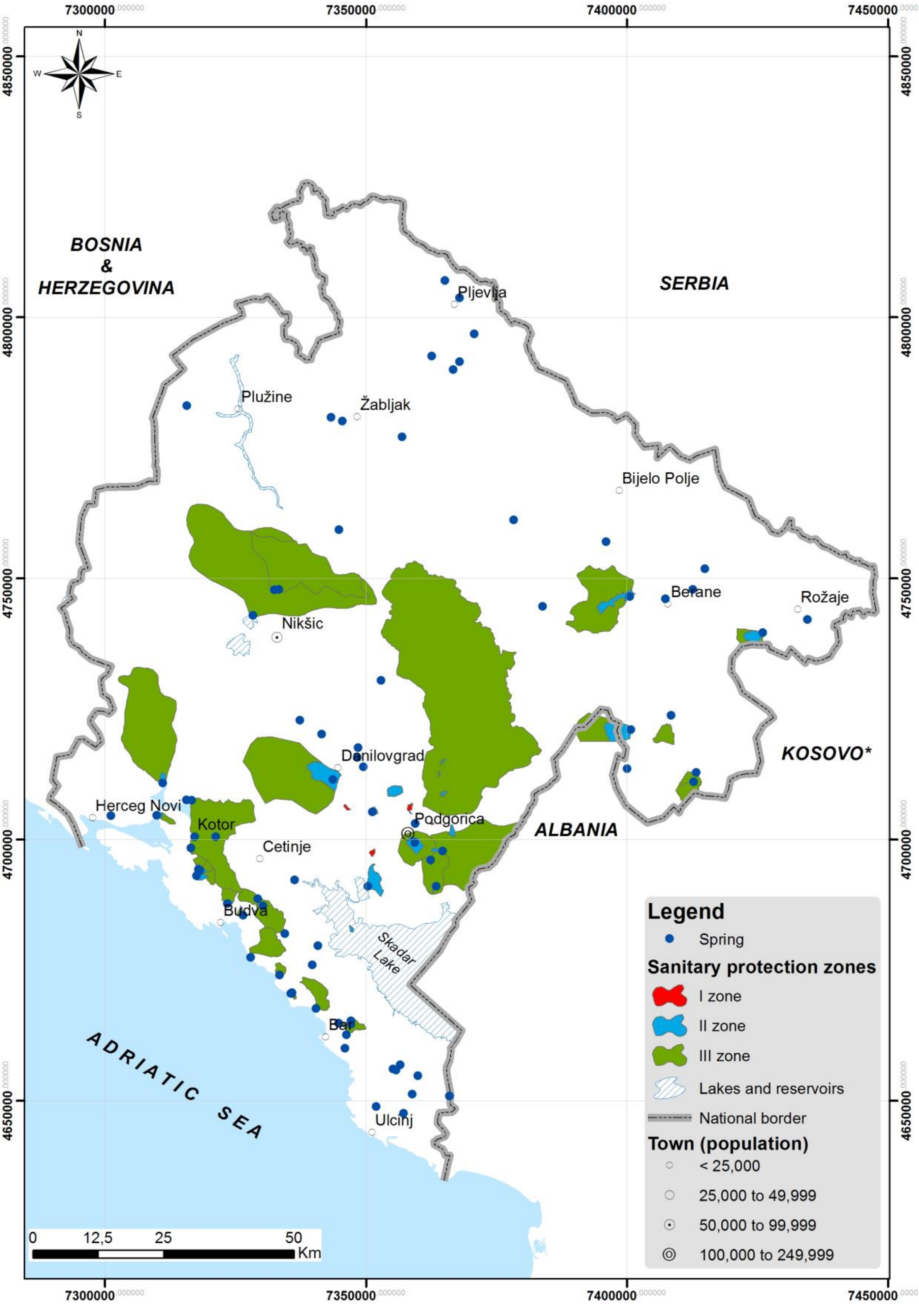
| No. | GW Body | Springs (both, tapped and non-tapped) ($Q_{min}/Q/Q_{max}$) | Protection Zones[122] |
|---|---|---|---|
| 1 | Southern Rim of the Skadar Lake | Raduš Spring ($Q_{min}$=0.06 $m^3/s$; Q=1.24 $m^3/s$; $Q_{max}$=50 $m^3/s$); Krnjice Spring (Q=0.7 $m^3/s$); Velje Oko (Q=1$m^3/s$); Malo Oko (Q=0.3 $m^3/s$); Okruglica Spring (Q=0.2 $m^3/s$) | Delineated for the water-source "Velje Oko" |
| 2 | Ulcinjsko polje | LisnaBori" (Q = 0.25 $m^3/s$) | Delineated for the water source "Lisna Bori" |
| 3 | Možura - Paštrovići | Q=20 l/s (Gač); Q=23 l/s (Klezna); Q=5 l/s (Mide); Q=2 l/s (Kaliman); Q=2 l/s (Salč); Q=60 l/s (Brca); Q=70 l/s (Kajnak); Q=20 l/s (Zaljevo); Q=1 l/s (Turčini); Q=2 l/s (Sustaš); Q=8 l/s (Čanj); Q=80 l/s (Reževića Spring); Q=25 l/s (Buljarica); Q=4 l/s (Lončar); Q=2 l/s (Kaliman); Q=2 l/s (Salč) | Delineated for the water-sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, Buljarica, Lončar, Kaliman and Salč |
| 4 | Grbalj - Luštica | Grbalj Spring, Pakočio, Rakita, Mezalinskavoda, Nova Voda, Smokvica, Kaludrak (Qmin=1 l/s), Tolinjak (Qmin=1 l/s), Piratac ($Q_{min}$=2 l/s; $Q_{max}$=25 l/s), Boretskavoda, Brca, Loznica ($Q_{min}$=2 l/s; $Q_{max}$=25 l/s), Tršljikovica, Podbabac, Babac, Kuljače, Spring under the Pyramid($Q_{min}$=5 l/s), Topliš Spring ($Q_{min}$=1 l/s); Lončar($Q_{min}$=4 l/s); Zagradac($Q_{min}$=2 l/s) | Delineated for the water-sources: Topliš (Tivat), Grbaljskopolje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring (Budva) |
| 5 | Opačica - Morinj | Morinj Springs ($Q_{min}$=1 $m^3/s$), Opačica ($Q_{min}$=0.035 $m^3/s$), Verige Springs; Česma Spring, Dizdarica Spring, Lovac Spring | Delineated for the water-sources: Opačica, Sutorinsko polje |

[128] Decision on Determination of Sources for Regional and Public Water Supply and Determination of their Boundaries ("Official Gazette of the Republic of Montenegro", No. 66/09),

| No. | GW Body | Springs (both, tapped and non-tapped) ($Q_{min}$/Q/$Q_{max}$) | Protection Zones[122] |
|---|---|---|---|
| **6** | Orjen | Risanska Spilja Spring ($Q_{min}$=0; $Q_{max}$=30 $m^3/s$); Sopot submarine spring; Smokovac Spring ($Q_{min}$=0.005 $m^3/s$); Matkova Voda, Sata, Subotića Vode, Džurina; Bljeljaj; Obodja Springs | Delineated for the water-sources: Risanska Spilja and Smokovac |
| **7** | Lovćen (Njeguši) | Plavda ($Q_{min}$=0.02 $m^3/s$), Gurdić ($Q_{min}$=0; $Q_{max}$=30 $m^3/s$), Škurda and Tabačina Springs ($Q_{min}$=0.1 $m^3/s$; $Q_{max}$=30 $m^3/s$), Ljuta ($Q_{min}$=0.1 $m^3/s$; $Q_{max}$=300 $m^3/s$), Cicanova Kuća Spring ($Q_{min}$=0.05 $m^3/s$), Spring in Tunnel Vrmac ($Q_{min}$=0.02 $m^3/s$) | Delineated for the water-sources: Plavda, Škurda and Tabačina, water sources Ercegovina and Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj |
| **8** | Orahovštica – Rijeka Crnojevića | Podgor ($Q_{min}$=0.237 $m^3/s$; Q=1.64 $m^3/s$; $Q_{max}$=11.9 $m^3/s$), Crnojevića spring ($Q_{min}$=1,12$m^3/s$; Q=6.15$m^3/s$; $Q_{max}$=12.26 $m^3/s$); Uganjska springs (Q=10-20 l/s); Obzovica Spring (Q=1 l/s) | Delineated for Podgor, Uganjska springs, Obzovica spring, water-source “Orahovsko Polje” and water-source “Sjenokos” |
| **9** | Karuč - Sinjac | **Springs of Karuč Bay**: Karuč, Volač, Đurovo Oko, Studenac, Radiševo Oko, Žabino Oko, Grivo Oko and Bazagurska Springs (total discharge: $Q_{min}$=2.5 $m^3/s$, Q=7 $m^3/s$, $Q_{max}$=25 $m^3/s$)<br>**Springs of Malo Blato**: Kaludjerovo Oko, Velja Šuica, Mala Šuica, Oko Krakala, Oko Bivo, Crno oko, Bolje Sestre, Oko Brodić, Biotsko oko, Oko Pod Bobovine and Krstato Oko (total discharge: $Q_{min}$=5 $m^3/s$, Q=12 $m^3/s$) | Delineated for water-source “Bolje Sestre” and “Župa Dobrska” |
| **10** | Zeta Valley | Springs of following streams: Plavnica, Zetica, Gostiljska River, Svinješ, Pjavnik, Velika Mrka, Mala Mrka, and many other nameless streams (total discharge is around 12 $m^3/s$ in average) | Delineated for the following water-sources: Ćemovsko polje, Zagorič, Tuzi, Dinoši, Vuksan Lekić |
| **11** | Prekornica - Bjelopavlići | Mareza (Qmin=1.6 $m^3/s$, Qav≈6 $m^3/s$; Qmax≈12 $m^3/s$), Kraljičino Oko Sprig (Qmin≈0.020 $m^3/s$; Qmax≈1 $m^3/s$), Crno Oko Spring, Vriješki Spring, Straganica springs, Iverak Spring (Qav≈0.012 $m^3/s$), Studeno Spring (Q≈0.001 $m^3/s$), Žarića Jama Spring (Qmin=0; Qmax≈1 $m^3/s$), Braovića Jama Spring, Slatina Springs (Qmin=0.015 $m^3/s$, Qav≈0.076 $m^3/s$; Qmax≈0.2 $m^3/s$), Smrdan Spring, Viški Springs | Delineated for water-sources “Mareza”, “Slatina”, “Iverak”. |
| **12** | Garač | **Springs of Tunjevo:** Milojevića Spring ($Q_{min}$=0.05 $m^3/s$, $Q_{max}$≈20 $m^3/s$), Dobrik Spring ($Q_{min}$=0.005 $m^3/s$, $Q_{max}$≈0.1 $m^3/s$), Tunjevo Srin<br>**Periodical springs along the Sušica River:** Oraška Jama, Šabovo Oko, Grgurovo Oko, Žablje Oko, Modro Oko (total discharge: $Q_{min}$= 0 $m^3/s$, $Q_{max}$≈10 $m^3/s$)<br>**Periodical springs of Bandići**: Vučiji Studenac, Modro Oko, Oko Kručice, Blizanci (total discharge: $Q_{min}$= 0 $m^3/s$, $Q_{max}$≈10 $m^3/s$)<br>**Orluina (Čevo) Spring** ($Q_{min}$=0.0005 $m^3/s$). | Delineated for water-sources “Oraška Jama” and “Milojevića Spring” |
| **13** | Vojnik | Upper Vidrovan Spring ($Q_{min}$= 0.2 $m^3/s$; Qmax≈10 $m^3/s$), Lower Vidrovan Spring ($Q_{min}$= 0.15 $m^3/s$; Qmax≈5 $m^3/s$), Vukov Spring ($Q_{min}$= 0.33 $m^3/s$), Zoja Spring, Rastovac Spring ($Q_{min}$= 0.2 $m^3/s$), Gornjepoljski Spring | Delineated for water-source “Vidrovan” |
| **14** | Nikšićko polje | Poklonci and Blaca Springs ($Q_{min}$=0.3 $m^3/s$), Studenački Spring ($Q_{min}$=0.05 $m^3/s$), Mrkošnica Spring, Krupačko Oko Spring ($Q_{min}$=0.13 $m^3/s$), Zminac and Žabica Springs ($Q_{min}$=0.1 $m^3/s$), Kusidska Springs, Slansko Oko Spring, Manito Oko Spring, Stružica and Krbanja Springs ($Q_{av}$=6.5 $m^3/s$), Bistrica Spring, Glibavačka Springs, Obošničko Oko Spring ($Q_{min}$=0.1 $m^3/s$), Glava Zete Spring ($Q_{min}$=3 $m^3/s$; | Delineated for water-source “Poklonci” |

| No. | GW Body | Springs (both, tapped and non-tapped) ($Q_{min}$/Q/$Q_{max}$) | Protection Zones[122] |
|---|---|---|---|
| | | Qmax=30 $m^3/s$), Svinjički Springs, Dobropoljski Springs ($Q_{min}$= 1 $m^3/s$; Qmax≈5 $m^3/s$) | |
| **15** | Trebišnjica (Bilećko Lake) | Zaslapnica Spring ($Q_{min}$ =54 l/s; $Q_{av}$=168 l/s; $Q_{max}$=1,381 l/s ); Crni Virovi; Zvjernica Spring; Bara Spring; Račevina Spring ($Q_{min}$ =20 l/s), Močila Spring, Korita Spring; Česmine, Nozdre Spring, Sige Spring, Mora Spring; Čarađe Spring ($Q_{min}$≈1 l/s); Mali Sopot; Veliki Sopot; Ogradenac Spring (territory of Montenegro); Trebišnjica Springs (Nikšić Springs and Dejanova Cave) ($Q_{min}$= 2$m^3/s$; $Q_{max}$> 800 $m^3/s$) (territory of Bosnia and Hercegovina) | Not delineated |
| **16** | Kuči | Ribnica Springs ($Q_{min}$≈0.001 $m^3/s$; $Q_{max}$≈100 $m^3/s$); Milješ Sring ($Q_{min}$= 0; $Q_{max}$≈2 $m^3/s$), Krvenica Spring ($Q_{min}$= 0; $Q_{max}$≈10 $m^3/s$; Vitoja Spring ($Q_{min}$≈0.01); Traboin Springs ($Q_{min}$≈0.002; $Q_{max}$≈0.1 $m^3/s$); Fundina Springs ($Q_{min}$≈0.002 $m^3/s$); Springs in canyon of Cijevna River; Springs in canyon of Mala River | Delineated for water-sources "Milješ" and "Bioče" |
| **17** | Morača | Bijeli Nerini Srings ($Q_{min}$= 0.5 $m^3/s$), Svetigora Spring (Monastery Morača), Springs under Vjetrina, Lanjevik Spring, Spring at Piletića household, Bešića Spring, Smokovac Spring, Kaludjer Spring, Bare Spring, Simov Spring | Protection zones are not delineated (there are no tapped water-sources). |

## Figure 5.1 Sanitary protection zones delineated around GW sources in Montenegro



## 5.3 Areas designated for the protection of economically significant aquatic species

There are no specific laws or policies dealing solely with surface water protected areas related to economically significant species in Montenegro. Instead, the main laws and strategic documents that apply for Protected Areas in general also apply for mentioned areas.

The Law on freshwater fishing ("Official Gazette of Montenegro", No. 11/2007) provides for restriction, control and monitoring of different categories of fisheries in Montenegro.

The Law on freshwater fishing together with the by-law[129] prescribes the protected fishing areas. These are the areas where fishing is not allowed for a limited time – and sometimes forever – in order to protect water sources or the water ecosystems.

Article 6 of the Law on Marine Fisheries and Aquaculture refer to the protection of the marine environment and of each resource: "Fish and other marine organisms, as well as marine biodiversity, shall be protected from threat to their vital environment and overexploitation."

## 5.4 Bodies of Water Designated as Recreational and Bathing Waters

The Law on Waters and by-law[130] defines that waters that can be used for bathing. Those are all surface and coastal seawater that are specifically intended or used for bathing and waters where no permanent bathing prohibition has been issued or a permanent anti-bathing recommendation.

Waters that can be used for bathing are classified in two classes: class K1 - excellent and class K2 - satisfactory.

Generally, largest number beaches are in the coast of Adriatic Sea.

The Law on Public Maritime Domain[131] regulates the management of the narrow coastal strip designated as public maritime domain, its use, improvement and protection. These jobs are performed by the Public Enterprise for the Management of Maritime Property.

The plan of objects of temporary character in the zone of the sea property, adopted by the Ministry of Sustainable Development and Tourism, defines the locations where organized and constructed bathing places are organized in accordance with the Ordinance on conditions to be fulfilled by the arranged and built swimming pools ("Official Gazette of the Republic of Montenegro", No. 20/08, 20/09, 25/09, 4/10, 61 / 10, 26/11). Currently, there are 361 bathing locations on the coast of the Adriatic Sea from Herceg Novi to Ulcinj.

[129] Order on fishing restrictions, restrictions and measures for the protection of fish stock, No.325-48/15-6 , April 15, 2015.

[130] Decree on the classification and categorization of surface and groundwater ("Official Gazette of Montenegro", No. 2/07)

[131] "Official Gazette of the Republic of Montenegro", No. 014/92, 059/92, 027/94, Official Gazette of Montenegro ", No. 051/08, 021/09, 073/10, 040/11

## 5.5 Nutrient sensitive areas

Montenegro has not transposed the Nitrate Directive. Thus, there is not a specific law that regulates protection of water resources from nitrates. Instead, various laws refer to pollution from nitrates, either directly or indirectly, as is the case of the Law on organic production (Official Gazette of Montenegro, No. 56/2013).

As to wastewater discharge sensitive areas in accordance with Article 74b of the Law on Waters, a Decision on the determination of sensitive areas in the Adriatic and Adriatic River Basins (("Official Gazette of Montenegro", No. 46/17) has been made.

Sensitive areas in the Adriatic River Basin are areas that are eutrophic or susceptible to eutrophication, sources of drinking water and other protected areas.

Sensitive areas in the Adriatic basin are:

1. Zeta River with tributaries and reservoirs: Liverovici, Krupac, Vrtac and Slano;
2. Captain's lake and river Morača with tributaries;
3. Basin of the Skadar Lake with tributaries other than Morača;
4. Basin of the river Bojana;
5. Watersheds that flow directly into the Adriatic Sea, except the Bojana River, including:
    - the accumulation of Grahovo, the area intended for catching drinking water, the area of the National Park Lovćen and the nature reserve Solila,
    - Bay of Kotor, and offshore seawater to the boundary line from which the breadth of territorial waters is measured

Montenegro has planned to identify nitrate vulnerable zones (NVZ) in the Adriatic River Basin between 2019 and 2020[132].

Article 5 of the Nitrates Directive requires the establishment of action programmes within two years of NVZ designation (or one year after additional designation) and implemented within four years of their establishment.

Action programmes shall consider:

- Available scientific and technical data, mainly with reference to respective nitrogen contributions originating from agricultural and other sources;
- Environmental conditions in the Adriatic River Basin.

Action programmes shall consist of the following mandatory measures:

- The measures in Annex III of the Nitrate Directive (summarized below);
- Those measures will be prescribed in the code(s) of good agricultural practice (Article 4) (unless superseded by the measures in Annex III of the Nitrate Directive).

Additional measures may also be considered necessary if it is apparent that the measures will not be sufficient for achieving the objectives of the Nitrate Directive. In selecting these measures or actions,

[132] EU Project starting in 2019. 'Support to implementation and monitoring of water management'. EuropeAid/139429/IH/SER/ME

consideration will be given to their effectiveness and their cost relative to other possible preventive measures. A suitable monitoring programmes will also be established.

Measures that will be Included in Action Programme (Annex III of the Nitrate Directive):

- Periods when the land application of certain types of fertilizer is prohibited;
- The capacity of storage vessels for livestock manure, which must exceed that required for storage throughout the longest period during which land application in the NVZ is prohibited (unless demonstrated manure in excess of the actual storage capacity will be disposed of in a manner which will not cause harm to the environment);
- Limitation of the land application of fertilizers, consistent with good agricultural practice and taking into account the characteristics of the NVZ, in particular:
  - Soil conditions, soil type and slope;
  - Climatic conditions, rainfall and irrigation;
  - Land use and agricultural practices, including crop rotation systems; and to be based on a balance between:
  - The foreseeable nitrogen requirements of the crops,
  - The nitrogen supply to the crops from the soil and from fertilization corresponding to:
  - The amount of nitrogen present in the soil at the moment when the crop starts to use it to a significant degree (outstanding amounts at the end of winter),
  - The supply of nitrogen through the net mineralization of the reserves of organic nitrogen in the soil,
  - Additions of nitrogen compounds from livestock manure,
  - Additions of nitrogen compounds from chemical and other fertilizers.

These measures will ensure that, for each farm or livestock unit, the amount of livestock manure applied to the land each year, including by the animals themselves, shall not exceed a specified amount per hectare, i.e. 170 kg N.

## 5.6 Areas designated for the protection of habitats or species

The strategic framework for the protection of biodiversity was developed including:

- The National Strategy on Sustainable Development
- The Spatial Plan of Montenegro 2020
- The National Biodiversity Strategy and Action Plan 2010-2015
- The Special Purpose Spatial Plan for the Public Maritime Domain

Apart from strategic framework, two major legal acts govern the proclamation and management of Protected Areas in the Adriatic River Basin:

- The Law on Nature Protection
- The Law on National Parks
- The Law on Public Maritime Domain.

The Law on Nature Protection was adopted in August 2008 (Official Gazette of Montenegro No. 51/08) aiming to transpose the key EU legislation in this area, such as Habitats and Birds Directives. It had several subsequent changes and amendments, the last one in December 2013.

The main goal for adoption of changes and amendments of the Law was to prescribe procedures for designation of protected areas (including a requirement for designation of managers for each category,) and to improve a legal basis for establishment of Natura 2000 network (chapter III, articles 30-34). Provisions on landscape protection and public participation (article 109) were also included in the Law.

According to the Law on Nature Protection[133], protected areas are “sites with significant biological, geological, ecosystem and landscape diversity”. Types, categories and regimes of protection (zoning) of protected areas are given in the Law on Nature Protection, chapters IV and V, related to Protected Natural Resources (articles 35-47) and Category and Regimes of Protection for protected areas (articles 48-54) respectively.

Six basic types of protected natural areas are defined in the Adriatic River Basin:

- Strict and special nature reserves
- National park
- Natural monument
- Regional park and nature park
- Protected habitat
- Area of exceptional quality.

The Law states that the categorization of protected areas shall be based on the following criteria:

- The essential traits of a protected natural asset:
- Function and importance of protected area:
- The threat to the protected area.

Furthermore, protected areas are sorted in the following 3 categories:

**Category I** – protected area of extraordinary importance: includes protected natural assets having one or more of the following features of exceptional importance for Montenegro:

- Authenticity from the point of view of fundamental natural sciences;
- Being representative in the sense of being relict, endemic, unique within its species;
- Diversity of natural occurrences and phenomena, richness of types and ecological processes;
- Integrity of habitats, ecosystems, landscapes, biomes and ecological processes;
- landscape values in the sense of its attractiveness with a specific disposition of ecosystems, communities and species, aesthetical, cultural, educational and historic value;
- Sites with endangered species or communities under the minimum for regeneration, rapid range decrease and disturbance in the ecosystem.

**Category II** - protected areas of great importance includes protected natural assets having one or more of the following features of great importance for Montenegro:

- Authenticity from the point of view of fundamental sciences and applied biotechnical disciplines;
- State of being endangered, decreasing in range or having reduced numbers of individuals or communities, ecosystem disturbance, and others;

[133] Law on Nature Protection ("Official Gazette of Montenegro", No. 54/16)

- Natural phenomenon or habitat of species with representative features at the level of regional geographic units;
- Attractive landscape features and cultural and historic values;
- Areas of exceptional importance for the conservation quality of the environment as well as the climate conservation and regulation.

**Category III** – includes significant protected areas that are not classified into categories I and II. Article 54 related to protection zones regulates the matter in the following way:

- **Protection regime of first degree** - strict protection is carried out in a protected natural asset with exceptional ecological significance or its part with slightly altered characteristics, by which natural biological processes, preservation of the integrity of habitats and living communities and extremely valuable cultural assets are enabled.

- **Protection regime of second degree** - the active protection is carried out in a protected natural asset with partially altered properties of natural habitats, but not to levels that threaten their functional and ecological significance, including valuable lands.

- **Protection Regime of third degree** - sustainable use is carried out in a protected natural asset or part of it with partially modified and / or altered habitat characteristics that enable a functioning ecological connectivity and integrity of protected natural resource.

In accordance with the provisions of the Law on Environment ("Official Gazette of Montenegro" No. 52/16), while respecting internationally accepted standards and obligations, the Agency for the Protection of Nature and Environment establishes and maintains an information system of the environment with integral part of the biodiversity, protection of Nature. Also, pursuant to the Law on Nature Protection ("Official Gazette of Montenegro", No. 54/16), the Agency is obliged to establish and maintain a Register of protected areas and areas under preventive protection.

In the period January-May 2017, activities on the establishment of the web portal "National Protected Areas" are realized.[134] The web portal consists of a map of national protected areas, databases and documents for each protected area with the aim of providing accurate and reliable data on national protected areas in Montenegro.

The number of species per area unit (or Simpsons Index of Diversity) in Montenegro is 0.837 (1 being the highest value possible) and is the highest recorded in all European countries.

The Adriatic River Basin has internationally recognized sites - two Ramsar sites and one UNESCO site. The Ramsar sites are: Special Flora and Fauna Reserve Tivat Saline (Tivatska solilaenlisted as a Ramsar site in 2013) located in the coastal strip of Tivat Bay between the rivers Odoljenštica and Koložunja, and the Montenegrin portion of Lake Skadar (Ramsar site since 2006). The UNESCO site of Kotor-Risan bay has been on the World Natural and Cultural Heritage list since 1979.

[134] http://prirodainfo.me

The national efforts for conservation of biodiversity and natural assets resulted in the designation of several Protected Areas under successive nature protection laws. The Adriatic River Basins two national parks at Skadar Lake and Lovcen, are the most important areas. The other protected areas, fall under the categories of strict nature reserves (3), special nature reserves (1), regional parks/nature parks (1), natural monuments (53) and areas of exception quality (2). Table 5.3 provides a summary of all the register of Protected Areas relevant from the aspect of habitat and species conservation in the Adriatic River Basin.

## Table 5.3 The register of Protected Areas relevant from the aspect of habitat and species conservation in the Adriatic River Basin

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Strict Nature Reserves** | | | | | | | | | | | | | | | |
| **1** | Ia | Manastirska tapija | - | Decision 01-959 Official Gaz. SRCG no. 30/68 | 28/12/ 1968 | Skadar lake Capital Podgorica | 120.00 | 42.286363 | 19.159001 | 6 | No | | | | |
| **2** | Ia | Panceva oka kod Huma | MNE0128 12196834 | Decision 01-959 Official Gaz. SRCG no. 30/68 | 28/12/ 1968 | Skadar lake Municipality of Bar | 300.00 | 42.285855 | 19.335469 | | No | | | | |
| **3** | Ia | Skadar lake Spawning fish | MNE0122 06196512 | Decision 01-358 / 1 to 9 | 22/06/ 1965 | Skadar lake Municipality of Bar | | 42.207683 | 19.183923 | | No | | | | |
| **2. National Park (NP)** | | | | | | | | | | | | | | | |
| **1** | II | Lovćen | MNE0220 0819521 | Official Gaz. NRCG 16-17/1952 | 20/08/ 1952 | Municipalities of Cetinje, Budva, Kotor | 6220.00 | 42.40589 | 18.840717 | 1749 (max) | Yes[137] | | Yes 6259.00 ha | | Yes 6267.00 ha |
| **2** | II | Skadarsko jezero | MNE0220 08198374 | Official Gaz. SRCG br. 33/83 | 25/11/ 1983 | Municipalities of Podgorica, Bar and Cetinje | 40000.00 | 42.2487531 | 19.2095489 | 5 | Yes [138] | | Yes 38388.00 ha | Yes from 15/12/ 1995 20000. 00 ha | Yes 38388.00 ha |

[135] Management Plan or Study of protection

[136] IPA - Important plant area

[137] Management plan of NP Lovćen from 2016 to 2020

[138] Management plan of the NP Skadar Lake from 2016 to 2020.

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3. Special Nature Reserves** | | | | | | | | | | | | | | | |
| **1** | | Tivatska solila | MNE0312 11200810 62 | Official Gaz. MNE 70/08 | 12/11/ 2008 | Coastal area-Municipality of Tivat | 150.00 | 42.395646 | 18.709705 | 0 | Yes[139] | | Yes 240.00 ha | Yes from 30/01/ 2013 150.00 ha | |
| **4. Regional Park and Nature Park** | | | | | | | | | | | | | | | |
| **1** | | Orjen | | | | Municipality of Herceg Novi | | | | | | | | | |
| **2** | | Lower reaches of the Zeta River | | | 5 December 2019 | Municipality of Danilovgrad | | | | | | | | | |
| **5. Natural Monument** | | | | | | | | | | | | | | | |
| **1** | III | Arboretum | MNE0522 05200010 63 | Decision 01 - 574 | 22/05/ 2000 | Municipality of Nikšić - Grahovu | 0.99 | 42.656886 | 18.663055 | 690 | Yes[140] | | | | |
| **2** | III | Hill Spas | MNE0528 12196833 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 131.00 | 42.281621 | 18.826823 | 50 - 385 | Yes [141] | | Yes 131.00 ha | | |
| **3** | III | Park of Njegoš | MNE0507 0519654 | Decision 01-298 | 07/05/ 1965 | Municipality of Cetinje | 4.20 | 42.386071 | 18.925247 | 670 | No | | | | |
| **4** | III | Park 13 jul | MNE0528 0419656 | Decision 01-300 | 28/04/ 1965 | Municipality of Cetinje | 3.63 | 42.386348 | 18.927978 | 670 | No | | | | |
| **5** | III | Park in the yard of a | MNE0507 0519657 | Decision 01-296 | 07/05/ 1965 | Municipality of Cetinje | 0.34 | 42.389302 | 18.927774 | 670 | No | | | | |

[139] DOSSIER of the protected area Solila

[140] DOSSIER of the Arboretum

[141] Study of protection hill Spas

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | children's hospital | | | | | | | | | | | | | |
| 6 | III | Green areas | MNE0528 08196510 6 | Decision 01-500/1 | 28/08/ 1965 | Municipality of Herceg Novi | 0.32 | | | | No | | | | |
| 7 | III | Gornjepoljs ki vir | MNE0509 07201462 | Official Gaz. MNE municipal regulations 20/14 | 09/07/ 2014 | Municipality of Nikšić | 2.21 | 42.846174 | 18.917448 | | Yes [142] | | | | |
| 8 | III | Park and museum building | MNE0528 0419659 | Decision 01-301 | 28/04/ 1965 | Municipality of Herceg Novi | 1.00 | 42.453568 | 18.527438 | | No | | | | |
| 9 | III | Park hotel "Boka" | MNE0528 0419655 | Decision 01-299 | 28/04/ 1965 | Municipality of Herceg Novi | 1.20 | 42.45213 | 18.533021 | | No | | | | |
| 10 | III | Big city park | MNE0528 12196836 | Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Tivat | 5.91 | 42.26 | 18.41483 | 3-24 | Yes[143] | | | | |
| 11 | III | Beach Becici | MNE0528 12196827 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 5.00 | 42.281164 | 18.871111 | 0 | Yes[144] | | | | |
| 12 | III | Beech Drobni pijesak | MNE0528 12196825 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 1.00 | 42.234538 | 18.902337 | 0 | No | | | | |
| 13 | III | Beach Jaz | MNE0528 12196830 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 4.00 | 42.28281 | 18.803149 | 0 | Yes[145] | | | | |
| 14 | III | Beach Lucice | MNE0528 12196823 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva-Petrovac | 0.90 | 42.200725 | 18.950591 | 0 | No | | | | |

[142] Study of protection of Gornjepoljski vir

[143] Management plan for the Big City Park

[144] Study of protection of Becici beach

[145] Study of protection of Jaz beach

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **15** | III | Beach Mogren | MNE0528 12196829 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva-Petrovac | 2.00 | 42.277089 | 18.832393 | 0 | No | | | | |
| **16** | III | Beach Petrovac | MNE0528 12196824 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva-Petrovac | 1.50 | 42.205583 | 18.940734 | 0 | Yes[146] | | | | |
| **17** | III | Beach Przno | MNE0528 12196831 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Tivat | 2.00 | 42.385967 | 18.682726 | 0 | No | | | | |
| **18** | III | Beach Sveti Stefana i Miločer | MNE0528 12196826 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 5.00 | 42.256307 | 18.893489 | 0 | No | | | | |
| **19** | III | Slovenska Plaža | MNE0528 12196828 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 4.00 | 42.284884 | 18.846357 | 0 | Yes[147] | | | | |
| **20** | III | Small beach | MNE0528 12196814 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj | 1.50 | 41.92367 | 19.204831 | 0 | No | | | | |
| **21** | III | Old Ulcinj (island and beach) | MNE0528 12196816 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj | 2.50 | 41.992595 | 19.139546 | 0 | No | | | | |
| **22** | III | Park of Museum on Topolici | MNE0528 12196835 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 2.00 | 42.100705 | 19.091974 | 0 | No | | | | |
| **23** | III | Beach Buljarica | MNE0528 12196822 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Budva | 4.00 | 42.193018 | 18.965651 | 0 | No | | Yes 156.00 ha | | Yes 156.00 ha |
| **24** | III | Beach Canj | MNE0528 12196820 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 3.50 | 42.160047 | 19.00079 | 0 | No | | | | |

[146] Study of protection of Petrovac beach

[147] Study of protection of Slovenska beach

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **25** | III | Beach Pecin | MNE0528 12196821 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 1.50 | 42.164199 | 18.988044 | 0 | No | | Yes 15.30 ha | | |
| **26** | III | Beach Sutomore | MNE0528 12196819 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 4.00 | 42.136387 | 19.055702 | 0 | Yes[148] | | | | |
| **27** | III | Beach Topolica | MNE0528 12196818 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 2.00 | 42.10225 | 19.088981 | 0 | No | | | | |
| **28** | III | Beach Valdanos | MNE0528 12196815 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 3.00 | 41.951418 | 19.165432 | 0 | No | | | | |
| **29** | III | Lovers and oleander above the Sopot spring near Risen | MNE0528 12196840 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Kotor | 40.00 | 42.516903 | 18.685146 | | No | | | | |
| **30** | III | Quercus pubescens | MNE0502 8126838 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Kotor-Donji Orahovac | 0 | | | | No | | | | |
| **31** | III | Quercus ilex | MNE0502 8126837 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar - on the Black Cape near Sutomore | 0 | | | | No | | | | |
| **32** | III | Beach Great sand | MNE0528 12196817 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 0.50 | 42.034725 | 19.142636 | 0 | No | | | | |
| **33** | III | Ratac peninsula | MNE0528 12196832 | Decision 01-959 | 28/12/ 1968 | Municipality of Bar | 30.00 | 42.122502 | 19.061231 | | Yes[149] | | | | |

[148] Study of protection of Sutomore beach

[149] Study of protection of Ratac peninsula

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Official Gaz. SRCG 30/68 | | | | | | | | | | | |
| **34** | III | Great Beach | MNE0528 12196813 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj | 600.00 | 41.8935 | 19.291745 | 0 | No | | Yes Great beach with Solana 2835.00 ha | | Yes Great beach and Ada Bojana 1014.00 ha |
| **35** | III | Cave Duboki Do | MNE0528 12196850 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Cetinje - Njegusi | 0 | 42.494883 | 18.810633 | 868 | No | | | | |
| **36** | III | Lipska cave | MNE0528 12196845 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Cetinje | 0 | 42.3670479 | 18.9509026 | | No | | | | |
| **37** | III | Globočica cave | MNE0528 12196847 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 0 | 42.287367 | 19.035383 | | No | | | | |
| **38** | III | Babatuša cave | MNE0528 12196848 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar | 0 | 42.292975 | 19.034425 | | No | | | | |
| **39** | III | Magara cave | MNE0528 12196846 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of podgorica | 0 | 42.458767 | 19.203037 | | No | | | | |
| **40** | III | Cave near Trnovo | MNE0528 12196849 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar - Virpazar | 0 | 42.291983 | 19.034433 | | No | | | | |
| **41** | III | Quercus ilex | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Bar - Sutomore | 0 | | | | No | | | | |
| **42** | III | Olive | MNE0502 06199421 2 | Decision 01-101 Official Gaz. RCG 20/94 | 02/06/ 1994 | Municipality of Budva | 0 | | | | No | | | | |

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **43** | III | Quercus ilex | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Herceg Novi- Ilinjica | 0 | | | | No | | | | |
| **44** | III | Quercus ilex | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Herceg Novi- Savinr | 0 | | | | No | | | | |
| **45** | III | Quercus pubescens | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Kotor | 0 | 42.419206 | 18.740632 | 173 | No | | | | |
| **46** | III | Quercus pubescens | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Podgorica- Vranje | 0 | | | | No | | | | |
| **47** | III | Quercus ilex | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj- Komina | 0 | | | | No | | | | |
| **48** | III | Quercus ilex | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj- Liman | 0 | | | | No | | | | |
| **49** | III | Quercus pubescens | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj- Kruti | 0 | | | | No | | | | |
| **50** | III | Quercus pubescens | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj, Zoganja | 0 | | | | No | | | | |
| **51** | III | Quercus pubescens | MNE0502 8126839 | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj, below the hotel Jadran | 0 | | | | No | | | | |
| **52** | III | Quercus pubescens | | Decision 01-959 Official Gaz. SRCG 30/68 | 28/12/ 1968 | Municipality of Ulcinj, Meterizima | 0 | | | | No | | | | |

| No. | Cat. | Name | National code | Act of Proclamation | Approval Date | Region | Surf (ha) | Central coordin. X | Central coordin. y | Elev. m | MP/ SP[135] | UNESCO Heritage | EMERALD Network | RAMSAR | IPA[136] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **53** | III | Canyon of Cijevna River Canyon | MNE0521 12201764 | Official Gaz. MNE municipal regulations 053/17 | 25/12/ 2017 | Capital city - Podgorica | 2022.20 | 42.400766 | 19.36576 | | Yes[150] | | | | |
| **6. Areas of Exceptional Quality** | | | | | | | | | | | | | | | |
| **1** | V | Savinska Dubrava | MNE0622 05196821 4 | Decision 01-307 | 22/05/ 1968 | Municipality of Herceg Novi | 37.05 | 6545631.44 | 4701198.44 | 107.8 0 (max) | Yes[151] | | | | |
| **2** | V | Trebjesa | MNE0622 01200121 5 | Official Gaz. MNE municipal regulations 1/2001 | 22/01/ 2001 | Municipality of Nikšić | 159.00 | | | 752 (max) | Yes[152] | | | | Yes 126.00 ha |

[150] N/A

[151] Study of protection of Savinska Dubrava

[152] N/A

### 5.6.1 Surface Waters in Protected Areas

Figures 5.2 and 5.3 illustrate the registered protected areas and the proposed EMERALD[153] network in the Adriatic River Basin, respectively.

It is critical to the RBMP that nature legislation is taken into account when applying protection to both surface and groundwaters. If there are any exemptions proposed from the WFD environmental objectives (see Section 9), they cannot be used to deviate from objectives and obligations set by other pieces of EU legislation, e.g. if a new development is proposed that would cause deterioration of status and a failure to achieve the objectives for a Natura 2000 site. In such a case, in order to fulfil both the WFD and the Habitats Directive: (i) The relevant conditions set out in Article 4.7 of the WFD for allowing deterioration of status would have to be met to the extent that it is a water body; and (ii) The conditions set out in Article 6 of the Habitats Directive (92/43/EEC) for allowing a failure to achieve a Natura 2000 site's objective would have to be met.

The WFD also ensures that the standards and objectives for protected areas are distinct from status objectives. Measures to meet protected area objectives may be focused within, but not necessarily restricted to, those protected areas. Measures to meet the status objectives are applied, as necessary, over the whole groundwater body. Article 4(2) of the WFD, states that where more than one objective applies to a water body, the most stringent objective shall apply. Within a protected area the most stringent of the protected area and, for example, the status objective would apply. However, even if it were more stringent, a protected area objective should not apply outside the designated protected area.

Figures 5.4 and 5.5 highlight the relationship between the surface water bodies and protected areas and the proposed the EMERALD network, respectively. Table 5.4 shows the surface water bodies that are in the registered protected areas. A total of only 6 out of 41 surface water bodies are present in the protected areas. 4 of the SWBs belong to Skadar Lake, one is Malo Blato Lake and the other is the Morača_7.

In line with the proposed EMERALD network, Table 5.5 provides the names of the surface water bodies that will require more stringent objectives in order to meet the requirements of the Habitats Directive (92/43/EEC), which is the cornerstone of Europe's nature conservation policy with the Birds Directive (2009/147/EC) and establishes the EU wide Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments.

In the event of the proposed EMERALD network being approved, the number of surface water bodies that require a higher level of protection would increase to 13 (31.7% of all SWBs). It should be borne in mind that the designation of the EMERALD network to encompass the rivers of Crmnička Rijeka, Mrtvica, Nožica, Mala Rijeka and Cijevna will result in need for surface water bodies to reach a ‘high’ level status, which is possible without incurring excessive and disproportionate costs. In the case of the Cijevna River, protection at a ‘high status’ would ultimately help prevent river status deterioration, which is likely to be caused in the future from upstream hydropower schemes in Albania.

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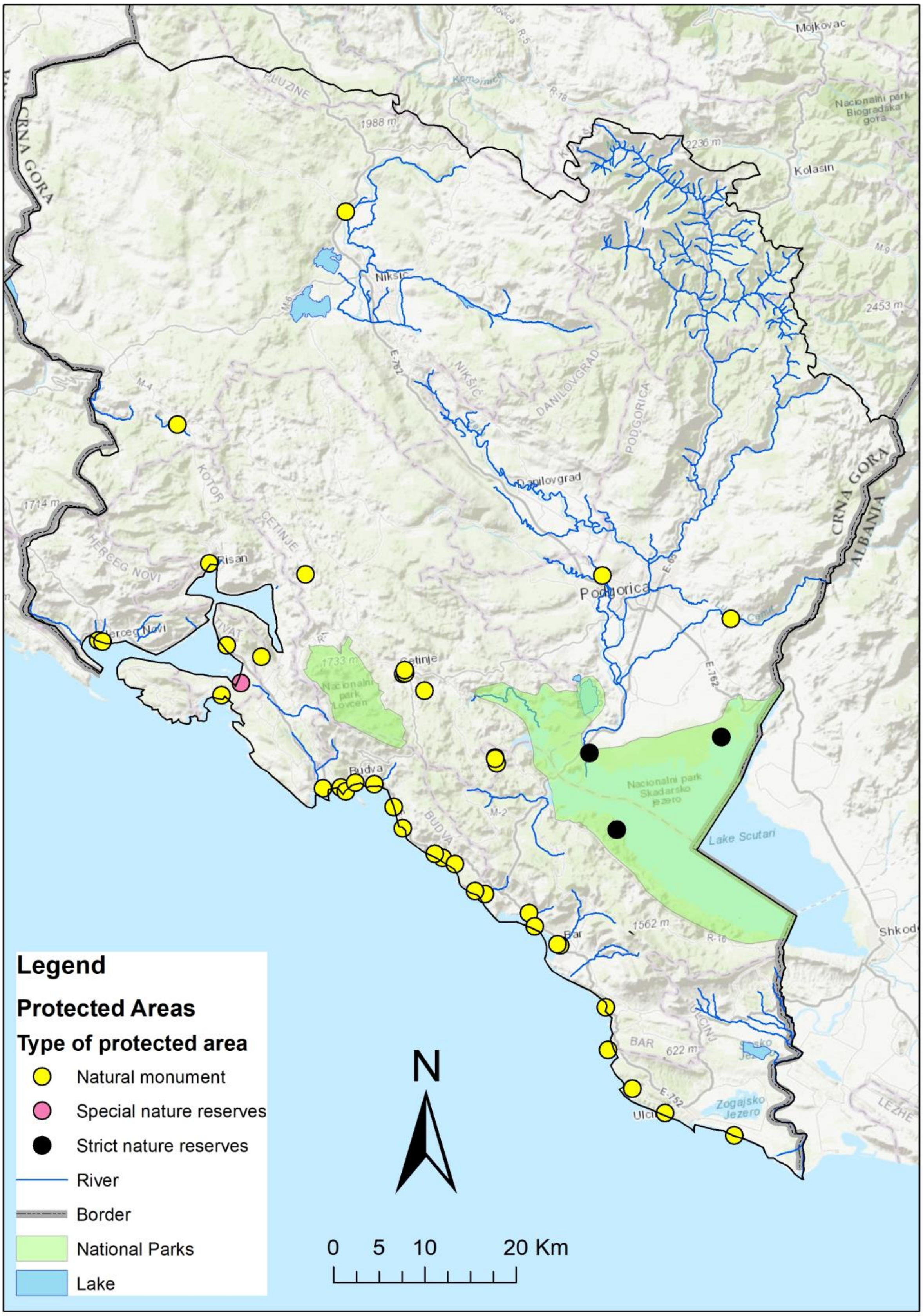
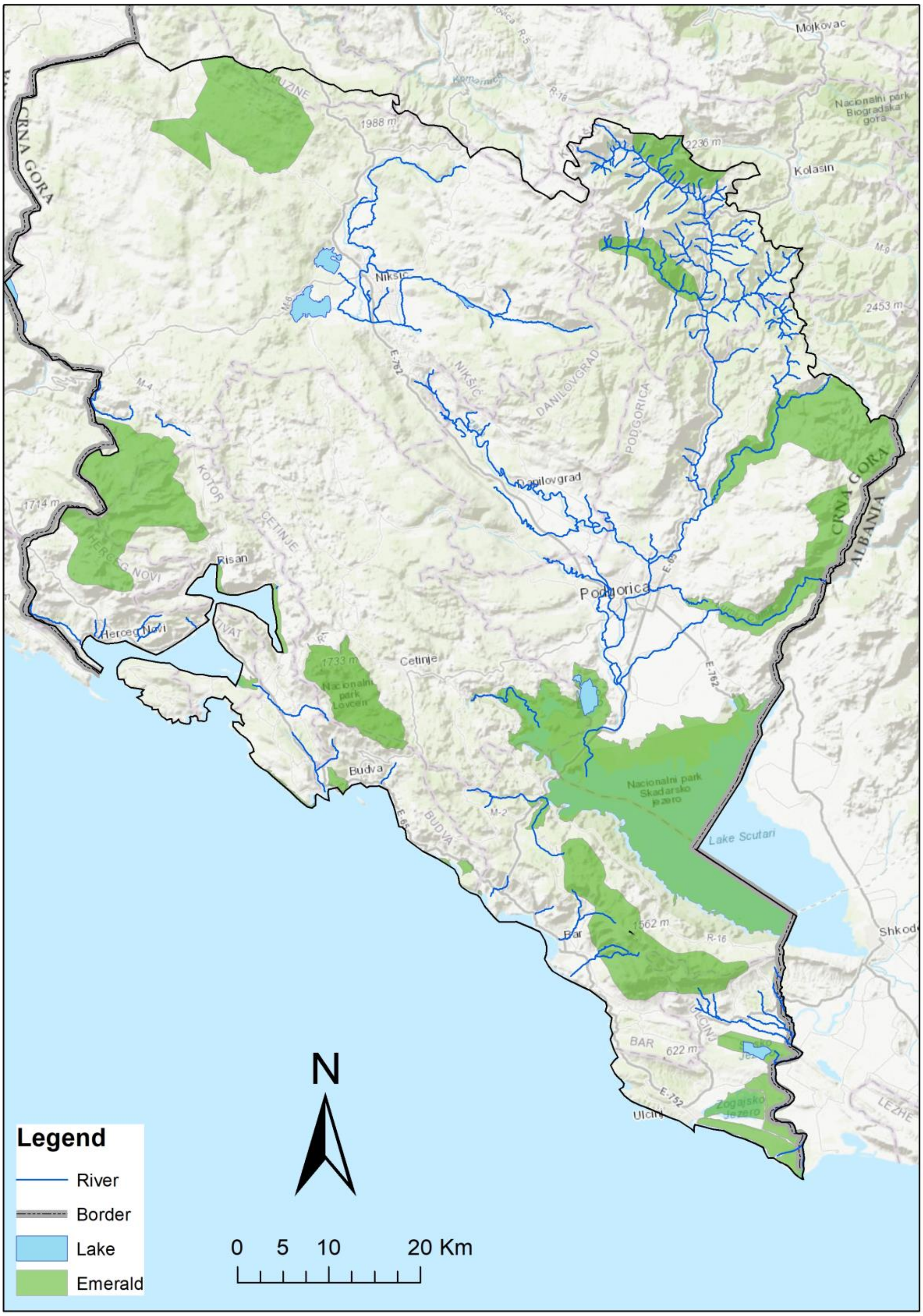
[153] The adherence to the prinicples governing the proposed EMERALD network sites is not currently officially recognised in Montenegro in the legal statutes.

## Figure 5.2 Registered Protected Areas in the Adriatic River Basin



## Figure 5.3 Proposed EMERALD Network and in the Adriatic River Basin



## Figure 5.4 The relationship between the surface water bodies and the registered protected areas in the Adriatic River Basin

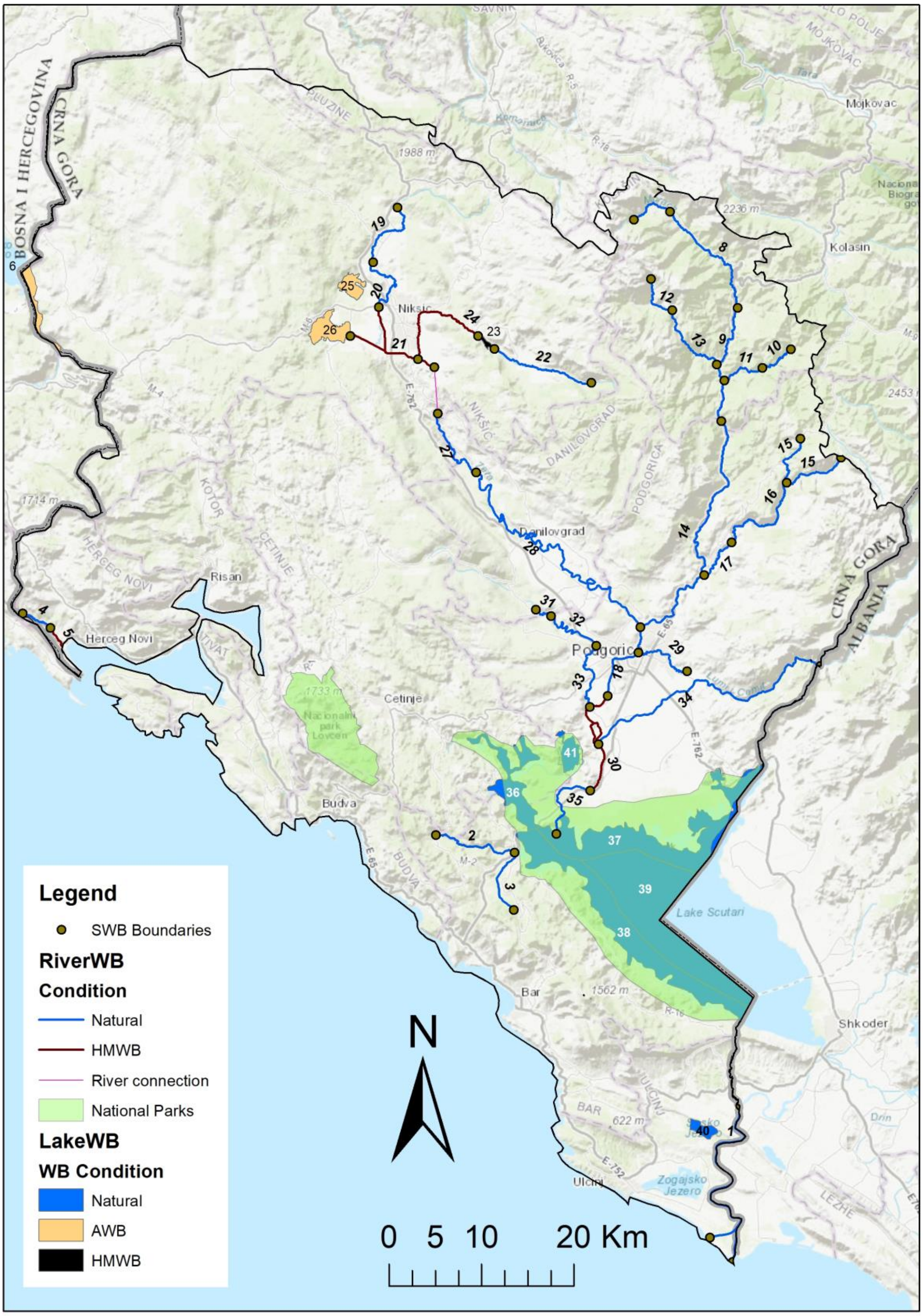
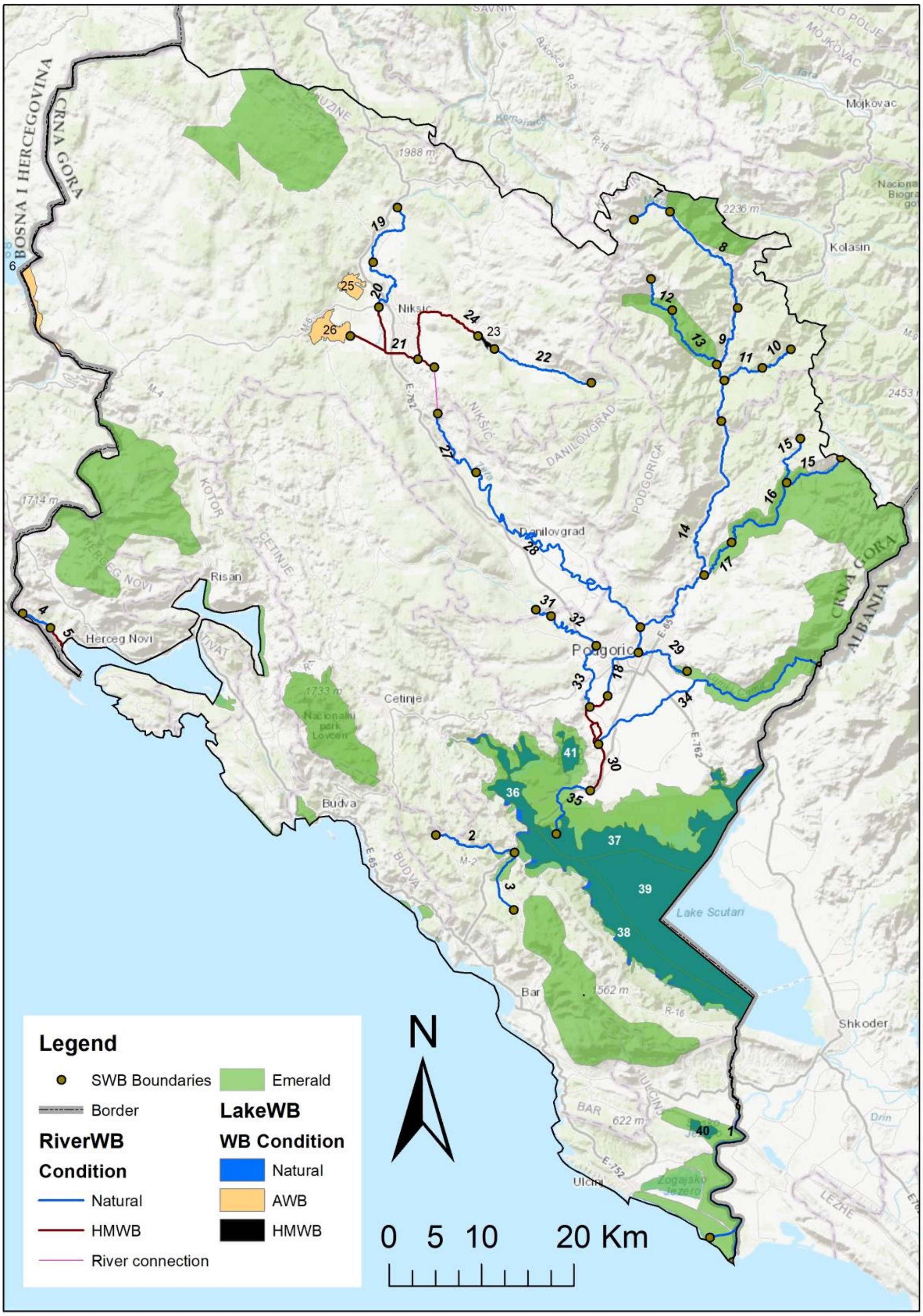


**Figure 5.5 The relationship between the surface water bodies and the proposed EMERALD Network in the Adriatic River Basin**



### Table 5.4 Surface water bodies that are within the protected areas in the Adriatic River Basin

| Municipality | Sub-Basin | SWB No. | Surface Water Bodies In Registered Protected Areas | Judged to be at Risk[154] |
|---|---|---|---|---|
| Podgorica | Skadar | 35 | Morača_7 | Possibly at risk |
| Cetinje/ Bar | Skadar | 36 | WB1_Vucko blato | Likely not at risk |
| Tuzi/ Podgorica | Skadar | 37 | WB 2_North | Possibly at risk |
| Bar/ Cetinje | Skadar | 38 | W3_South west | Likely not at risk |
| - | Skadar | 39 | W4_Pelagic zone | Likely not at risk |
| Cetinje/ Podgorica | Skadar | 41 | Malo Blato Lake | Likely not at risk |

### Table 5.5 Surface water bodies that are within the protected areas and the proposed EMERALD network in the Adriatic River Basin

| Municipality | Sub-Basin | SWB No. | Surface Water Bodies In Proposed EMERALD network | Judged to be at Risk[155] |
|---|---|---|---|---|
| Bar | Skadar | 3 | Crmnička rijeka | Possibly at risk |
| Kolasin | Morača | 12 | Mrtvica_1 | Likely not at risk |
| Kolasin | Morača | 13 | Mrtvica_2 | Likely not at risk |
| Podgorica | Morača | 15 | Nožica | Likely not at risk |
| Podgorica | Morača | 16 | Mala Rijeka_1 | Likely not at risk |
| Podgorica | Morača | 17 | Mala Rijeka_1 | Likely not at risk |
| Tuzi/ Podgorica | Skadar | 34 | Cijevna | Possibly at risk |
| Podgorica | Skadar | 35 | Morača_7 | Possibly at risk |
| Cetinje/ Bar | Skadar | 36 | WB1_Vucko blato | Likely not at risk |
| Tuzi/ Podgorica | Skadar | 37 | WB 2_North | Possibly at risk |
| Bar/Cetinje | Skadar | 38 | W3_South west | Likely not at risk |
| - | Skadar | 39 | W4_Pelagic zone | Likely not at risk |
| Cetinje/ Podgorica | Skadar | 41 | Malo Blato Lake | Likely not at risk |

[154] See Section 6 for the full assessment of surface water bodies in terms of risk

[155] See Section 6 for the full assessment of surface water bodies in terms of risk

### 5.6.2 Karstic Springs in Protected Areas

Figures 5.6 and 5.7 show the relationship between the groundwater bodies and groundwater springs in the areas inside the registered protected areas those that would be in the proposed EMERALD Network, respectively.

Table 5.6 shows the names of 6 Karstic springs inside of the registered protected areas. Table 5.7 provides the names of 14 karstic springs that are located inside the proposed EMERALD network.

**Table 5.6 Karstic springs within the designated protected areas and in the Adriatic River Basin**

| No.[156] | Karstic Springs | Groundwater Body |
|---|---|---|
| 18 | Krnjice | Southern Rim of the Skadar Lake |
| 19 | Raduš | Southern Rim of the Skadar Lake |
| 22 | Crnojevića Spring | Orahovštica – Rijeka Crnojevića |
| 23 | Karuč springs | Karuč - Sinjac |
| 24 | Bolje Sestre | Karuč - Sinjac |
| 25 | Vitoja springs | Kuči |

**Table 5.7 Karstic springs within the proposed EMERALD network in the Adriatic River Basin**

| No. | Karstic Springs | Groundwater Body |
|---|---|---|
| 3 | Klezna | Ulcinjsko polje |
| 4 | Kaliman | Možura - Paštrovići |
| 6 | Kajnak | Možura - Paštrovići |
| 10 | Škurda | Lovćen (Njeguši) |
| 11 | Ljuta | Lovćen (Njeguši) |
| 14 | Sopot springs | Orjen |
| 15 | Morinj | Opačica - Morinj |
| 18 | Krnjice | Southern Rim of the Skadar Lake |
| 19 | Raduš | Southern Rim of the Skadar Lake |
| 22 | Crnojevića Spring | Orahovštica – Rijeka Crnojevića |
| 23 | Karuč springs | Karuč - Sinjac |

[156] Numbers in reference to Figures 4.5 and 4.6

| No. | Karstic Springs | Groundwater Body |
|---|---|---|
| 24 | Bolje Sestre | Karuč - Sinjac |
| 25 | Vitoja springs | Kuči |
| 41 | Bijeli Nerini | Morača |

**Figure 5.6 The relationship between the karstic springs and the registered protected areas in the Adriatic River Basin**

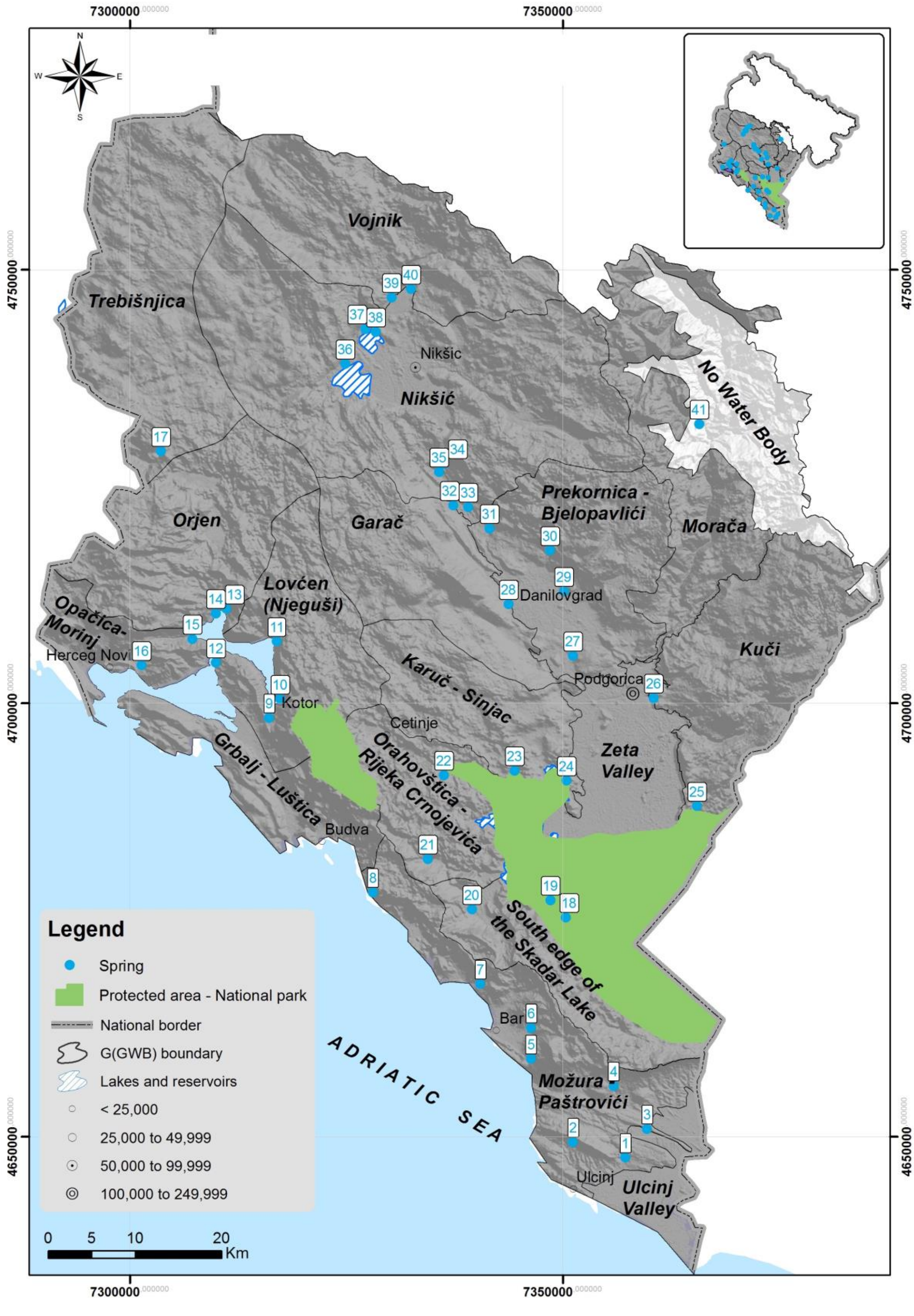
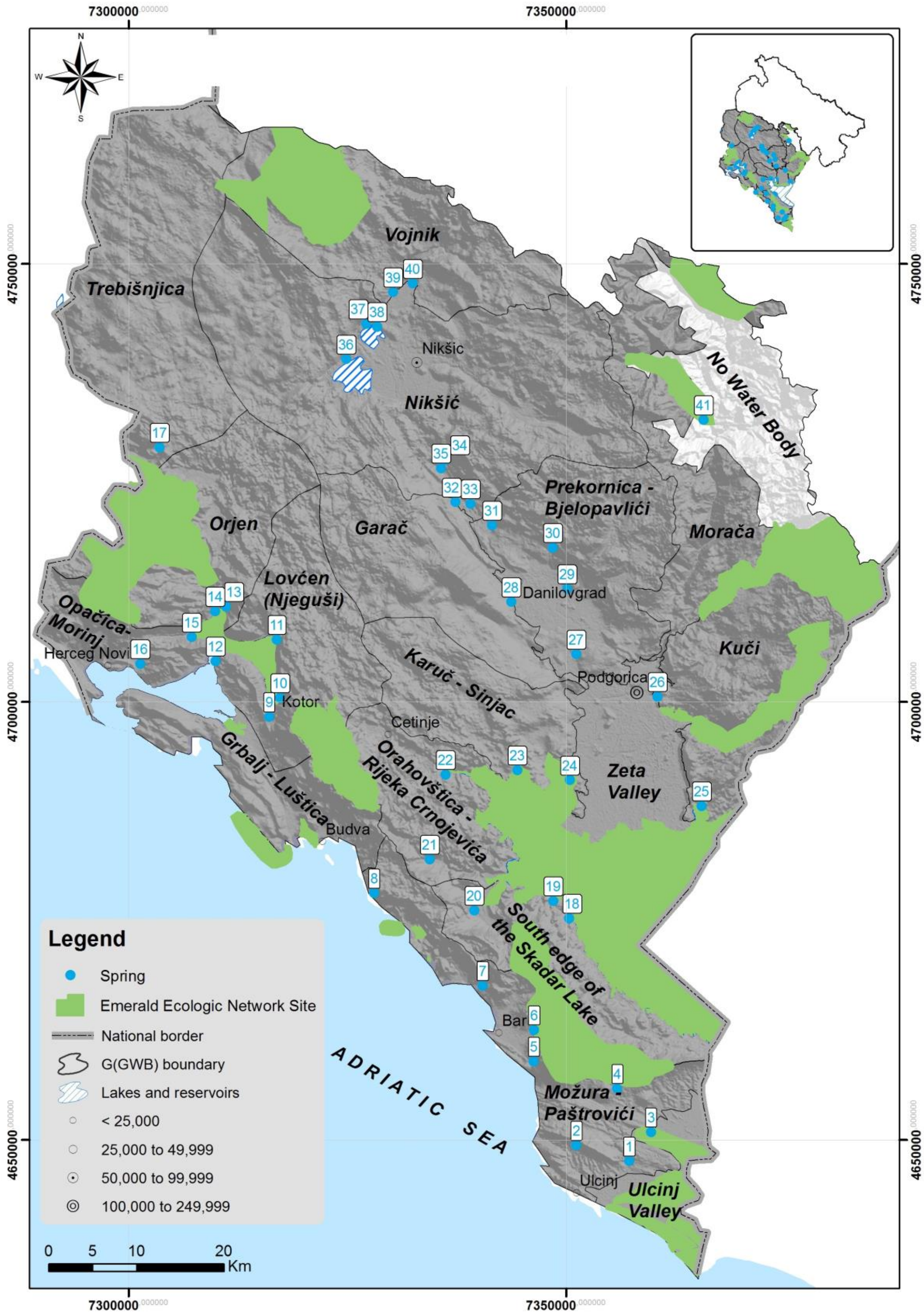


**Figure 5.7 The relationship between the karstic springs and the proposed EMERALD Network in the Adriatic River Basin**



### 5.6.3 Small hydropower plants in protected areas

Figure 5.8 highlights the fact that no SHPPs in construction or in the planning phase are located in the registered protected areas of the Adriatic River Basin.

Figure 5.9 shows the location of the relationship between the EMERALD Network and the SHPPs. In this case, it is clear that 3 of the SHPPs in the stage of planning would be located inside of the boundaries of the proposed EMERALD network.

**Figure 5.8 The relationship between SHPPs in construction or planned and the registered protected areas in the Adriatic River Basin**

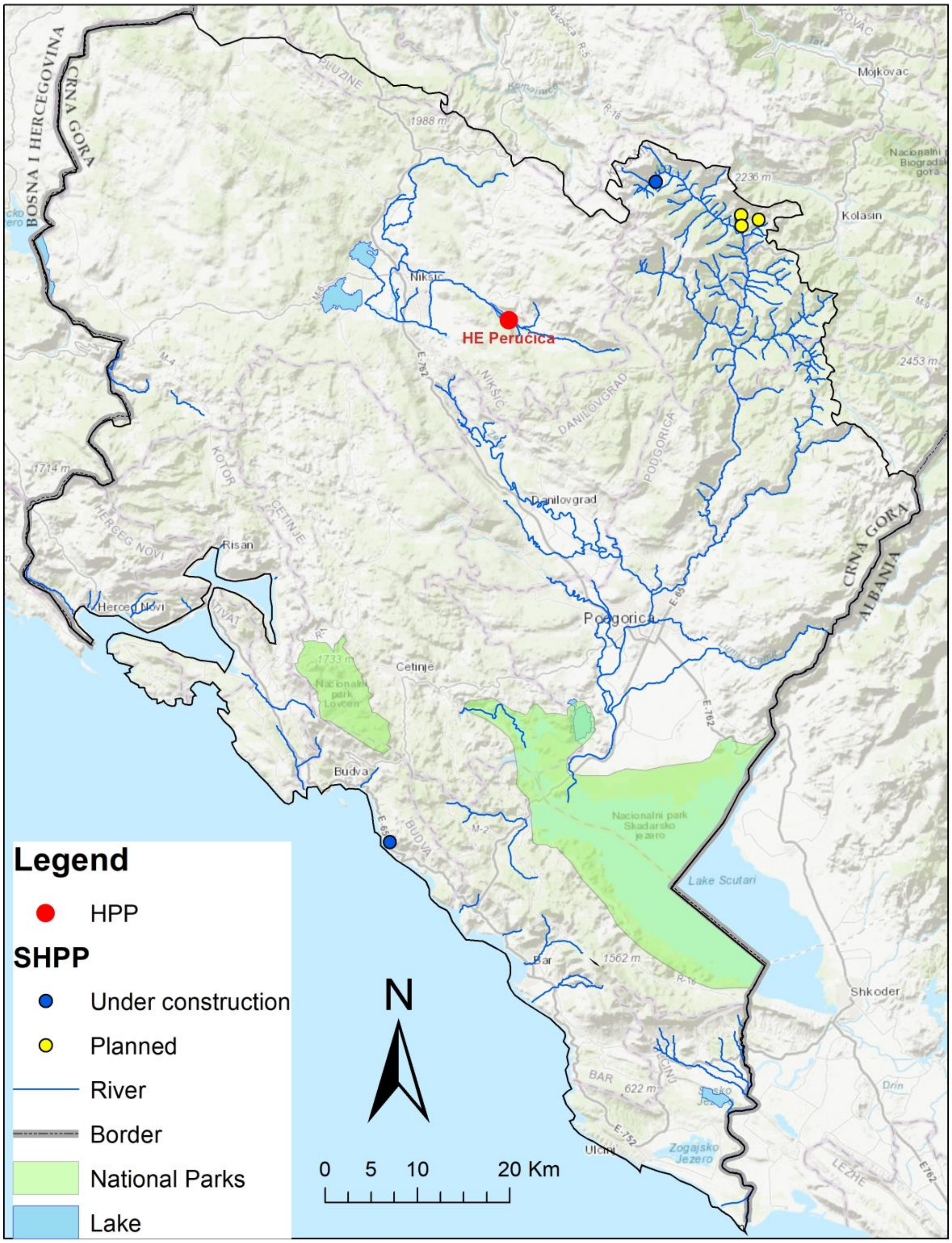
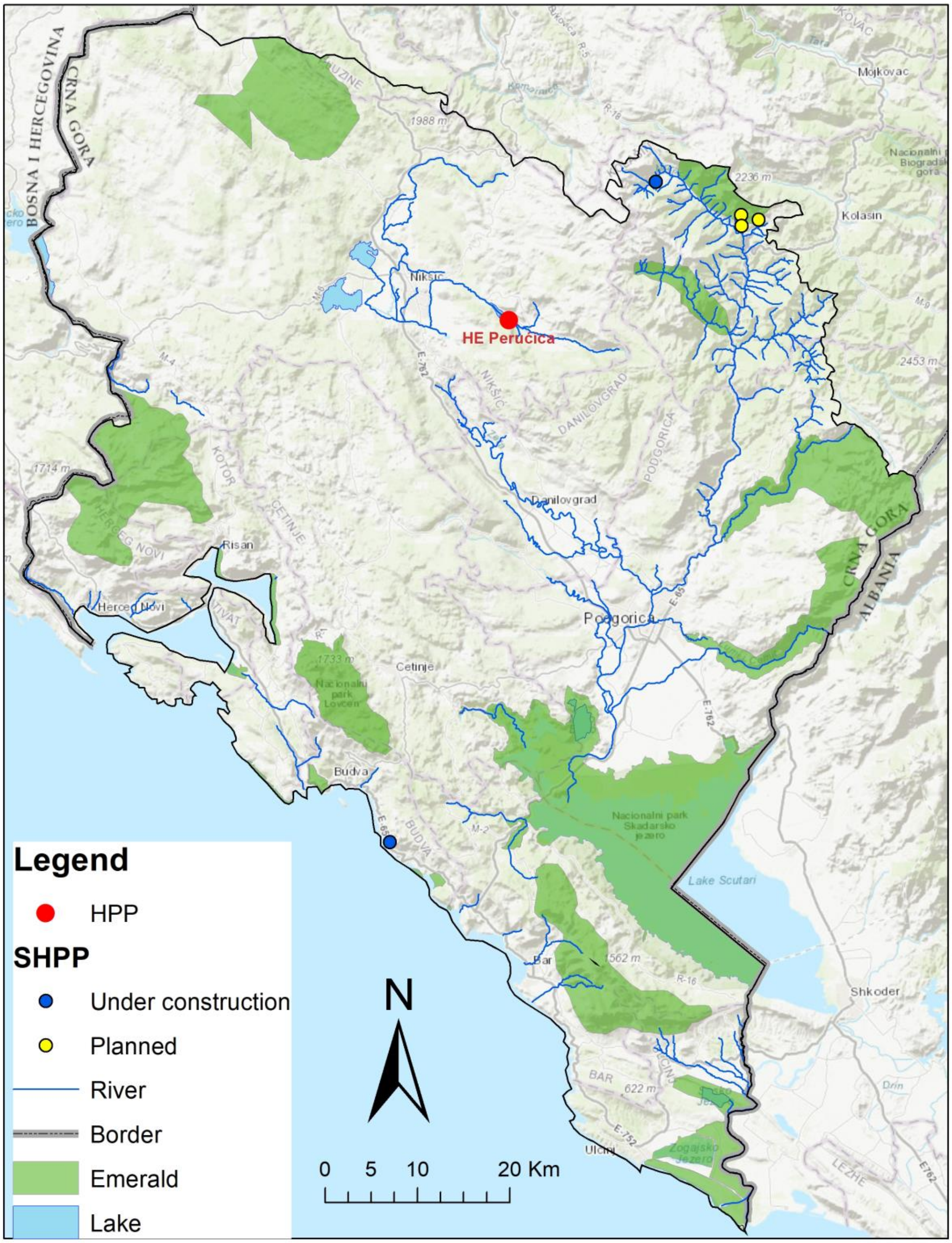


**Figure 5.9 The relationship between SHPPs in construction or planned and the proposed EMERALD Network in the Adriatic River Basin**



# 6 MONITORING NETWORKS

## 6.1 Surface water monitoring requirements under the WFD

The Water Framework Directive covers all waters of the Adriatic River Basin, which includes both surface water and groundwater[157].

The Directive requires states to establish a surface water-monitoring network that provides a coherent and comprehensive overview of ecological and chemical status in each river basin. Data on surface water monitoring serves also the purpose of supplementing and validating the risk assessment procedure, supporting the design of future monitoring programmes, assessing long-term changes in natural conditions and those resulting from anthropogenic activities, estimate pollutants loads transferred across international boundaries or discharging into seas, assess changes in status of those bodies identified as being at risk in response to the application of measures for improvement or prevention of deterioration, ascertaining causes of water bodies failing to achieve environmental objectives where the reason for failure has not been identified, ascertaining the magnitude and impacts of accidental pollution, use in the intercalibration exercise, assessing compliance with the standards and objectives of Protected Areas; and, quantifying reference conditions (where they exist) for surface water bodies[158].

The ecological status of water bodies in a River Basin is defined based on biological, hydromorphological and general physico-chemical quality elements (Table 6.1)[159]. The quality elements applicable to artificial and heavily modified surface water bodies are those applicable to whichever of the four natural surface water categories above most closely resembles the heavily modified or artificial water body concerned[160]. Subject to funding, states are required to monitor parameters, which are indicative of the status of each relevant quality element and include estimates of the level of confidence and precision of the results in the monitoring program.

For rivers and lakes, the ecological status of water can be determined as high, good and moderate status while for artificial and heavily modified surface water bodies it can be classified as good ecological potential and good surface water chemical status. Waters achieving a status below moderate are classified as poor or bad[161].

The WFD requires States to establish surveillance, operational and investigative monitoring types. As a general guide, the surveillance and the operational monitoring program are required for each period to which a river basin management plan applies. The investigative monitoring programme is required in cases of accidences or when there is need to ascertain the causes of a water body to achieve the environmental objectives or to ascertain the magnitude and impacts of accidental pollution[162]. A brief description of the three types of monitoring is provided below.

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[157] Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No 7, Monitoring under the Water Framework Directive, European Communities 2003

[158] Directive 2000/60/EC, Annex V

[159] Directive 2000/60/EC

[160] Directive 2000/60/EC, Annex V

[161] Directive 2000/60/EC, Annex V/1.2

[162] Directive 2000/60/EC, Annex V, 1.3

### 6.1.1 Surveillance monitoring

The objective of surveillance monitoring is to identify water bodies at risk in order to establish a quantitative baseline for future assessments of long-term natural or anthropogenically induced changes[163]. **Surveillance monitoring is required for each monitoring site for a period of one year during the period covered by a RBMP for *parameters* indicative of all biological quality elements, all hydromorphological quality elements and all general physico-chemical quality elements** (Table 6.1). In cases, there is lack of monitoring information about the overall surface water status within each catchment and sub-catchment of the river basin district, the WFD suggest states to undertake a surveillance monitoring each year, at least during the first three years in order to achieve concision and confidence in monitoring data. In case there are no changes in the ecological status of the water bodies in a River Basin, States are left the flexibility to conduct a surveillance monitoring in three River Basin Plans (once in 18 years).

### 6.1.2 Operational monitoring

This type of monitoring **focuses on water bodies that surveillance monitoring has identified as being at risk of failing their environmental objectives and is conducted to assess the changes that occur in the "at risk" water bodies after the implementation of the programme of measures**[164]. The monitoring includes characteristics that are indicative of the pressures to which the bodies are subject[165]. The WFD emphasizes the need to monitor the water bodies that are most sensitive to or are exposed more to such pressures by selecting the following type of monitoring stations[166]:

- Reference stations (where the impact of human activity is at a minimum to measure high and good status);
- Representative stations, (which are representative of the whole water body);
- Flux stations (representing pollutant discharge loads and for international comparisons and exchange of information);
- Sensitive area waters (for protection of drinking water sources, bathing waters, fish, birds, habitats, wetlands, etc.);
- Hot-spot or impact monitoring stations (to evaluate the impact of point or diffuse sources of pollution);
- Key stations (for large or important water bodies).

**Parameters**: The WFD recommends monitoring parameters that are indicative of the biological and hydromorphological quality elements most sensitive to the pressures to which the body is subject, all priority substances discharged, and other substances discharged in significant quantities[167].

[163] European Community 2003, Guidance Document No 7

[164] European Community 2003, Guidance Document No 7

[165] European Community 2003, Guidance Document No 7

[166] European Community 2003, Guidance Document No 7

[167] European Community 2003, Guidance Document No 7

### 6.1.3 Investigative monitoring

This monitoring is **case specific and thus is required in specified cases where there is need to ascertain the causes of a water body or water bodies failing to achieve the environmental objectives**, or to ascertain the magnitude and impacts of accidental pollution. Considering the specific nature of this type of monitoring, the WFD requires to design it on a case-by-case need.

### 6.1.4 Monitoring frequency

WFD recommends the monitoring frequencies reported in Table 6.2 for the required parameters in the monitoring programme. For Operational Monitoring, states have the flexibility to determine the monitoring frequency and parameters with the condition to not exceed the recommended monitoring intervals unless it is justified on the basis of technical knowledge and expert judgment.

Frequencies shall be chosen so as to achieve an acceptable level of confidence and precision. Monitoring frequencies shall be selected while taking into account the variability in parameters resulting from both natural and anthropogenic conditions. The times at which monitoring is undertaken shall be selected so as to minimize the impact of seasonal variation on the results[168], and thus ensure that the results reflect changes in the water body as a result of changes due to anthropogenic pressure. Additional monitoring during different seasons of the same year shall be carried out, where necessary, to achieve this objective.

[168] Directive 2000/60/EC, Annex V, 1.3.5

## Table 6.1 Surface water quality elements for the classification of the ecological status according to WFD[169]

| Monitoring elements (parameters) for surface water bodies | | | Surface water bodies | | | |
|---|---|---|---|---|---|---|
| | | | Rivers | Lakes | Transitional Waters | Coastal Waters |
| **Biological elements** | Composition and abundance of aquatic flora | | √ | √ | √ | √ |
| | Composition and abundance of benthic invertebrate fauna | | √ | √ | √ | √ |
| | Composition, abundance and age structure of fish fauna | | √ | √ | √ | |
| | Composition, abundance and biomass of phytoplankton | | | √ | √ | √ |
| **Hydro-morphological elements** | Hydrological regime | Quantity and dynamics of water flow | √ | √ | | |
| | | Connection to groundwater bodies | √ | √ | | |
| | | Residence time | | √ | | |
| | Morphological conditions | River continuity | √ | | | |
| | | Depth and width variation | √ | Depth variation | Depth variation | Depth variation |
| | | Structure and substrate of the bed | √ | √ | √ | √ |
| | | Structure of the riparian zone | √ | Structure of lake shore | Structure of lake shore | Structure of inter-tidal zone |
| | Tidal Regime | Freshwater flow | | | √ | |
| | | Wave exposure | | | √ | √ |
| | | Direction of dominant currents | | | | √ |
| **Chemical and physico-chemical elements** | General | Transparency | | √ | √ | √ |
| | | Thermal conditions | √ | √ | √ | √ |
| | | Oxygenation conditions | √ | √ | √ | √ |
| | | Acidification status | √ | √ | | |
| | | Nutrient conditions | √ | √ | √ | √ |
| | Specific pollutants | Pollution by all priority substances identified as being discharged into the body of water | √ | √ | √ | √ |
| | | Pollution by other substances identified as being discharged in significant quantities into the body of water | √ | √ | √ | √ |

[169] Directive 2000/60/EC, Annex V

**Table 6.2 Monitoring frequency of quality elements in surface water bodies according to WFD[170]**

| Quality Elements | Surface Water Bodies | | | |
|---|---|---|---|---|
| | Rivers | Lakes | Transitional | Coastal |
| **Biological quality elements** | | | | |
| **Phytoplankton** | 6 months | 6 months | 6 months | 6 months |
| **Other aquatic flora** | 3 years | 3 years | 3 years | 3 years |
| **Macro invertebrates** | 3 years | 3 years | 3 years | 3 years |
| **Fish** | 3 years | 3 years | 3 years | |
| **Hydromorphological elements** | | | | |
| **Continuity** | 6 years | | | |
| **Hydrology** | continuous | 1 month | | |
| **Morphology** | 6 years | 6 years | 6 years | 6 years |
| **Physico-chemical elements** | | | | |
| **Thermal conditions** | 3 months | 3 months | 3 months | 3 months |
| **Oxygenation** | 3 months | 3 months | 3 months | 3 months |
| **Salinity** | 3 months | 3 months | 3 months | 3 months |
| **Nutrient status** | 3 months | 3 months | 3 months | 3 months |
| **Acidification status/pH** | 3 months | 3 months | 3 months | 3 months |
| **Other pollutants** | 3 months | 3 months | 3 months | 3 months |
| **Priority substances** | 1 month | 1 month | 1 month | 1 month |

### 6.1.5 Determining environmental quality standards (EQS) for chemical quality elements

WFD defines an environmental quality standard as the concentration of a particular pollutant or group of pollutants in water, sediment or biota, which should not be exceeded in order to protect human health and the environment[171]. The directive recommends countries to set EQS for *water, sediment and biota* intended for the protection of the aquatic life although WFD does not require countries to monitor pollution in the sediment of the water bodies[172].

EQS are specifically required for the main pollutants included in the indicative list provided in Annex VIII of the WFD[173], which includes organohalogens and substances which may form such compounds in the aquatic environment, organophosphorous and organotin compounds, substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other

[170] Source: WFD, Annex 5/1.3.4

[171] Directive 2000/60/EC, Article 2

[172] Directive 2000/60/EC, Annex V, 1.2.6

[173] Directive 2000/60/EC, Annex VIII

endocrine-related functions in or via the aquatic environment, persistent hydrocarbons and persistent and bioaccumulable organic toxic substances, cyanides, metals and their compounds, arsenic and its compounds, and biocides and plant protection products[174].

### 6.1.6 Environmental Quality Ratio (EQR)

WFD requires countries to make monitoring results of the biological elements comparable between River Basins (and between countries) by expressing them in Ecological Quality Ratio (EQR). EQR represents the relationship between the values of the biological parameters observed for a given body of surface water and the values for these parameters in the reference conditions applicable to that body. The ratio shall be expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero. Ecological quality ratio scale should be divided for each surface water category into five classes ranging from high to bad ecological status by assigning a numerical value to each of the boundaries between the classes. The value for the boundary between the classes of high and good status, and the value for the boundary between good and moderate status shall be established through an international inter-calibration exercise.

The intercalibration exercise is intended to be a one-off exercise although, according to EU principles, all countries are required to repeat it. An intercalibration exercise will also be required once the accession countries join the EU[175]. The Commission has committed to play the role of the facilitator in the intercalibration exercise.

### 6.1.7 Reference conditions for surface water bodies

Member States[176] are required to establish reference conditions based on existing high-status water bodies where they still exist[177]. In this case monitoring will be required to define the values of the biological quality elements, type-specific hydromorphological and physico-chemical conditions for each water body type at high ecological status. Type-specific hydromorphological, physicochemical and biological reference conditions can be derived from spatially based or modelling based methods, a combination of both or based on the expert judgment[178].

Whenever the variability of the water body is high, the specific water body can be excluded from the assessment of the ecological status. In the case of the heavily modified or artificial surface water bodies references to high ecological status is construed as references to maximum ecological potential. The values for maximum ecological potential for a water body need to be reviewed every six years[179]. In addition, reference stations, for which there are long time series of data, which indicate stable conditions under the present conditions, may not need high sampling frequencies.

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[174] Directive 2000/60/EC, Annex VIII

[175] European Community 2003, Guidance Document No 7, 2.12.2

[176] European Community 2003, Guidance Document No 7

[177] European Community 2003, Guidance Document No 7

[178] Directive 2000/60/EC, Annex II

[179] Directive 2000/60/EC

### 6.1.8 Monitoring standards/methods

Standardized methods for sampling techniques, sample preparation and analysis are essential in order to make data comparable scientifically[180]. For this reason, the WFD requires states to monitor surface water preferably based on standardized methods such as ISO, EN, or national standards and recommends the development of appropriate standards for those aspects of monitoring for which there are no internationally agreed standards or techniques/methods[181].

## 6.2 WFD compliant surface water monitoring program for the Adriatic River Basin

This section describes the approach in monitoring programme for the Adriatic River Basin in Montenegro that is designed according the requirements of the Water Framework Directive (WFD – Directive 2000/60/EC) taking into the consideration available state of the art in monitoring practice in Montenegro, as well as financial and expert capacity in the country.

In accordance with the requirements of Article 8 of the Water Framework Directive (WFD), it is necessary to establish a network for monitoring surface waters.

On the basis of the characterization that is in accordance with Article 5 of Annex II of the Directive (WFD), it is necessary to establish three types of monitoring for each river basin management plan:

- Surveillance monitoring program,
- Operational monitoring program and
- If necessary, investigative monitoring program.

Parameters that are characteristic of each relevant quality element must be monitored. When selecting parameters for biological quality elements it should be taken into account the selection of appropriate taxonomic category which is required to order to achieve reliability and accuracy in the process of classification of quality components. Assessment of data of monitoring program and achieved degree of reliability and accuracy should be included in water management plan for each water body.

To establish an effective monitoring system, type specific reference values for the selected parameters must be defined. In addition, optimum sampling frequency, sampling methodology and the method of analysis and assessment must be determined.

### 6.2.1 Overview of the monitoring program

In general, the surface water-monitoring program for the Adriatic River Basin is designed to collect comparable data in order to provide a comprehensive overview of water status of identified water bodies in target area. Data on surface water monitoring serves to design an effective water management system - assess long-term changes resulting from anthropogenic activities, estimate pollutants loads, identification of causes of water bodies failing to achieve environmental objectives, constant upgrading and optimization (in sense of confidence and cost effectiveness) of monitoring

[180] Directive 2000/60/EC, Annex V

[181] European Community 2003, Guidance Document No 7

programmes, identification of programmes of measures for improvement of water status and checking the effectiveness of applied measures.

Although water quality monitoring in Montenegro has a long-term tradition, the WFD compliant data is limited. Thus, the approach presented here should provide the data for initial development of the WFD compliant monitoring and relevant information on general situation in the Adriatic River Basin related to water status. The WFD and related guidance documents recommend and support constant development of water management systems in EU countries, including the system of monitoring and assessment. Thus, the objective of presented monitoring scheme for the Adriatic River Basin is to provide basic frame for further development – it should be considered as "living" system needed to be improved during forthcoming river basin management 6-year cycle and later. General consideration of monitoring types, mandatory elements and minimal frequency is presented above in Section 6.1.4.

A battery of hydrobiological and chemical methodologies is required to obtain information on the ecological and chemical status of individual surface water bodies according to the WFD. Failure to achieve good ecological or chemical status should trigger an appropriate Programme of Measures to bring the affected water bodies into good status.

Biological monitoring is, together with supporting parameters (physico-chemical and hydromrphological), a crucial part for assessment of ecological status.

The WFD compliant monitoring includes:

1. Biological monitoring must cover five obligatory Biological Quality Elements (BQEs):

- Benthic invertebrates
- Phytoplankton
- Phytobenthos
- Macrophytes
- Fish

2. Monitoring of general physico-chemical parameters to support biological monitoring: analysis of basic water quality parameters such as pH, temperature, oxygen level, alkalinity, salinity, nutrients etc.

3. Monitoring of hydromorphological elements to support biological monitoring: quantity and dynamics of water flow, connection to ground water bodies, river continuity, depth and width variation, structure and substrate of the river bed, structure of the riparian zone etc.

**The information on the obligatory biological quality elements for water body type groups is presented in the proposed ecological status assessment system in Annex 2**.

Chemical monitoring covers:

- Analysis of 45 WFD priority substances as defined in the Environmental Quality Standards Directive (EQSD 2013/39/EU) taking into account QA/QC Directive (2009/90/EC) to determine chemical status.
- Identification of Montenegro River Basin Specific Pollutants (RBSPs; WFD 2000/60/EC) with the aim of setting up their EQSs and follow up monitoring to assess the ecological status.

Table 6.3 contains the data on monitoring type and consequently chemical monitoring requirements for each monitoring stations.

The data for **seven sites, which are identified as sites of high priority** (Table 6.3) should provide confidence data with optimal quantity for the identification of the Montenegro River Basin Specific Pollutants (RBSPs; WFD 2000/60/EC).As the bases for this process, the determinants identified as important for the Adriatic River Basin District should be considered (www.icpdr.org).

Montenegro is in the process of adoption of the water status monitoring methodology that is compliant with requirements of the WFD. Thus, in this section, for the purpose to provide initial monitoring methodology, the procedures for provisional ecological status assessment is provided in Annex 2. In the case of chemical monitoring, the approach is defined in the relevant EU Directive (EQSD 2013/39/EU), but also taking into account QA/QC Directive (2009/90/EC) to determine chemical status.

The monitoring programme should also provide information for the identification of Montenegro River Basin Specific Pollutants (RBSPs; WFD 2000/60/EC) with the aim of setting up their EQSs and follow up monitoring to assess the ecological status. Thus, the designed monitoring network should also provide confident data to select RBSP for the Adriatic River Basin in Montenegro.

The proposed WFD compliant monitoring programme for the Adriatic River Basin in Montenegro is detailed in Table 6.3 and illustrated in Figure 6.1.

The WFD compliant monitoring network for the Adriatic River Basin for inland waters covers 35 sites. A total of 26 sites are identified for surveillance monitoring, 13 for operational (all of them are in the same time surveillance monitoring sites), while 19 sites are proposed for investigative monitoring (either as reference or near natural site in order to assess reference or best available conditions, or to collect additional data for further characterization). For some sites it is assessed that different types of monitoring should be applied. Beside the information on monitoring type per site, Table 6.3 provides the data on proposed monitoring elements relevant for each site.

The network that coverts transitional and coastal water covers two coastal and one transitional WB selected for surveillance monitoring. The identification of operational monitoring sites should be done in consequent period, based on the results of surveillance monitoring Table 6.3.

In addition, the investigative monitoring at the Bojana River should provide confident data for characterization of transitional water body in the lower stretch of this river and in the zone of influence of the Bojana to the Adriatic Sea. The position of site (or area of investigation in this particular case) for investigative monitoring should be identified based on measurements of salinity and investigation of BQEs and it is not listed in the Table 6.3.

The surveillance monitoring network has been designed in order to provide data on general status of water bodies within the Adriatic River Basin. During the site selection, the position of previous monitoring sites has been taken into the consideration in order to provide continuity of the monitoring to a greater possible extent.

Surveillance monitoring programmes should be established to provide information for:

- Supplementing and validating the impact assessment procedure
- The efficient and effective design of future monitoring programmes
- The assessment of long-term changes in natural conditions
- The assessment of long-term changes resulting from widespread anthropogenic activity.

The results of surveillance monitoring shall be reviewed and used in combination with the impact assessment procedure, as described in Annex II of WFD, in order to determine requirement for monitoring programmes in the actual and subsequent river basin management plans.

Surveillance monitoring shall cover sufficient number of surface water bodies to provide an assessment of the overall surface water status within each basin or sub basin within the area that is the subject of the RBMP.

Criteria for selection of sites for the surveillance monitoring are the following:

- The rate of water flow is significant within the river basin district as a whole; including points on large rivers where the catchment area is greater than 2,500 $km^2$,
- The volume of water present is significant within the river basin district, including large lakes and reservoirs,
- Significant bodies of water cross boundary,
- Sites are identified under the Information Exchange Decision 77/795/EEC
- Sites are required to estimate the pollutant load which is transferred across boundaries.

Surveillance monitoring shall be carried out for each monitoring site for a period of one year during the period covered by a river basin management plan for:

- Parameters indicative of all biological quality elements,
- Parameters indicative of all hydromorphological quality elements,
- Parameters indicative of all general physico-chemical quality elements,
- Priority list pollutants which are discharged into the river basin or sub-basin and
- Other pollutants discharged in significant quantities in the river basin or sub-basin, unless the previous surveillance monitoring exercise showed that the body concerned reached good status and there is no evidence from the review of impact of human activity, that the impacts on the body have changed (in these cases, surveillance monitoring shall be carried out once every three river basin management plans).

According to the WFD recommendation, it is possible to group water bodies of the same type (type group) if the pressures are of the same general type and similar intensity. The details on the type and intensity of stress are elaborated in Section 4, Table 4.37 and summarized in Table 6.3. Surveillance monitoring sites are grouped based on the same type and intensity of stress assessed (based on pressure analyses and limited monitoring data) for water bodies of the same type group (abiotic types are grouped based on analyses of potential biotic communities (Annex 2), which is presented in Table 6.3, which is also the part of monitoring network optimization and cost reduction.

Identification of operational monitoring sites is based on existing information on type and intensity of pressures and limited data on chemical and ecological status. The programme for operational monitoring sites is presented in Table 6.3. Operational monitoring parameters are those that are indicative for type of recorded/expected stress (pollution or hydromorphological degradation) and thus involve measurements of limited parameters and represents optimization (reduction of costs and effort) of monitoring system.

**Seven sites on inland waters are identified are considered as high priority sites – first order sites** Table 6.3. Those sites are considered as frame of monitoring system and should provide confident information for trend analyses, assessment of cross border pollution, and are the basis for providing the data for international cooperation – e.g. delivery of data for European Environment Information and Observation Network (EIONET). High priority sites should also provide the data for identification of Montenegro River Basin Specific Pollutants, as identified for the Adriatic River Basin (RBSPs; WFD 2000/60/EC).

The network identified for investigative monitoring includes the sites that are under minor anthropogenic influence (reference or “near natural” sites) and sites that are needed to be further investigated, since the data is insufficient/missing to be properly characterized. The information from those sites should be used for more accurate identification of reference conditions or “best available” values that should be used for further upgrade of system of ecological status assessment.

### Table 6.3 Proposed monitoring stations for the WFD compliant monitoring programme for the Adriatic River Basin

| No. | Monitoring Stations – WFD compliant | Station type | Monitoring Parameters | Risk | SWB No. | Type No. | Surface Water Body | Priority | Name of River or Lake | Grouping of SWBs | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Inland Waters** | | | | | | | | | | | |
| **1** | Bojana Fraskanjel | S, O | PH, HYMO, B (all), C | Possibly at risk | 1 | R9 | Bojana | High | Bojana | | E |
| **2** | Orahovštica | I | HYMO, B (MZB, PB), PH | At risk | 2 | R3 | Orahovštica | | Orahovštica | | |
| **3** | Crmnica | I | HYMO, B (MZB, PB), PH | Possibly at risk | 3 | R3 | Crmnička rijeka | | Crmnička rijeka | | |
| **4** | Sutorina 1 | I | HYMO, B (MZB, PB), PH | At risk | 4 | R3 | Sutorina_1 | | Sutorina | | |
| **5** | Sutorina 2 | S | PH, HYMO, B (MZB, C | At risk | 5 | R3 | Sutorina_2 | | Sutorina | | |
| **6** | Bilećko jezero | S | PH, HYMO, B (all), C | Likely not at risk | 6 | N/A | Bilećko Lake | | Bilećko Lake | | Position of site to be further elaborated |
| **7** | Morača Manastir | S, O | PH, HYMO, B (MZB, PB), C | Likely not at risk | 9 | R5 | Morača 3 | High | Morača | 7, 8, 9 | E |
| **8** | Sjevernica | S, I | PH, HYMO, B (MZB, PB), C | Likely not at risk | 11 | R2 | Sjevernica_2 | | Sjevernica | 10, 11 | |
| **9** | Mrtvica | S, I | PH, HYMO, B (MZB, PB), C | Likely not at risk | 13 | R2 | Mrtvica 2 | | Mrtvica | 12, 13 | |
| **10** | Morača Zlatica | S, O | PH, HYMO, B (MZB, PB), C | At risk | 14 | R6 | Morača 4 | | Morača | | E |

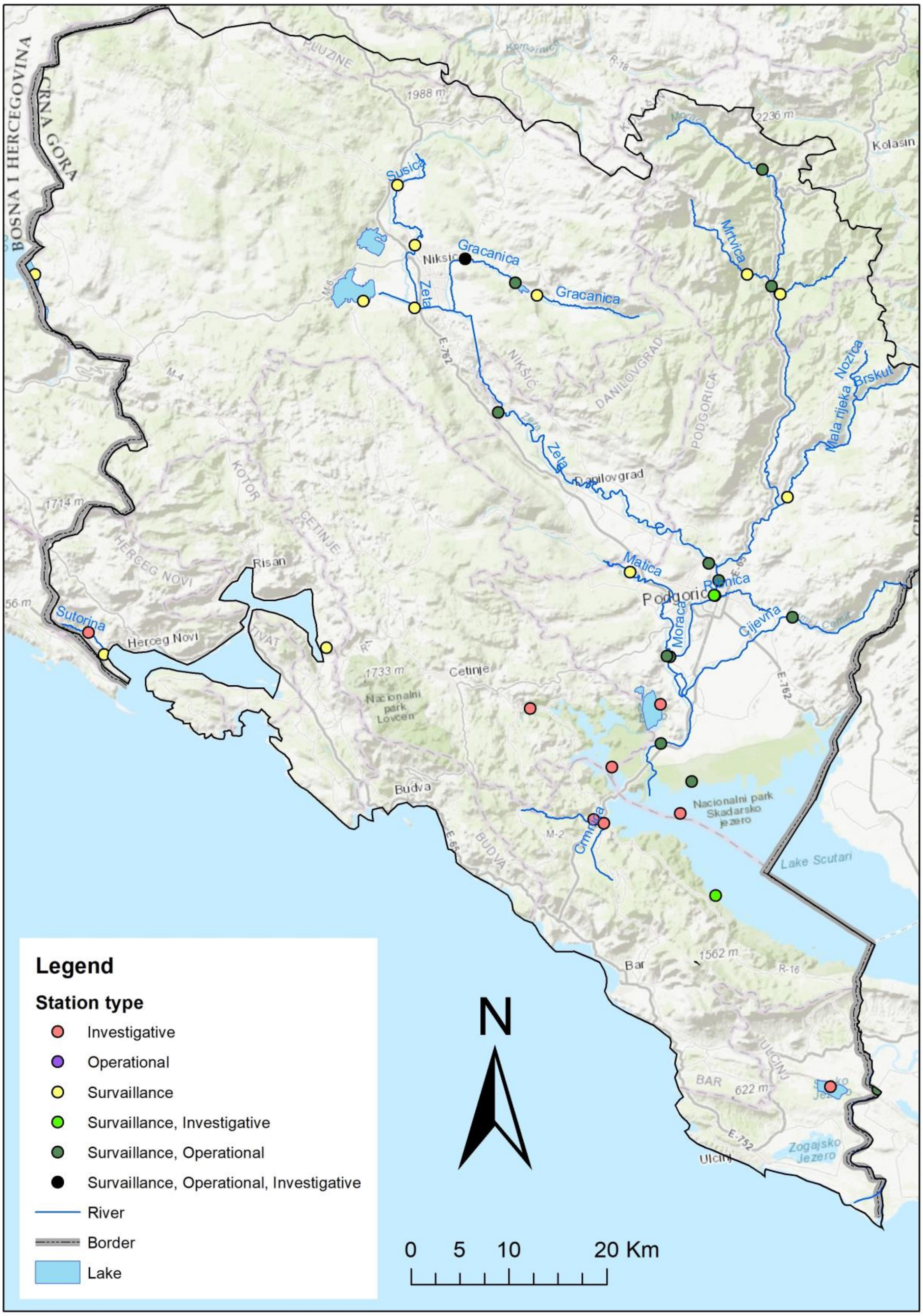
| No. | Monitoring Stations – WFD compliant | Station type | Monitoring Parameters | Risk | SWB No. | Type No. | Surface Water Body | Priority | Name of River or Lake | Grouping of SWBs | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **11** | Bioče | S, I | PH, HYMO, B (MZB, PB), C | Likely not at risk | 17 | R3 | Mala rijeka 2 | | Mala rijeka | 15, 16, 17 | E |
| **12** | Morača Podgorica | S, O | PH, HYMO, B (MZB, PB), C | At risk | 18 | R8 | Morača 5 | High | Morača | | E |
| **13** | Vir | S, I | PH, HYMO, B (MZB, PB), C | Likely not at risk | 19 | R2 | Sušica | | Sušica | | E |
| **14** | Zeta Duklov most | S, I | PH, HYMO, B (MZB, PB, macrophyte), C | Likely not at risk | 20 | R5 | Zeta 1 | High | Zeta | | E |
| **15** | Vrtačka brana | S | PH, HYMO, B (MZB, PB), C | Likely not at risk | 21 | R5 | Zeta_2 | | Zeta | | |
| **16** | Manastir Sv. Luke | S, I | PH, HYMO, B (MZB, PB), C | Likely not at risk | 22 | R2 | Gračanica_1 | | Gračanica | | |
| **17** | Liverovići Reservoir | S, O | PH, HYMO, B (all), C | Possibly at risk | 23 | R2 | Liverovići Reservoir | | Gračanica | | |
| **18** | Rubeža | S, O, I | PH, HYMO, B (MZB, PB), C | Possibly at risk | 24 | R2 | Gračanica_2 | | Gračanica | | |
| **19** | Orlina | S | PH, HYMO, B (all), C | Likely not at risk | 26 | N/A | Slansko Lake | | Slansko Lake | 25, 26 | |
| **20** | Zeta Tunjevo | S, O | PH, HYMO, B (MZB, PB), C | At risk | 27 | R6 | Zeta 3 | | Zeta | | E |
| **21** | Zeta Vranjske njive | S, O | PH, HYMO, B (MZB, PB), C | Possibly at risk | 28 | R8 | Zeta 4 | High | Zeta | | E |
| **22** | Ribnica Gornji tok | I | PH, HYMO, B (MZB, PB), C | Possibly at risk | 29 | R6 | Ribnica | | Ribnica | | |

| No. | Monitoring Stations – WFD compliant | Station type | Monitoring Parameters | Risk | SWB No. | Type No. | Surface Water Body | Priority | Name of River or Lake | Grouping of SWBs | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **23** | Sastavci | S, I | PH, HYMO, B (MZB, PB), C | Possibly at risk | 29 | R6 | Ribnica | | Ribnica | | |
| **24** | Donji Kokoti - Lekići | S, O | PH, HYMO, B (MZB, PB), C | At risk | 30 | R8 | Morača_6 | High | Morača | | |
| **25** | Matica | S | PH, HYMO, B (MZB, PB), C | Likely not at risk | 32 | R6 | Matica_2 | | Matica | 31, 32 | |
| **26** | Ušće | S, O | PH, HYMO, B (MZB, PB), C | Possibly at risk | 33 | R3 | Sitnica | | Sitnica | | |
| **27** | Cijevna Dinosa | S, O | PH, HYMO, B (MZB, PB), C | Possibly at risk | 34 | R6 | Cijevna | | Cijevna | | |
| **28** | Bistrice | S, O | PH, HYMO, B (MZB, PB), C | Possibly at risk | 35 | R8 | Morača_7 | High | Morača | | |
| **29** | Vucno blato | I | B (MZB, PB), PH | Likely not at risk | 36 | L4 | WB1_Vucko blato | | Skadarsko jezero | | |
| **30** | Skadarsko Plavnica | S, O | PH, HYMO, B (all), C | Possibly at risk | 37 | L5 | WB2_North | | Skadarsko jezero | | |
| **31** | Donji Murići | S, I | PH, HYMO, B (all), C | Likely not at risk | 38 | L5 | W3_South west | | Skadarsko jezero | | |
| **32** | Skadarsko Open Waters | I | B (MZB, PB, PP), PH | Likely not at risk | 39 | L6 | W4_pelagic Zone | | Skadarsko jezero | | |
| **33** | Šasi | I | B (MZB, PB, PP), PH | Likely not at risk | 40 | L4 | Šasko Lake | | Šasko jezero | | |

| No. | Monitoring Stations – WFD compliant | Station type | Monitoring Parameters | Risk | SWB No. | Type No. | Surface Water Body | Priority | Name of River or Lake | Grouping of SWBs | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **34** | Bolje sestre | I | B (MZB, PB, PP), PH | Likely not at risk | 41 | L3 | Malo Blato Lake | | Malo Blatno jezero | | |
| **35** | Rijeka Crnojevica | I | PH, HYMO, B (MZB, PB), C | Likely not at risk | - | R2 | N/A | High | Rijeka Crnojevića | | |
| **Transitional and Coastal Waters** | | | | | | | | | | | |
| **1.** | Bar, Rt. Volujica | S | PH, HYMO, B (all), C | Possibly at risk | N/A | CWB | MNE_CW4 | High | Adriatic Sea | | |
| **2.** | Budva | S | PH, HYMO, B (all), C | Possibly at risk | N/A | CWB | MNE_CW4 | High | Adriatic Sea | | |
| **3.** | Kotor | S | PH, HYMO, B (all), C | Possibly at risk | N/A | TWB | Kotorski | High | Boka Bay | | |

**Priority monitoring sites marked in green**. E - Indicates that site was included in previous routine monitoring in Montenegro. Abbreviations: S – surveillance monitoring; O- Operational monitoring; I – Investigative monitoring; PH – Physico-chemical monitoring; MZB – Macroinvertebrate monitoring; PB – Phytobenthos monitoring; PP – Phytoplankton monitoring; HYMO – Hydromorphological monitoring; B – Biological monitoring (5 Biological quality elements); C – Monitoring of priority chemicals; HMWB – Heavily Modified Water Body; N/A – Not applicable; CWB – Coastal Water Body; TWB – Transitional Water Body; Grouping – indicates whish WBs are grouped based on same type group and similar intensity and type of pressures (numbers as in SWB No. column); **Column "Priority" – where indicated as "High", this is characterized as a "site of high priority", or the "First order site"**.

**Figure 6.1 Proposed inland surface water monitoring network for the WFD compliant monitoring programme for the Adriatic River Basin**



### 6.2.2 Hydrological monitoring

There are three basic issues in relation to the achievement of the goals of the Water Framework Directive that are clearly linked to hydrological measurements, namely:

(i) Quantification of water balance dynamics for both surface and groundwaters for a defined spatial scale and temporal scale, according to the WFD Guidance document No. 34[182].
(ii) Environmental flows, which describe the timing and quality of water flows, including groundwater interactions that are required to sustain freshwater ecosystems, according to WFD Guidance document No. 31.
(iii) Flood risk assessment and management, which requires the use of long term hydrological and meteorological data sets and complex modelling to predict specific areas of inundation in line with the requirements of the Floods Directive (2007/60/EC).

Hydrological monitoring and measurements are conducted by the hydro-meteorological service (IHMS). In the Adriatic River Basin there are currently 11 hydrological stations in operation for level data, 8 of which also collect flow data. There are also 8 new stations planned for installation in 2019-2020 for both flow and level data (Tables 6.4 and Figure 6.2). Upgrading of the existing stations has been initiated thought the EU IPA projects in 2018.

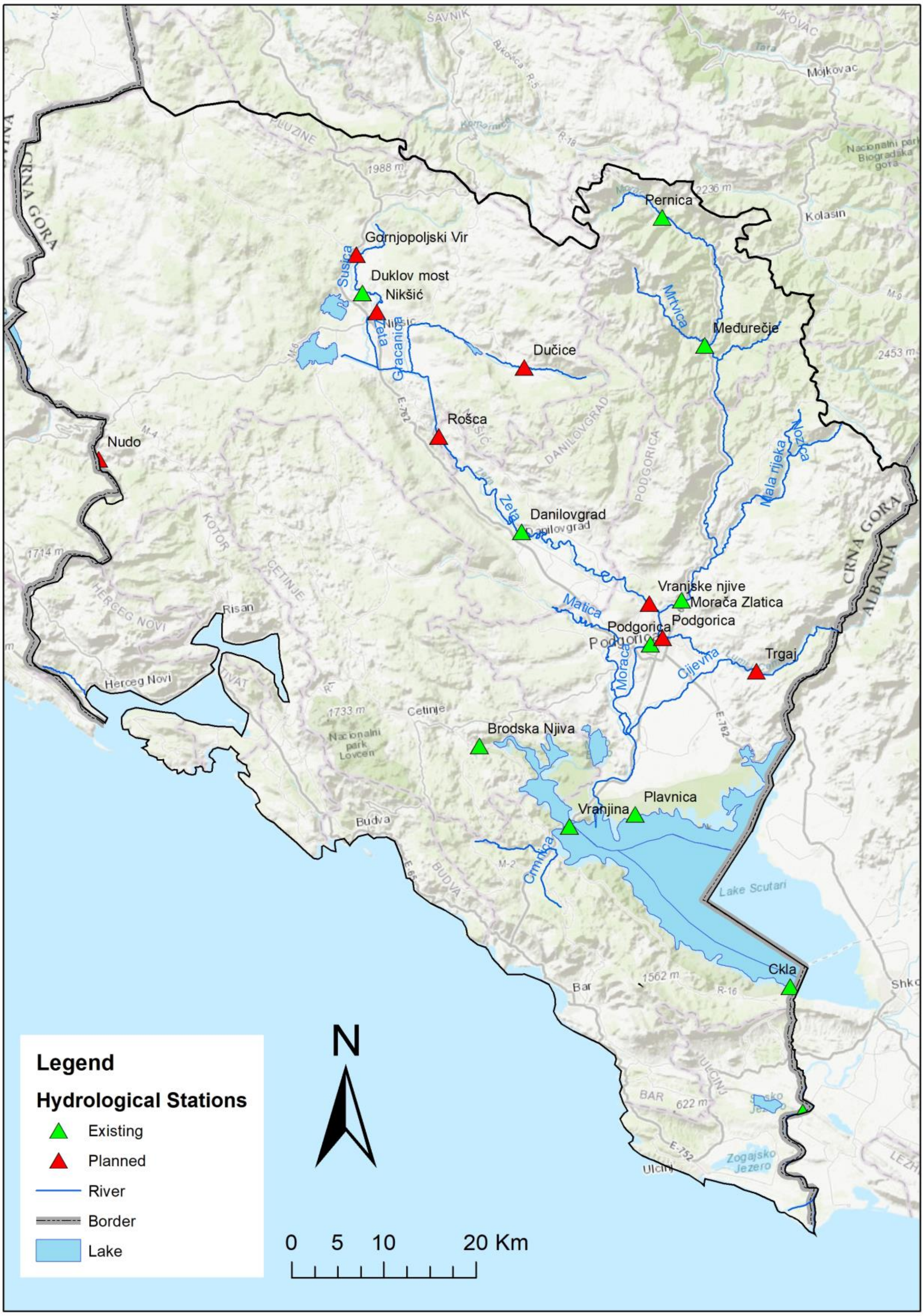
**Table 6.4 Operational and planned hydrological Stations in the Adriatic River Basin[183]**

| No. | Station Name | River/Lake | Sub-Basin | Surface Water Body (SWB) | SWB No. |
|---|---|---|---|---|---|
| **Operational** | | | | | |
| 1 | Pernica | Morača | Morača | Morača_2 | 8 |
| 2 | Međuriječje | Mrtvica | Morača | Mrtvica_2 | 13 |
| 3 | Zlatica | Morača | Morača | Morača_4 | 14 |
| 4 | Fraskanjel | Bojana | Bojana | Bojana | 1 |
| 5 | Brodska njiva | Rijeka crnojevića | Skadar | WB1_Vucko blato | 36 |
| 6 | Danilovgrad | Zeta | Zeta | Zeta_4 | 28 |
| 7 | Podgorica | Morača | Morača | Morača_5 | 18 |
| 8 | Duklov Most | Zeta | Zeta | Zeta_1 | 20 |
| 9 | Plavnica | Skadar Lake* | Skadar | WB 2_North | 37 |
| 10 | Vranjina | Skadar Lake* | Skadar | W3_South west | 38 |
| 11 | Ckla | Skadar Lake* | Skadar | W3_South west | 38 |
| **Planned** | | | | | |
| 12 | Trgaj | Cijevna | Skadar | Cijevna | 34 |
| 13 | Vranjske njive | Zeta | Morača | Zeta_4 | 28 |
| 14 | Gornjopoljski vir | Sušica | Zeta | Sušica | 19 |
| 15 | Nikšić | Bistrica | Zeta | Zeta_1 | 20 |
| 16 | Dučice | Gračanica | Zeta | Gračanica_1 | 22 |
| 17 | Rošca | Zeta | Zeta | Zeta_3 | 27 |
| 18 | Podgorica | Ribnica | Morača | Morača_5 | 18 |
| 19 | Nudo | Nudolska rijeka | Adriatic | Bilećko Lake | 6 |

*Level data collected only

[182] http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm
[183] Support to water resources management in the Drina River Basin, World Bank (2016)

## Figure 6.2 Location of hydrological Stations in the Adriatic River Basin



## 6.3 Groundwater monitoring

### 6.3.1 Specific requirements for groundwater monitoring under the EU WFD

As a first step towards creation of an optimal groundwater network a body of groundwater designated within a geological formation should be delineated and taken as the basis for groundwater monitoring. In accordance to hydrogeology setting of the Adriatic River Basin, all designated groundwater bodies (GWBs) or group of groundwater bodies (GGWBs) have been classified as karstic or karstic-fissured, and intergranular groundwater bodies. In some cases, complex GWB consists of these two types has also been designated. The delineation represents very first step towards WFD implementation (See Section 3.6, Figures 3.7 and 3.8 and Table 3.9).

The second step requires characterization and includes the determination/description and quantification of geological and hydrogeological conditions, particularly the geometry of the GWBs and GGWBs, the nature of the aquifer roof and floor, the rate of water exchange, and the dependence of terrestrial ecosystems on infiltrated or discharged groundwater. The extensive characterisation of all 17 groundwater bodies and groups of groundwater bodies in the Adriatic River Basin is provided in Annex 1.

The third step, as a part of characterization process is to define qualitative (chemical) and quantitative status of GWBs and GGWBs. The focus is on chemical quality pressures—diffuse and point sources of pollution, as well as quantity pressures—abstraction rates and artificial recharge, if they exist. Once the status of GWBs and GGWBs is determined and if they are at risk (quantitative or qualitative, or both) an adequate monitoring and mitigation measures to protect and save quality of GW can be undertaken.

The WFD introduces 'surveillance monitoring' and 'operational monitoring' depending on the nature of groundwater pressures. Operational monitoring requires a higher monitoring frequency and surveying of specific components, critical to water quality. Monitoring points are not necessarily required in all groundwater bodies, but they must be located so that they are representative of all groundwater bodies within a river basin district.[184]

In terms of quantitative assessment, the distribution of monitoring points must ensure that the spatial and temporal variability of the groundwater surface can be sufficiently well recorded within a groundwater body. Pumped wells are not normally suitable for use as water level monitoring points. In the WFD, the groundwater level is the main parameter that defines the quantitative status. There is no exact limit, but it needs to ensure that long-term use will not threaten the available groundwater resource, that the environmental objectives of associated surface water bodies will be achieved and that there will be no threat to terrestrial ecosystems. Given that there was some doubt as to what over-exploitation means and when it occurs, it is necessary to stay within relative categories and ensure that water extraction rate in long- and medium term would not exceed aquifer recharge[185].

The problem with determining the chemical status is that maximum permissible concentrations have not been defined at the level of EU, except for a few parameters. To achieve objectives, if good status

[184] IGWWG (Ireland GW Working Group), 2005: WFD-River Basin District Management Systems, Advice on the implementation of guidance on monitoring groundwater, Guidance document no. GW6, Dublin

[185] Stevanović Z. 2011: Menadžment podzemnih vodnih resursa (Management of Groundwater Resources), Fac. Min. & Geol. Univ. of Belgrade, Belgrade, 340 p.

cannot be restored or attained, then the chemical status must be at least that which existed before applicable legislation was adopted, or before its implementation began.

### 6.3.2 Criteria and conditions for Montenegro's new groundwater monitoring network

Concerning the actual situation of groundwater monitoring in the Adriatic River Basin, a new monitoring network of Montenegro has to be gradually built. The target for its completion should be the year 2027 or 2028. To get feasible and non-expensive network the existing waterworks and companies that receive concessions for water extraction, must be obliged to fulfil their obligations to regularly observe discharges, water tables and chemistry of tapped springs and wells and to deliver this data to responsible authorities.

As the setup of the groundwater monitoring network will rise in stages, the prioritization in selection of monitoring sites has been given to GWBs under already recognized or assumed pressures.

In term of pressure to groundwater quantity, an assessment of available renewable reserves versus exploitation capacity is required for each of GWB. When pressures to groundwater quality are considered, the best way for realistic assessment is to compare the aquifers' vulnerability against anthropogenic (diffuse and punctual) hazards. Section 4 provides the results of a vulnerability assessment followed by a hazard and risk assessment of all of the GWBs and GGWBs in the Adriatic River Basin.

**Frequency and monitoring parameters**

The frequency of monitoring should be elaborated upon following the risk assessment process and a review of obtained water quality data. The frequency of monitoring should enable assessment of the chemical status of delineated GWBs and GGWBs and depends on local hydrogeological conditions (aquifer regime and vulnerability). Even though WFD does not recognizes "investigation monitoring" in term of groundwater (introduced for surface waters exclusively) it is quite logical that first monitoring surveys of GW quantity and chemistry should direct further monitoring which will continue as surveillance or operational type.

**Surveillance Monitoring**

The monitoring frequency for surveillance monitoring should be a minimum of twice per year (spring and autumn, or high and low water table). After WFD and CIS Guidance Document for GW the minimum frequency set out in Table 6.5 will be used as a general guide.

In case of the Adriatic River Basin,  GWBs and GGWBs which comprise karstic as well as transboundary aquifers should be monitored more frequently. In addition, monitoring sites that demonstrate strong variation of chemical components throughout the year will also be examined more often as indicated in Table 6.6 below.

### Table 6.5 Proposed minimum monitoring frequencies for surveillance monitoring after WFD (adapted)

| | | Aquifer – GWB (Flow) Type | | | | |
|---|---|---|---|---|---|---|
| | | **Confined** | **Unconfined** | | | |
| | | | Intergranular GWB significant | | Fracture GWB only | Karst GWB ** |
| | | | Significant deep flows common | Shallow flow | | |
| Initial frequency* – core and additional parameters | | Twice per year | Quarterly | Quarterly | Quarterly | Quarterly |
| Long terms frequency – core parameters | General high to moderate transmissivity | Every 2 years | Annual | Twice per year | Twice per year | Twice per year |
| | General low transmissivity | Every 6 years | Annual | Annual | Annual | Twice per year |
| Additional parameters (on going-validation) | | Every 6 years | Every 6 years | Every 6 years | Every 6 years | |

* Initial frequency period is defined as a minimum of two years.
** Continuous temperature and conductivity measurements at selected representative sites.

### Operational monitoring

After WFD and CIS Guidance Document for GW operational monitoring shall be carried out (i) at a minimum of once per year and (ii) between the sampling dates of the surveillance monitoring programme. Table 6.6 sets out the minimum frequency requirements.[186]

### Table 6.6 Proposed minimum monitoring frequencies for operational monitoring after WFD (adapted)

| | | Aquifer – GWB (Flow) Type | | | | |
|---|---|---|---|---|---|---|
| | | **Confined** | **Unconfined** | | | |
| | | | Intergranular GWB significant | | Fracture GWB only | Karst GWB ** |
| | | | Significant deep flows common | Shallow flow | | |
| Higher vulnerability groundwater | Continuous pressures | - | Twice per year | Twice per year | Quarterly | Quarterly |
| | Seasonal or intermittent pressures | - | Annual | As appropriate | As appropriate | As appropriate |
| Lower vulnerability groundwater | Continuous pressures | Annual | Annual | Twice per year | Twice per year | Quarterly |
| | Seasonal or intermittent pressures | Annual | Annual | As appropriate | As appropriate | As appropriate |

186 IGWWG (Ireland GW Working Group), 2005: WFD-River Basin District Management Systems, Advice on the implementation of guidance on monitoring groundwater, Guidance document no. GW6, Dublin

| | | | | |
|---|---|---|---|---|
| Trend assessments | Annual | Twice per year | Twice per year | Twice per year |

The groundwater bodies will be monitored for the following minimum set of parameters in all cases:

- Temperature (T)
- Oxygen content (DO)
- pH value (pH)
- Electrical Conductivity (EC)
- Nitrate ($NO_3$)
- Ammonium ($NH_3$)

The measurements of T, DO, EC, pH will be undertaken directly in the field. The GWBs that have been identified as being at significant risk of failing to meet the objectives shall be monitored for those parameters which are indicative of the risk. In the case of transboundary groundwater bodies, they shall be monitored for parameters and potential pollutants found in the area which are relevant for the protection of all of the uses supported by the groundwater flow.

The list of chosen monitoring parameters of water quality (chemistry) will need to be elaborated upon following a review of water quality data in an "investigation" phase. Therefore, list of parameters to be followed for operational monitoring will generally include those required for surveillance monitoring but will be extended as necessary to include those additional parameters that are indicative of the identified risks.

The proposed type of monitoring of the quality and quantity for each groundwater body in the Adriatic River Basin is presented in Table 6.7. For some of GWB and GGWB is recommended to impose operational monitoring for GW quality in initial stage, although there are no indications of high pressures. Reasons are very dynamic karst waters regime and variability of water quality which is depending on rainfall and river flow regime as main factors of GW recharge. In addition to, in these GWBs and GGWBs although not in extensive range, some point source pollutants are indicated (expressed via PE in characterization tables I-XVII in Annex 1).

### Table 6.7 Proposed monitoring of quality and quantity of groundwater bodies in the Adriatic River Basin

| No. | GW Body | Groundwater Monitoring | | | |
|---|---|---|---|---|---|
| | | Quality | | Quantity | |
| | | Existing | Proposed | Existing | Proposed |
| 1 | Southern Rim of the Skadar Lake | Existing: Continual for water-source "Velje Oko" | Surveillance monitoring | Continual for water-source "Velje Oko" | Surveillance monitoring |
| 2 | Ulcinjsko polje | Continual for water-source "Lisna Bori" | Operational monitoring | Continual for water-source "Lisna Bori" | Operational monitoring |
| 3 | Možura - Paštrovići | Continual for the water sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, | Operational monitoring | Continual for the water sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, | Surveillance monitoring |

| No. | GW Body | Groundwater Monitoring | | | |
|---|---|---|---|---|---|
| | | Quality | | Quantity | |
| | | Existing | Proposed | Existing | Proposed |
| | | Buljarica, Lončar, Kaliman and Salč | | Buljarica, Lončar, Kaliman and Salč/ | |
| 4 | Grbalj - Luštica | Continual for the water sources: Topliš (Tivat), Grbaljsko polje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring (Budva) | Operational monitoring | Continual for the water sources: Topliš (Tivat), Grbaljsko polje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring (Budva) | Surveillance monitoring |
| 5 | Opačica - Morinj | Continual for the water sources: Opačica, Sutorinsko polje | Operational monitoring | Water sources: Opačica, Sutorinsko polje | Surveillance monitoring |
| 6 | Orjen | Continual for the water sources Risanska Spilja and Smokovac Spring | Surveillance monitoring | Water sources Risanska Spilja and Smokovac Spring | Surveillance monitoring |
| 7 | Lovćen (Njeguši) | Continual for the water sources: Plavda, Škurda and Tabačina, water sources Ercegovina and Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj | Operational monitoring | Water sources: Plavda, Škurda and Tabačina, water sources Ercegovina and Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj | Surveillance monitoring |
| 8 | Orahovštica – Rijeka Crnojevića | Continual for Podgor, Uganjska springs, Obzovica springs, water-source “Orahovsko Polje” and water-source “Sjenokos” | Operational monitoring | Continual for Crnojevića spring and temporary for Podgor, Uganjska springs and Obzovica spring | Surveillance monitoring |
| 9 | Karuč - Sinjac | Continual for Bolje Sestre Spring | Operational monitoring | Continual for Bolje Sestre Spring | Operational monitoring |
| 10 | Zeta Valley | Continual for water-sources Ćemovsko polje, Zagorič, Tuzi, Dinoši, Vuksan Lekić | Operational monitoring | Continual for water-sources Ćemovsko polje, Zagorič, Tuzi, Dinoši, Vuksan Lekić | Operational monitoring |
| 11 | Prekornica - Bjelopavlići | Continual for Mareza Springs, Slatina Spring, Žarića Jama, Brajovića Jama, Iverak, Viški Well | Operational monitoring | Continual for Mareza Spring | Operational monitoring |
| 12 | Garač | Continual for “Oraška Jama” and “Milojevića Spring” | Surveillance monitoring | Continual for “Oraška Jama” and “Milojevića Spring” | Surveillance monitoring |
| 13 | Vojnik | Continual for water source “Vidrovan” | Surveillance monitoring | Continual for water source “Vidrovan”/ | Surveillance monitoring |

| No. | GW Body | Groundwater Monitoring | | | |
|---|---|---|---|---|---|
| | | Quality | | Quantity | |
| | | Existing | Proposed | Existing | Proposed |
| 14 | Nikšićko polje | Continual for water source “Poklonci” | Operational monitoring | Continual for water source “Poklonci”/ | Surveillance monitoring |
| 15 | Trebišnjica (Bilećko Lake) | There are no monitoring points | Surveillance monitoring | There are no monitoring points | Surveillance monitoring |
| 16 | Kuči | Continual for water sources “Milješ” and “Bioče” | Operational monitoring | Continual for water sources “Milješ” and “Bioče” | Surveillance monitoring |
| 17 | Morača | There are no monitoring points | Surveillance monitoring | There are no monitoring points | Surveillance monitoring |

The list of current groundwater monitoring stations, as of 2019, is presented in Table 6.8 The location of all monitoring points in each of the groundwater bodies the Adriatic River Basin is illustrated in Figure 6.3.

For the selection of monitoring points two important factors are considered:

- Areas which should be prioritized for systematic monitoring, and
- M&O cost, i.e. availability of equipment and funds.

The following areas are selected:

- Areas of intensive land use (industry, mining, agriculture, urbanized zones), and zones with contaminated or possibly contaminated soil (and water):
- Transboundary aquifers:
- Remote areas, mainly in karst, with unsolved local water supply.

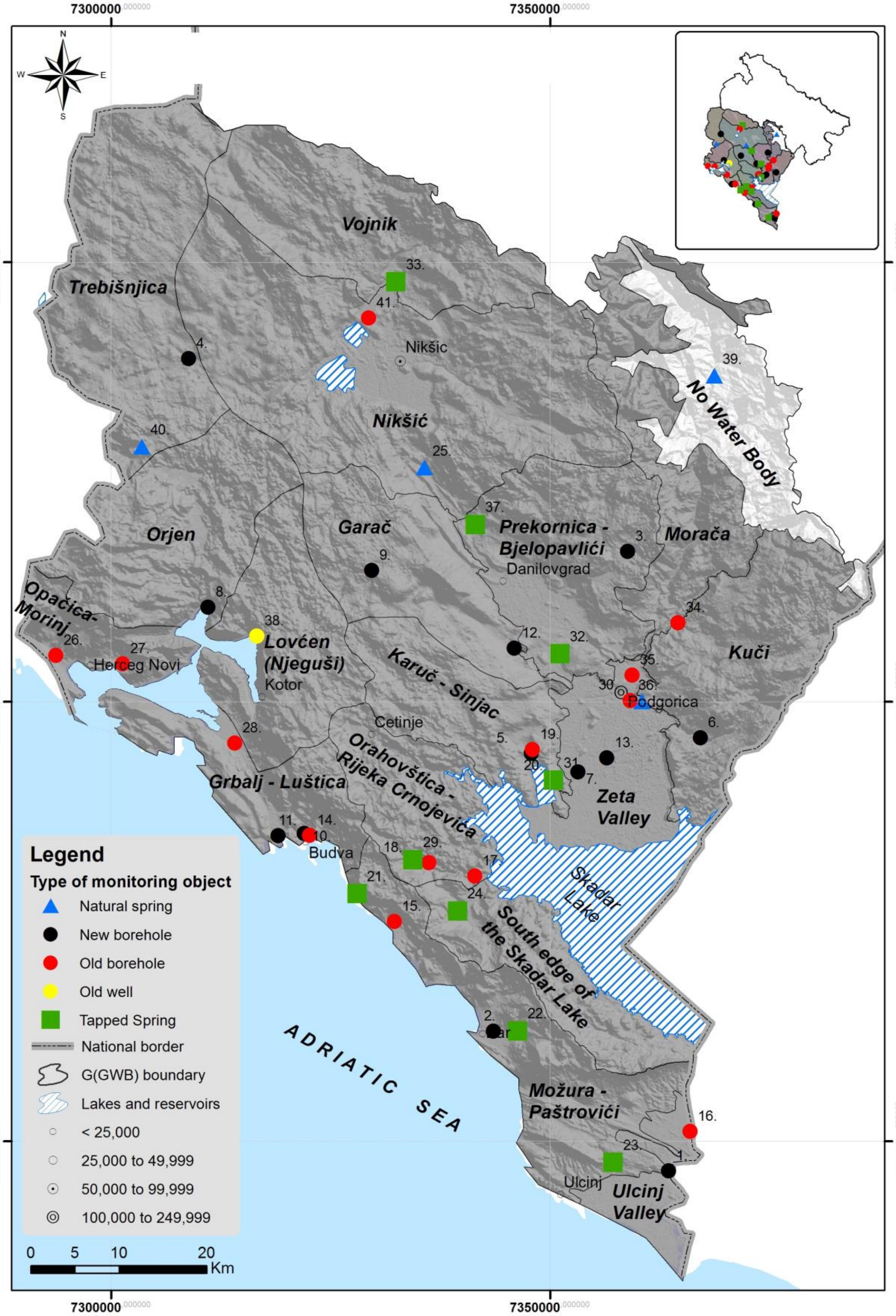
Considering fact that Montenegro is lacking systematic groundwater monitoring, the creation of monitoring network by drilling new boreholes and purchasing / installing equipment into piezometers, enable historical progress in this field.

### Table 6.8 Groundwater monitoring stations in the Adriatic River Basin

| MNE No. | Name | Type | Code of GWB/GGWB |
|---|---|---|---|
| 1 | Sv. Djordje (Ulcinj) | New borehole | ME_AB_GW_I_1 |
| 2 | Popovići (Bar) | New borehole | ME_ABGGW_K_2 |
| 3 | Radovče | New borehole | ME_AB_GGW_C_2 |
| 4 | Riječani | New borehole | ME_AB_GGW_K_10 |
| 5 | Goljemadi | New borehole | ME_AB_GGW_K_7 |

| MNE No. | Name | Type | Code of GWB/GGWB |
|---|---|---|---|
| 6 | Trgaj (Cijevna) | New borehole | ME_AB_GGW_C_4 |
| 7 | Cijevna (mouth) | New borehole | ME_AB_GGW_I_2 |
| 8 | Risan (near school) | New borehole | ME_AB_GW_K_5 |
| 9 | Čevo | New borehole | ME_AB_GGW_K_8 |
| 10 | Lugovi (Budva) | New borehole | ME_AB_GGW_K_3 |
| 11 | Jaz | New borehole | ME_AB_GGW_K_3 |
| 12 | Bandići (Vučiji Studenac) | New borehole | ME_AB_GGW_K_8 |
| 13 | Plantaže | New borehole | ME_AB_GGW_I_2 |
| 14 | Budva (bus station) | Old borehole | ME_AB_GGW_K_3 |
| 15 | Buljarica | Old borehole | ME_AB_GGW_K_2 |
| 16 | Lisna Bori | Old borehole | ME_AB_GW_I_1 |
| 17 | Orahovsko polje | Old borehole | ME_AB_GGW_C_1 |
| 18 | Sjenokos | Old borehole | ME_AB_GGW_C_1 |
| 19 | Kaludjerovo Oko | Old borehole | ME_AB_GGW_K_7 |
| 20 | Bolje Sestre (borehole) | Old borehole | ME_AB_GGW_K_7 |
| 21 | Reževića River Spring | Tapped Spring | ME_AB_GGW_K_2 |
| 22 | Kajnak Spring | Tapped Spring | ME_AB_GGW_K_2 |
| 23 | Gač Spring | Tapped Spring | ME_AB_GGW_K_2 |
| 24 | Velje Oko Spring | Tapped Spring | ME_AB_GGW_K_1 |
| 25 | Obošničko Oko | Natural Spring | ME_AB_GGW_C_3 |
| 26 | Sutorinsko polje | Old borehole | ME_AB_GW_K_4 |
| 27 | Opačica | Old borehole | ME_AB_GW_K_4 |
| 28 | Grbaljsko polje | Old borehole | ME_AB_GGW_K_3 |
| 29 | Podgorska Spring | Tapped Spring | ME_AB_GGW_C_1 |
| 30 | Ribnička Spring | Natural Spring | ME_AB_GGW_C_4 |
| 31 | Bolje Sestre Spring | Tapped Spring | ME_AB_GGW_K_7 |
| 32 | Mareza Spring | Tapped Spring | ME_AB_GGW_C_2 |
| 33 | Vidrovan Spring | Tapped Spring | ME_AB_GGW_K_9 |
| 34 | Bioče | Old borehole | ME_AB_GGW_C_4 |
| 35 | Zagorič | Old borehole | ME_AB_GGW_I_2 |
| 36 | Ćemovsko polje | Old borehole | ME_AB_GGW_I_2 |
| 37 | Viš springs | Tapped Spring | ME_AB_GGW_C_2 |
| 38 | Orahovac | Old well | ME_AB_GW_K_6 |
| 39 | Svetigora spring | Natural spring | ME_AB_GGW_K_11 |
| 40 | Zaslapnica | Natural spring | ME_AB_GGW_K_10 |
| 41 | Nikšić (Miločani) | Old borehole | ME_AB_GGW_C_3 |

## Figure 6.3 Location of Groundwater monitoring stations in the Adriatic River Basin



# 7 WATER STATUS

## 7.1 Surface waters

A combination of hydrobiological and chemical methods is required to obtain information on the ecological and chemical status of individual surface water bodies according to the WFD. Surface water status is the general expression of the status of a body of surface water, determined by the poorer of its ecological and chemical status. Good surface water status means that its ecological and chemical status is at least “good”.

### 7.1.1 Chemical status approach and assessment

Montenegro is in process of adoption of relevant national regulative for assessment of chemical status of water bodies. The methodology and Ecological Quality Standards (EQSs) are prescribed in the relevant EU Directive (EQSD 2013/39/EU) and QA/QC Directive (2009/90/EC) to determine chemical status and those documents have been used as tool for indicative chemical status assessment. Here we underline that it is indicative chemical status assessment since the data on chemical status is limited and in majority of SWBs, the indicative chemical status is assessed taking into the consideration the risk analysis and information on type and intensity of pressures, involving also “expert judgment” as a tool for summarizing information on pressures and relevant impacts to particular water body.

**Table 7.1 Assessment of indicative chemical status based on 2018 survey[187]**

| No. | | Water body | Name of site | Chemical Status | WFD PS causing exceedance of EQS (W - water/B - biota) |
|---|---|---|---|---|---|
| **1** | Zeta | Zeta 1 | Duklov most | | |
| **2** | Zeta | Zeta 4 | Vranjske njive | | |
| **3** | Morača | Morača 4 | Zlatica | | DEHP (W) |
| **4** | Morača | Morača 5 | City collector | | DEHP (W) |
| **5** | Rijeka Crnojevića | N/A | Upstr. Rijeka Crnojevića | | |
| **6** | Skadar Lake | WB2_North | Vranjina | | BDEs (B-2 positive samples) |
| **7** | Bojana | Bojana | Fraskanjel | | Ni (W) |
| **8** | Transitional | Kotorski | Kotor Bay-IBM | | BDEs (B) |
| **9** | Coastal | MNE_CW4 | Budva Bay-Slovenska plaža | | BDEs (B) |
| **10** | Coastal | MNE_CW4 | MNE_CW 4-Drobni pijesak | | Ni (W) |

- chemical status: - good
- chemical status: - failing to achieve good status

187 Carried out in 2018 under the EU project: Strengthening Capacities for Implementation of the EU Water Framework Directive in Montenegro.

The following results regarding the priority pollutants can be underlined for the Adriatic River Basin:

- Except the monitored sites on the Zeta and Rijeka Crnojevića Rivers, all other sites covered by 2018 chemical monitoring failed to achieve good status.

- An overview on the presence of metals in the Adriatic River Basin shows that out of the four WFD PS metals only Ni (AA-EQS 4 ug/l) exceeded the EQS value at two sites - Bojana - Fraskanjel; 8.9 ug/l and Coastal - MNE_CW 4-Drobni pijesak; 5 ug/l.

- Analyses of other metals and metalloids: arsenic (As), barium (Ba), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and vanadium (V) showed high concentrations of Cr with highest value 7.2 ug/l at Zeta – Downstream Danilovgrad – Vranjske njive.

- The group of industrial pollutants comprised of 6 WFD PS. DEHP, a ubiquitous plasticiser, was determined in all water samples and exceeded its AA-EQS (1.3 ug/l) at two sites at the Morača River – Zlatica and City collector.

- Tributyltin compounds and PAHs (13 compounds) were not detected in analysed water samples.

- Non-target screening of the whole water revealed presence of several tens of compounds in the samples; approximately 36% of the detected compounds could be provisionally identified whereas the rest of them stayed unknown. Majority of the identified substances belong to the naturally occurring compounds such as branched alkanes, alkenes, fatty acids and their respective esters and alcohols. Several identified substances could be unambiguously linked to the human and industrial activities. The most abundant group of pollutants were phthalates (plasticisers) – typically occurring derivatives of phthalates were determined in all samples. The most contaminated were sampling sites Morača – City collector and Kotor Bay, containing diethyl phthalate, disobutyl phthalate and, excessively, dibutyl phthalate (1250 and 1130 ng/l, respectively). The concentration levels were ca. two-fold in comparison with the rest of samples. Anthropogenic pollution is reflected in high concentrations of nicotine and Caffeine (highest concentrations in sample Morača - City collector - 1.4 and 1.6 ug/l, respectively). Octocrylene, typically used as an ingredient in sunscreens and cosmetics and benzophenone, which prevents ultraviolet light from damaging scents and colours in products such as perfumes and soaps, were dominant in sea water samples. This could, of course, be expected since that samples were taken at beach areas crowded by people at the peak of the summer holiday season. Sampling points sites Morača – City collector was polluted also by other compounds, such as N,N,N',N'-tetraacetylethylenediamine, used as a detergent ingredient; dimethyl lauramine, used as a corrosion inhibitor; tetrabutylurea, used as a plasticizer; a group of phenols used as antioxidants; versalide– polycyclic (synthetic) musk used at the manufacturing of perfumes, soaps, and cosmetics. Rather alarmingly, samples from these two public beach sampling sites showed presence of markers of faecal sterols pollution such as cholestanol and cholestane-3,5-diol, 5-acetate, (3β,5α)-, which may be linked to improperly working WWTPs. In addition, high levels of plasticiser bisphenol A were determined at sampling sites Skadar Lake – Vranjina and Budva Bay.

- In respect to measurement of mercury concentration in biota, the analyses has been done in two coastal sites and one transitional WB (in all cases in *Mullus barbatus*, as well as at the Skadar Lake (*Perca fluviatilis*) and in all cases mercury concentration was exceeded EQS, which indicate that it is of high importance to monitor mercury in biota in consequent period.

- Dioxins and dioxin-like compounds were identified in one biota sample from the Boka Bay, but bellow EQS.

- Brominated diphenyl ethers (BDEs) were found to be important pollutants in the Adriatic River Basin of Montenegro. Based on 2018 survey, four out of five analysed biota samples exceeded the EQS value with highest accumulation in fish (*Rutilus rutilus*) caught in Skadar Lake. In this case, the EQS was exceeded more than 20 times. The pollution with BDEs poses the worldwide threat for both aquatic organisms and subsequently humans.

- Although concentrations of pollutants in sediments are not regulated by the WFD (used only for recording trends of pollution), it is a matrix of choice for getting the picture of long-term exposure. Extracts from two sediment samples were subjected to analysis by different GC-MS methods. Acidified extracts were tested for presence of metals using ICP-MS. Results indicated that all metals were present in all samples, with the exception of cadmium, which was below LOD in the samples from Skadar Lake and Kotor Bay. The highest concentration level of mercury -a WFD PS metal with a high tendency for bioaccumulation, was found in Kotor Bay sediment (215 ug/kg). Only one out of the seven studied pesticides was detected - p,p'-DDE (degradation product of p,p'-DDT; banned from use in Europesince1972), which was found in two sediment samples from Kotor bay (12.6 ng/kg) and Skadar Lake (10.8 ng/kg). All sediment samples were polluted with two contaminants from the group of industrial pollutants; plasticiser DEHP as a ubiquitous pollutant (concentrations ranging of 66 ng/kg at Kotor Bay) and hexachlorobenzene. Highest sum of concentrations of selected PAHs was detected in sediment sample from Kotor Bay. This sampling point also contained high concentration of the WFD PS benzo(a)pyrene (81.1 ug/kg).

- In order to obtain an overview on the candidate chemicals for the Adriatic River Basin RBSPs, non-target screening was performed at sites Skadar Lake - Vranjina and Kotor Bay.Non-target/suspect screening by liquid chromatography–mass spectrometry (LC-MS) chromatography–mass spectrometry (GC-MS) methods pointed out at occurrence of several environmentally relevant compounds - phthalates (plasticizers), and dibutyl phthalate and diethyl phthalate are among candidates to be included in the Montenegro RBSPs, together with tetra butyl urea (the same group of plasticizers), nicotine, caffeine; octocrylene (sunscreen agent), benzophenone, N.N.N',N'-tetraacetylethylenediamine (detergent ingredient), versalide (polycyclic musk used in perfumes and cosmetics) and bisphenol A (used primarily in plastics). Non-target screening of sediments confirmed the presence of degradation product of p,p'-DDT; p,p'-DDE was found in Skadar Lake - Vranjina and Transitional - Kotor Bay. Screening also confirmed the omnipresence of hexachlorobenzene in each sample. The evaluation of non-target screening chromatograms of sediments revealed presence of several congeners of PCBs in Skadar Lake - Vranjina and Transitional - Kotor Bay samples at trace levels (ng/kg).

- Plasticiser bisphenol A and pesticide malathion were detected at concentrations exceeding their PNEC values and should be considered to be included among the Montenegro RBSPs.

### 7.1.2 Ecological status/potential approach and assessment

Ecological status is an expression of the quality of the structure and functioning of aquatic ecosystems. Good ecological status is the status of body of surface water classified in accordance with Annex V of the Water Framework Directive (WFD). Good ecological potential is the status of heavily modified or artificial body of water.

Ecological status classification involves:

- Type specific classification,
- Selected quality elements should reflect the stress/pressure,
- Classification by used quality elements should fulfil normative definitions and
- The procedure of assessment is based on the comparison to the reference conditions.

Since Montenegro is in the process of adoption of the monitoring methodology for the assessment of ecological status, together with other documents that should provide procedures that are compliant with requirements of the WFD, in this document indicative ecological status is assessed based on the procedure described in Annex 2. The status is considered as indicative due to limited data on obligatory Biological Quality Elements (BQE), lack of adopted methodology, and consequently low confidence level of assessment of ecological status. The procedure of assessment of confidence level is also presented in Annex 2.

Ecological classification consists of quality elements:

- Biological quality elements
- Physical-chemical quality elements, and
- Hydro-morphological quality elements

The normative definitions provide a basis for classifying surface waters according to their ecological status. Biological as well as supporting hydromorphological and physico-chemical elements are to be used in assessment of ecological status. Ecological status classification should be made based on relevant biological and physico-chemical monitoring results. The ecological status is represented by the lower of the value of the biological and physico-chemical monitoring results for the relevant quality element.

WFD sets the normative definitions for individual biological quality elements (phytoplankton, phytobenthos and macrophytes, benthic invertebrates, fish), for each category (e.g. rivers, lakes) and for high, good and moderate status. Definitions for maximum, good and moderate ecological potential for heavily modified or artificial water bodies are also given for each quality element.

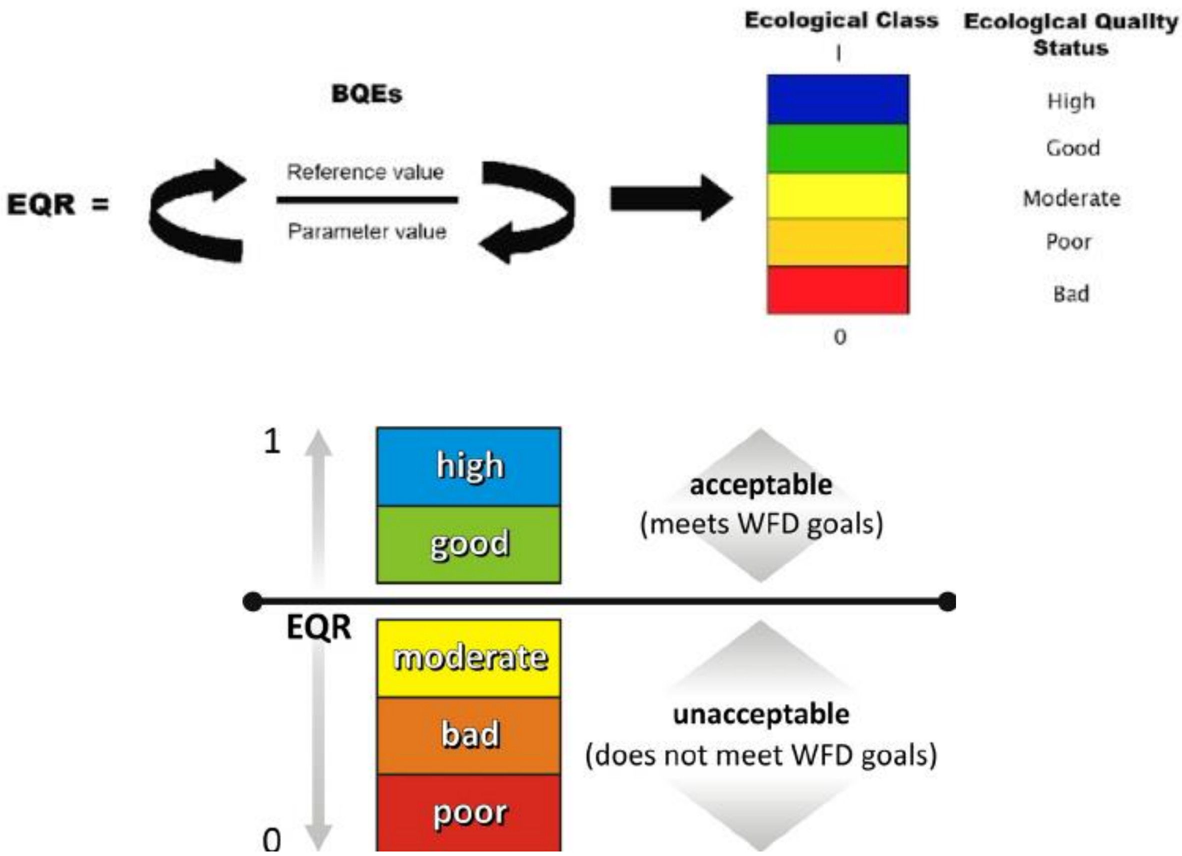
**For high status** - There are no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion. These are the type specific conditions and communities.

**For good status** - The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

**For moderate status** - The values of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Normative definitions should express the taxonomic composition and abundance; the ratio of disturbance sensitive taxa to insensitive taxa and the level of diversity. Expressing is done using metrics and/or indices. Observed value of metric and/or index is divided by reference value of metric and/or index. Results of assessment varied between 0 and 1.

### Figure 7.1 Basic principles for classification of ecological status based on Ecological Quality Ratio (EQR)




Classification of the ecological status is made based on the methodology provide in Annex 2.

For heavily modified and artificial water bodies the ecological potential is to be identified. The good ecological potential is that where the good or better ecological potential has been identified, which is also the part of procedures presented in Annex 2.

**Biological Parameters**

The information of indicative BQEs for identified SWBs in the Adriatic River Basin is presented in Annex 2, together with proposed reference values and ecological status class boundaries.

**Supporting Parameters**

Selected general physico-chemical parameters and the assessed level of hydromorphological degradation are considered as parameters supporting biological parameters in assessment of ecological status.

## 7.1.3 Hydromorphological assessment and methods

The monitoring and assessment of the hydromorphological quality of rivers is an integrated part of the EU Water Framework Directive. Hydromorphology is a basic prerequisite for biotic communities in streams and rivers. Rivers are characterized by a dynamic environment, constantly changing due to variations in flow and sediment transport. These variations and the resulting physical structures of the riverbed, banks and riparian zones are important boundary conditions for riverine ecosystems.

Hydromorphological quality elements are supporting elements to biological ones during the establishment of ecological status of the relevant water body.

The WFD requires a type specific and reference-based assessment. Based on the typology type-specific reference conditions should be described for all main parameters (including hydromorphological). While some hydromorphological parameters can be derived from various historical sources (such as planform, floodplain extent, land use), other parameters can be only defined as presence or absence (degree) of human alterations, namely the amount of artificial bank material. This requires a special field survey.

Hydromorphological monitoring involves:

- Recognizing hydromorphological features/assessment units, usually WBs,
- Determining boundaries/areas for field surveys (survey strategies),
- Accurate completion of field survey protocols based on standard EN 15843:2010 and
- Interpretation of additional data, e.g. reference photographs, historical maps, aerial photos, historical data about river interventions and works (a catalogue of hydraulic structures), etc.

The results of indicative hydromorphological assessment are presented in Table 7.2. The hydomorphological assessment involves a detail survey once per six years on each identified WB, applying standardised methodology. The assessment presented here is based on limited field information collected during 2017 and 2018 for SWBs in the Adriatic River Basin and could be considered as low to medium confidence assessment.

Hydromorphological pressures have not been assessed for transitional and coastal WBs.

In the case of inland waters, out of 41 total surface water bodies delineated in the Adriatic River Basin, 24 are considered to be without significant hydromorphological pressures. For 10 surface water bodies, hydromorphological degradation is assessed as moderate to high. Five surface water bodies are preliminary identified as HMWB, however, according to the EU regulations and requirements, that fact has to be confirmed by biological data in a consequent period. For five WBs there was no enough information to roughly assess HYMO status. In addition, one WB is considered to be HMWB candidate (Ribnica River), and status has to be confirmed in consequent period. It should be noted that that medium to high confidence HYMO status was assessed only for four WBs (applying HYMO assessment protocols), while the rest is assessed based on the field notes (2017 and 2018 data), using analyses of satellite images and maps and expert opinion (descriptive, by using normative definitions on HYMO assessment).

### 7.1.4 Surface water body (SWB) status – an overview

An assessment of surface water quality status has been made for all 41 delineated inland surface water bodies, two coastal and one transitional water body. An initial assessment of the pressures was completed, as shown in Section 4, which was based on the principles of risk assessment according to the EU WFD CIS guidelines. Furthermore, during 2018, surveillance monitoring was carried out on a number of key surface water bodies in order to serve three purposes. Firstly, to determine the actual ecological and chemical status, and secondly, to determine the parameters that would be required to be monitored at those sites during subsequent operational monitoring. An explanation of the difference between surveillance, operational and investigative monitoring is provided in Section 6.1. The third and equally important function of the monitoring exercise was to provide critical training to IHMS who are tasked with conducting all monitoring of waters in Montenegro.

Based on available data for particular WB, the confidence of the assessment has been evaluated, based on criteria presented in Table 7.2.

**Table 7.2 Description of Confidence Levels**

| Confidence level | Description |
|---|---|
| **HIGH** | All of the following criteria apply:<br>**Biology**:<br>• WFD-compliant monitoring data;<br>• Biological monitoring complies fully with preconditions for sampling/analysis;<br>• WFD compliant methods included in intercalibration process;<br>• Biological monitoring results are supported by:<br>• Results of hydromorphological quality elements (for structural degradation);<br>• Results of physico-chemical quality elements (for nutrient/organic poll.);<br>• Aggregation (grouping procedure) of water bodies in compliance with WFD shows plausible results.<br>**Chemistry:**<br>• National ecological quality standards (EQS) available for specific pollutants and sufficient monitoring data (WFD compliant frequency) available; Aggregation (grouping procedure) of water bodies in compliance with WFD shows plausible results. |
| **MEDIUM** | One or more of the following criteria apply:<br>**Biology**:<br>• WFD compliant methods not included in intercalibration process;<br>• WFD compliant monitoring data, but:<br>• biological results not in agreement with supportive quality elements or<br>• only few biological data available (possibly showing different results);<br>• Medium confidence in grouping of water bodies;<br>• Biological monitoring does not comply completely with preconditions for sampling and analysis (e.g. use of incorrect sampling period).<br>**Chemistry:**<br>• National EQS available but insufficient data available (according to WFD); Medium confidence in grouping of water bodies. |

| Confidence level | Description |
|---|---|
| | |
| **LOW** | One or more of the following criteria apply:<br>**Biology**:<br>• No WFD-compliant methods and/or monitoring data available;<br>• Evaluation from risk assessment to EQ (updated risk assessment is mandatory).<br>**Chemistry:**<br>• No national EQS available for specific pollutants, but limited data available (pollution is detectable). |

Table 7.3 shows the analysis of the pressures on all 41 surface water bodies to determine if the surface water bodies are judged to be 'at risk', 'possibly at risk' or 'likely not at risk'. This analysis provides the key information required to formulate the monitoring network for ecological status (or ecological potential), chemical status and the supporting elements of hydromorphology, which encompasses hydrological analysis (Section 6.2).

**Based on the indicative status assessment, out of 41 assessed inland SWBs, a total of 21 SWBs (51.22%) are judged to have failed to achieve good status** and mitigation measures have to be identified and applied (Section 10).

**Both coastal and one transitional SWB that were assessed as failed to achieve good status.** For 3 coastal and 4 transitional WBs the data for status assessment is not available.

In respect to interpretation of the data presented in Table 7.3, it should be underlined that only for four WBs confidence of status assessment are evaluated to be of medium confidence, which is 9.76% of total number of assessed SWBs, or 9.30% of the total length of assessed SWBs if we consider inland waters. Thus, for the complete design of mitigation measures, more information is required.

## Table 7.3 Assessment of surface water quality status in the Adriatic River Basin

**Key:**

High Status | Good Status | Moderate Status | Poor Status | Bad Status

| Sub-Basin | No.[188] | Surface Water Body | Type | Condition | Length or Area | Overall Status | HYMO[189] | Risk[190] | Confidence Level |
|---|---|---|---|---|---|---|---|---|---|
| Bojana | 1 | Bojana | R9 | Natural | 28.77 km | | | Possibly at risk | Low |
| Skadar | 2 | Orahovštica | R3 | Natural | 10.32 km | | NA | At risk | Low |
| Skadar | 3 | Crmnička rijeka | R3 | Natural | 7.91 km | | NA | Possibly at risk | Low |
| Adriatic | 4 | Sutorina_1 | R3 | Natural | 3.88 km | | NA | At risk | Low |
| Adriatic | 5 | Sutorina_2[191] | R3 | HMWB | 3.15 km | | NA | At risk | Low |
| Adriatic | 6 | Bilećko Lake | N/A | AWB | | | NA | Likely not at risk | Low |
| Morača | 7 | Morača_1 | R1 | Natural | 5.34 km | | | Likely not at risk | Low |
| Morača | 8 | Morača_2 | R2 | Natural | 15.08 km | | | Likely not at risk | Low |
| Morača | 9 | Morača_3 | R5 | Natural | 14.52 km | | | Likely not at risk | Low |
| Morača | 10 | Sjevernica_1 | R1 | Natural | 4.87 km | | | Likely not at risk | Low |
| Morača | 11 | Sjevernica_2 | R2 | Natural | 5.44 km | | | Likely not at risk | Low |
| Morača | 12 | Mrtvica_1 | R1 | Natural | 5.41 km | | | Likely not at risk | Low |
| Morača | 13 | Mrtvica_2 | R2 | Natural | 9.51 km | | | Likely not at risk | Low |
| Morača | 14 | Morača_4 | R6 | Natural | 31.95 km | | | Likely not at risk | Medium |
| Morača | 15 | Nožica | R1 | Natural | 14.44 km | | | Likely not at risk | Low |
| Morača | 16 | Mala Rijeka_1 | R2 | Natural | 12.72 km | | | Likely not at risk | Low |
| Morača | 17 | Mala Rijeka_2 | R3 | Natural | 5.66 km | | | Likely not at risk | Low |
| Morača | 18 | Morača_5 | R8 | Natural | 9.99 km | | | At risk | Medium |
| Zeta | 19 | Sušica | R2 | Natural | 6.47 km | | | Likely not at risk | Low |
| Zeta | 20 | Zeta_1 | R5 | Natural | 9.13 km | | | Likely not at risk | Low |

[188] Map numbers refer to the position of the surface water bodies shown in Section 3, Figure 3.3

[189] HYMO: hydromorphological monitoring

[190] The actual pressures on the surface water bodies are clarified in Section 4, Table 4.38

[191] Riverbed in concrete

| Sub-Basin | No.[188] | Surface Water Body | Type | Condition | Length or Area | Overall Status | HYMO[189] | Risk[190] | Confidence Level |
|---|---|---|---|---|---|---|---|---|---|
| Zeta | 21 | Zeta_2[192] | R5 | HMWB | 11.09 km | | NA | At risk | Low |
| Zeta | 22 | Gračanica_1 | R2 | Natural | 12.66 km | | | At risk | Low |
| Zeta | 23 | Liverovići[193] | R2 | HMWB | | | | Likely not at risk | Low |
| Zeta | 24 | Gračanica_2[194] | R2 | HMWB | 13.05 km | | | At risk | Low |
| Zeta | 25 | Krupac Lake | N/A | AWB | 9 $km^2$ | | NA | Likely not at risk | Low |
| Zeta | 26 | Slansko Lake | N/A | AWB | | | NA | Likely not at risk | Low |
| Zeta | 27 | Zeta_3 | R6 | Natural | 10.15 km | | | Possibly at risk | Low |
| Zeta | 28 | Zeta_4 | R8 | Natural | 36.70 km | | | At risk | Low |
| Morača | 29 | Ribnica | R6 | Natural | 8.09 km | | | At risk | Low |
| Skadar | 30 | Morača_6[195] | R8 | HMWB | 16.82 km | | | At risk | Low |
| Morača | 31 | Matica_1 | R3 | Natural | 2.73 km | | | Likely not at risk | Low |
| Morača | 32 | Matica_2 | R6 | Natural | 6.14 km | | | Likely not at risk | Low |
| Morača | 33 | Sitnica | R3 | Natural | 9.29 km | | | Possibly at risk | Low |
| Skadar | 34 | Cijevna | R6 | Natural | 31.77 km | | | Possibly at risk | Low |
| Skadar | 35 | Morača_7 | R8 | Natural | 9.17 km | | | Possibly at risk | Low |
| Skadar | 36 | WB1_Vucko blato | L4 | Natural | | | | Likely not at risk | Low |
| Skadar | 37 | WB 2_North | L5 | Natural | | | | Possibly at risk | Low |
| Skadar | 38 | W3_South west | L5 | Natural | | | | Likely not at risk | Low |
| Skadar | 39 | W4_Pelagic zone | L6 | Natural | | | | Likely not at risk | Medium |
| Bojana | 40 | Saško Lake | L4 | Natural | | | | Likely not at risk | Low |
| Skadar | 41 | Malo Blato Lake | L3 | Natural | | | | Likely not at risk | Low |
| | | MNE_CW4 | Coastal | Natural | 34.1 $km^2$ | | NA | Possibly at risk | Low |
| | | MNE_CW4 | Coastal | Natural | 34.1 $km^2$ | | NA | Possibly at risk | Low |
| | | Kotorski | Transitional | Natural | 16.3 $km^2$ | | NA | Possibly at risk | Low |

Abbreviations: HMWB – Heavily Modified Water Body; NA – Not assessed; N/A – Not applicable

[192] River connectivity lost due to hydropower plant "Salp Zete"

[193] Reservoir

[194] River substantially altered by gravel extraction

[195] River substantially altered by gravel extraction

## 7.2 Groundwater status

### 7.2.1 Groundwater body No. 1 "Southern Rim of the Skadar Lake"

The group of groundwater bodies "Southern Rim of the Skadar Lake" (ME_AB_GGW_K_1) is located in the southern part of Montenegro. It is distributed from state border with Albanian the southeast to Crmnica in the northwest, and from the top of Rumija Mountain in the southwest to Skadar Lake in the northeast. The total area is 243.3 km$^2$, of which 238.5 km$^2$is represented by karst.

Groundwater is abstracted just from water-source "Velje Oko" for supplying Bar Municipality. The total abstraction amounts in average 40 l/s. The assessed groundwater resources are around 11,500 l/s or even greater (according to the assessed effective infiltration), so it can be concluded that **the GGWB is not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ and $Mg^{2+}$ ions. Protection zones are delineated for water-source "Malo Oko".

There are two aquatic ecosystems which depend of water from this GGWB, that are Skadar Lake and Crmnica River.

According to the Vulnerability map, the classes "Very High" and "High" are not present while Low vulnerability occupy around 77% of GGWB area. The point sources of pollution are also missing in this area (Population Equivalent, PE load is practically zero). The diffuse sources of pollution are represented by agricultural areas, local landfills and settlements which are not connected to sewage system. However, Small and Moderate risk categories are prevailing, both occupying 48% of this GWB. Also, the main road Podgorica-Bar (with tunnel "Sozina") is one of the potential source of pollution but the risk is limited because the wastewater from road is collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is small, and can be concluded that **the GGWB is not under the qualitative pressure and not at risk**.

Bearing in mind the significance of this GGWB, the surveillance monitoring of groundwater should be established. The current monitoring network is very poor (parameters are periodically measured just on water source "Velje Oko"). The proposed monitoring will provide parameters for qualitative and quantitative status, so adequate precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.2 Groundwater body No. 2 "Ulcinjsko polje"

The transboundary groundwater body "Ulcinjsko polje" (ME_AB_GW_I_1) is located in the south part of Montenegro. It is distributed from Adriatic Sea in the south to Fuša Kravari in the north, and from Bojana River in the east to Ulcinj in the west. The total area is 111.1 km$^2$.

Groundwater abstraction amounts 250 l/s, mainly for Ulcinj Municipality water supply. There is one water-sources which is connected to water supply system, that is water source "Lisna Bori". Also, there are many private wells with unknown abstraction rates distributed over the valley. The assessed groundwater resources in this GWB are around 900 l/s, while projected water demands are around

300 l/s. In case that the city continue to exploite “Lisna Bori” for its water supply would instead to be fully connected to the Regional Waterworks for Montenegrin Coast, the pressure on groundwater resources is likely to increase in near future. Based on established criteria for quantitative risk assessment it can be therefore concluded that **the GGWB is under the quantitative pressure and at risk.**

The salinity of groundwater is increased in the central and southern part of Ulcinj polje (concentrations of $Na^+$, $Cl^-$ and $SO_4^{2-}$ are high). In the water source “Lisna Bori” salinity is lower, because of larger distance from the coastline, but the amounts of organic matter and $H_2S$ are increased, so the water does not meet the criteria for drinking water without additional treatments. Protection zones are delineated for the water source “Lisna Bori”.

There are five ecosystems which depend of water from this GWB: Bojana River, Šasko Lake, Porta Milena, Kodra Wetland and Adriatic Sea.

According to the Vulnerability map, the classes “Very High” and “High” vulnerability occupy around 39% and 4%, respectively of GWB area. There are no considerable point sources of pollution in this area (TBD). The diffuse sources of pollution are represented by agricultural areas, local landfills, road network and settlements which are not connected to sewage system. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is still relatively low, PE load is assessed on c. 10 000 PE. In accordance with established criteria PE Load / Vulnerability is 11.77 and results with GWB under pressure and “Potentially at Risk”. The main problem for the groundwater quality represents the natural chemical composition, i.e. increased concentrations of $Na^+$, $Cl^-$ and $SO_4^{2-}$, $H_2S$ and organic matter. According to this information, it can be concluded that the quality status for this GWB is poor**.** Except for naturally ‘poor’ quality status, **the GWB is actually under the qualitative pressure and potentially at risk, with threats for additional quality degradation due to intrusion of sea water**.

Bearing in mind the significance of this GWB, the operational for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on water source “Lisna Bori”). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.3 Groundwater body No. 3 “Možura - Paštrovići”

The group of groundwater bodies “Možura-Paštrovići” (ME_AB_GGW_K_2) is located in the southern part of Montenegro. It is elongated along the SE-NW direction, from Ulcinj to Sveti Stefan Island. The total area of GGWB is 399 $km^2$.

The total registered groundwater abstraction amounts around 326 l/s in average. The main water-sources are: Gač (Q=20 l/s), Klezna (Q=23 l/s), Mide (Q=5 l/s), Kaliman (Q=2 l/s), Salč (Q=2 l/s), Brca (Q=60 l/s), Kajnak (Q=70 l/s), Zaljevo (Q=20 l/s), Turčini (Q=1 l/s), Sustaš (Q=2 l/s), Čanj (Q=8 l/s), Reževića Spring (Q=80 l/s), Buljarica (Q=25 l/s), Lončar (Q=4 l/s), Kaliman (Q=2 l/s) and Salč (Q=2 l/s) (PLTWSM 2016). The assessed groundwater resources are around 8,000 l/s. Considering actual groundwater extraction of 326 l/s, only about 5% of renewable resources are currently utilized. It can be thus concluded that the **GGWB is in good status, not under the quantitative pressure and not at risk**.

The groundwater quality is relatively good, except of groundwater from coastal intergranular aquifers (Bar and Buljarica) where water salinity is higher closer to the coast, because of sea water intrusion.

After extreme rainfall events there is increase of turbidity and bacteria in spring water. Generally, the spring water has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for water sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, Buljarica, Lončar, Kaliman and Salč.

The main ecosystem which depend of water from this GGWB is Adriatic Sea, but there are also numerous small streams that receives water from the springs.

According to the Vulnerability map, the class "Very High" vulnerability occupies around 4% of GGWB area. There are no large point sources of pollution in this area except of port "Bar"(according to the map of industrial polluters). The PE Load is assessed on 2 000 PE. The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Many septic tanks exist in touristic, not permanently inhabited houses. Also, the main road Ulcinj-Budva is one of the potential sources of pollution because the wastewater from road is not collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is relatively low. According to this assessment, it can be concluded that **the GGWB is Not under the qualitative pressure and** actually **Not at risk**, but this is to be verified by future monitoring.

Bearing in mind the significance of this GGWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is not good enough (parameters are periodically measured just on water sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, Buljarica, Lončar, Kaliman and Salč). The proposed monitoring should provide parameters for qualitative and quantitative status assessment, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.4 Groundwater body No. 4 "Grbalj - Luštica"

The group of groundwater bodies "Grbalj-Luštica" (ME_AB_GGW_K_3) is located in the southern part of Montenegro. It is elongated along the SE-NW direction, from Sveti Stefan Island to Luštica Peninsula. The total area is 257.9 $km^2$.

The total groundwater abstraction amounts around 65 l/s. The main water-sources are: Topliš-Tivat (Q=20 l/s), Grbaljsko polje (Q=30 l/s), Spring under the Pyramid (Q=5 l/s), Lončar (Q=4 l/s), Zagradac (Q=2 l/s), Zagora (Q=3 l/s), Topliš Spring-Budva (Q=1 l/s) (PLTWSM 2016). The assessed groundwater resources are around 7,000 l/s. Considering actual groundwater extraction of 65 l/s, only about 0.9% of renewable resources are currently utilized. It can be thus concluded that **the GGWB is in good status, not under the quantitative pressure and not at risk**.

The groundwater quality is relatively good, except of groundwater from coastal aquifers (Bečići, Budva, Jaz, Grbalj and Luštica) where a salinity is high, because of sea water intrusion. After extreme rainfall events there is an increase of turbidity and bacteria in spring water. Generally, the spring water has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for water sources: Topliš-Tivat, Grbaljsko polje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring-Budva.

The main ecosystem which depend of water from this GGWB is Adriatic Sea, but there are also numerous small streams that receives water from the springs.

According to the Vulnerability map, the classes “Moderate“ vulnerability is dominant and occupies 77% of GWB, while “High” vulnerability occupies less than 1% of GGWB area. Concerning point sources of pollution in this highly touristic area the actual PE Load is assessed on 15 874 PE, which considering established criterion PE Load vs. Vulnerability is at potential risk level (ratio 12.55). The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Also, the main road Petrovac-Tivat is one of the potential sources of pollution because the wastewater from road is not properly collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is still low. According to this assessment, it can be concluded that **the GGWB is under pressure on water quality and potentially at risk,** but this need verification through systematic operational monitoring.

Bearing in mind the significance of this GGWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is not sufficient (parameters are periodically measured just on water sources: Topliš-Tivat, Grbaljsko polje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring-Budva). The proposed monitoring should provide parameters for more detailed assessment of qualitative and quantitative status, in order to take precautionary protection measures necessary for sustainable groundwater development.

### 7.2.5 Groundwater body No. 5 “Opačica - Morinj”

The groundwater body “Opačica-Morinj” (ME_AB_GW_K_4) is located in the south-western part of Montenegro. It is extended from Prevlaka and border with Croatia in south to Krivošije in north, and from Verige in east to Debeli Brijeg in west. The total area is 136 $km^2$, of which around 102 $km^2$ is karst.

The total groundwater abstraction amounts around 80 l/s. There are two water-sources: Opačica (Q=50 l/s) and Sutorinsko polje (Q=30 l/s). The assessed groundwater resources are around 8 – 8.2 $m^3/s$. Considering actual groundwater extraction of 80 l/s, only about 1-1.5% of renewable resources are currently utilized. It can be thus concluded that the **GWB is in good status, not under the quantitative pressure and not at risk**.

The groundwater quality is relatively good, except of groundwater from coastal aquifers (Morinj Springs, Verige Springs) where a salinity is high in summer-time, because of sea water intrusion. After extreme rainfall events there is increase of turbidity and bacteria in spring water. Generally, the spring water has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for water sources “Opačica” and “Sutorinsko polje”.

The main ecosystems which depend of water from this GWB is Adriatic Sea (Herceg Novi Bay) and Sutorina River.

According to the Vulnerability map, the classes “Very High” and “Moderate to High” vulnerability have large distribution and occupy around 80% of GWB area. There are no known large point sources of pollution in this area except of port “Zelenika” (according to the map of industrial polluters). The calculated PE Load is 500. The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is still relatively low, ratio PE Load vs. Vulnerability is 0.37. According to this assessment, it can be concluded that **the GWB is actually not under the qualitative pressure and at risk.** But operational monitoring of groundwater quality for verify such a statement is highly recommended.

Therefore, bearing in mind the significance of this GWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is not adequate (parameters are periodically measured just on water sources: “Opačica” and “Sutorinsko polje”). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.6 Groundwater body No. 6 “Orjen”

The groundwater body “Orjen” (ME_AB_GW_K_5) is located in the south-western part of Montenegro. It is distributed from Lipci in south to Jabuke in north, and from Jastrebica in west to Perast in east. The total area is 409.6, of which even 407.3 $km^2$ is karst.

The total groundwater abstraction amounts around 25 l/s and most of settlements are now connected to Regional waterworks. The main water-sources are: Risanska Spilja (Q=20 l/s), Smokovac Spring (Q=5 l/s) and Grahovo Lake (Q=1 l/s). The assessed groundwater resources are around 35,000 l/s (Radulović, 2000). Considering actual groundwater extraction of 25 l/s, only about 0.07% of renewable resources are currently utilized. It can be thus concluded that the **GWB is in good status, not under the quantitative pressure and not at risk**.

The groundwater quality is relatively good during the rainy period (autumn, winter, spring). Generally, the spring water has low TDS (around 300 mg/l) in that period of year, with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. After extreme rainfall events there is increase of turbidity and bacteria in spring water. However, the groundwater quality of coastal aquifer is disturbed during the summer because of sea water intrusion (salinity, i.e. concentration of $Na^+$, $Cl^-$ and $SO_4^{2-}$ ions, exceeds threshold value). Protection zones are delineated for water sources: Risanska Spilja and Smokovac Spring.

There are two ecosystems which depend of water from this GWB: Adriatic Sea (Risan Bay) and Grahovo Lake (reservoir).

According to the Vulnerability map, and considering the fact that karst is dominant the classes “Very High” and “Moderate to High” vulnerability occupy around 81% of GWB area. There are no known point sources of pollution in this area. The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Also, the main road Risan-Vilusi is one of the potential sources of pollution because the wastewater from road is not adequately collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is still low except the traffic. According to this assessment, it can be concluded that **the GWB is not under qualitative pressure and not at risk.**

Bearing in mind the significance of this GWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is not good enough (parameters are periodically measured just on water sources: Risanska Spilja and Smokovac Spring). The proposed monitoring will provide parameters for qualitative and quantitative status, and precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.7 Groundwater body No. 7 “Lovćen (Njeguši)”

The groundwater body “Lovćen (Njeguši)” (ME_AB_GW_K_6) is located in the southern part of Montenegro. It is extended from Radanovići in the south to Čumojevica in north, and from Verige in west to Resna in east. The total area is 330.2 $km^2$, of which 308 $km^2$ is karst.

The total groundwater abstraction amounts around 360 l/s, which is still far below existing groundwater resources. The main water-sources are: Plavda (Q=20 l/s), Škurda and Tabačina (Q=200 l/s), water sources Ercegovina and Cicanova Kuća in Orahovac (Q=120 l/s), Tunnel Vrmac (Q=20 l/s), Simoš Spring (Q=5 l/s), Gornji Grbalj (Q=15 l/s) (PLTWSM 2016). The assessed groundwater resources are around 10,000 l/s (Radulović 2000) or greater 16,000 l/s (according to the assessed effective infiltration). Considering actual groundwater extraction (mostly from tapped springs) of 360 l/s, only about 2.2–3.6% (calculated by both assessments) of renewable resources are currently utilized. It can be thus concluded that the **GWB is in good status, not under the quantitative pressure and not at risk**.

The groundwater quality is relatively good during the rainy period (autumn, winter, spring). Generally, the spring water has low TDS (around 300 mg/l) in that period of year, with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. After extreme rainfall events there is increase of turbidity and bacteria in spring water. However, the groundwater quality of coastal aquifers is disturbed during the summer because of sea water intrusion (salinity, i.e. concentration of $Na^+$, $Cl^-$ and $SO_4^{2-}$ ions, exceeds threshold value). This is especially important for the springs around the Kotor city, where salinity increases during recession periods.

Protection zones are delineated for water sources: Plavda, Škurda and Tabačina, water sources Ercegovina and Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj.

The main ecosystem which depend of water from this GWB is Adriatic Sea (Kotor Bay).

According to the Vulnerability map and dominant presence of karstified rocks, the classes "Very High” and "Moderate to High” vulnerability occupy around 67.8% of GWB area. According to the map of industrial polluters polluters there are few potential point sources of pollution such as: meat processing "Niksen Cavor", Port Kotor, marina Tivat and meat processing in Njeguši. The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Also, the Tunnel Vrmac, even it has a waste water drainage system, could be the potential source of pollution in accident situations. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is still low, having ratio PE Load vs. vulnerability below 2 (1.89). According to this assessment, it can be concluded that **the GWB is not under the qualitative pressure and not at risk.**

Bearing in mind the significance of this GWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is not good enough (parameters are periodically measured just on water sources: Plavda, Škurda and Tabačina, water sources Ercegovina and Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.8 Groundwater body No. 8 “Orahovštica – Rijeka Crnojevića”

The group of groundwater bodies “Orahovštica-Rijeka Crnojevića” (ME_AB_GGW_C_1) is located in the southern part of Montenegro. It is distributed from Lovćen Mountain in the west to Skadar Lake in the east, and from Jankovići in the north to Paštrovska Mountain in the south. The total area is 241.3 $km^2$, of which 237.5 $km^2$ is represented by karst.

The total groundwater abstraction amounts in average 460 l/s. There is five water sources: Podgor (200 l/s), Uganjska springs (10 l/s), Obzovica Spring (1 l/s), Orahovsko Polje (150 l/s) and Sjenokos (100 l/s). The assessed groundwater resources are around 8,400 l/s (Radulović 2000) or greater (according to the assessed effective infiltration), so it can be concluded that **the GGWB is not under the quantitative pressure and not at risk.**

Except of the water from Crnojevića Spring, a groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ and $Mg^{2+}$ ions. The Crnojevića Spring is polluted by wastewater of Cetinje. During period of heavy and intense rains swallow holes could not efficiently absorb all runoff water and this may cause temporary polje flooding (several cases during 1980s and 1990s). Improper waste management also contribute to limiting capacity of swallow holes as they become filled with solid waste. Protection zones are delineated for each mentioned water sources used for water supply.

There are three ecosystems which depend of water from this GGWB: Skadar Lake, Crnojevića River and Orahovštica River.

According to the Vulnerability map, the classes "Very High” and "High” vulnerability occupy around less than 5% of GGWB area. The discharge of untereated wastewater from Cetinje polje, which discharging into the swallow hole and further to karst aquifer, is the main point source of pollution. According to the map of industrial polluters polluters there are some more potential point sources of pollution such as: factory of paper "Kartonaža", Meat processing "Interproduct" and fish processing "Ribarstvo Rijeka" The diffuse sources of pollution are represented by agricultural areas, local landfills and settlements which are not connected to sewage system. Also, the main road Podgorica-Budva is one of the potential sources of pollution because the wastewater from road is not collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is still relatively high, due to calculated PE Load of 17,560. According to the assessment (PE / Vulnerability of 14.78), it can be concluded that **the GGWB is under the qualitative pressure and potentially at risk.**

Bearing in mind the significance of this GGWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on water sources connected to water-supply system). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.9 Groundwater body No. 9 “Karuč - Sinjac”

The group of groundwater bodies “Karuč-Sinjac” (ME_AB_GGW_K_7) is located in the southern part of Montenegro. It is distributed from Bjelice in the northwest to Malo Blato in the southeast. The total area of the GGWB is 277.2 $km^2$.

The total groundwater abstraction amounts 1,515 l/s. The main water-source is Bolje Sestre Spring which is used for the water supply of almost entire Montenegrin coast during the summer months (Q=1,500 l/s, but this discharge is never fully utilized). Also, there are abstraction wells in Rvaši (Q=5 l/s), Drušići (Q=5 l/s), Župa Dobrska (Q=5 l/s) and Goljemadi (water-source is under construction). The assessed groundwater resources of GGWB are around 19,000 l/s (Zogović 1992; Radulović et al. 1979), so it can be concluded that **the GGWB is not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is temporary increase of turbidity and bacteria in water. The bacteriological pollution is detected few times in the samples of water from Karuč Spring. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$. Protection zones are delineated for the water-sources "Bolje Sestre" (only zones I and II, and not III SPZ) and "Župa Dobrska".

There are two aquatic ecosystems which depend of water from this GGWB: Skadar Lake and Malo Blato.

According to the Vulnerability map, the class "Moderate to High" vulnerability occupies around 79% of GGWB area, 50% and 29% respectively. There are no direct point sources of polution within the area of GGWB. The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and villages such as Grbavci which are not connected to sewage system. Also, the main road Podgorica-Cetinje-Budva is one of the potential sources of pollution because the wastewater from road is not collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer pollution is still relatively low concerning direct surface of this GWB. But, due to very probable established hydraulic connection with alluvial aquifer of Moraca and Cijevna rivers in adjacent GWB Zeta Valley, there is threat on water quality. Therefore, if uncontrolled extraction of gravel from Morača River valley close to Grbavci is likely to continue the current alluvial "buffer" can be damaged and direct hydraulic connection with river water established. This may have negative implications on water quality of tapped karst aquifer. Along with removal of alluvial "buffer" consists of gravel and sand It is also possible to have increased river flow and reduced aquifers' recharge. However, this possibility should be further studied, especially because III Sanitary protection zone of the source is still not determined. Potential serious problems for water quality could be planned construction of the Podgorica waste water treatment plant upstream of Grbavci, as well as highway which should partly crossing this GWB. According to current situation and assessment made, it can be concluded that **the GWB is actually not under the qualitative pressure but is potentially at risk.**

Bearing in mind the significance of this GGWB for regional water supply for entire Adriatic Coast, the operational monitoring for both, quantity, and quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on water source "Bolje Sestre"). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary and possibly remedial protection measures necessary for sustainable groundwater development can be timely taken.

### 7.2.10 Groundwater body No. 10 "Zeta Valley"

The group of groundwater bodies "Zeta Valley" (ME_AB_GGW_I_2) is located in the central part of Montenegro. It is distributed from Zlatica in the north to Skadar Lake in the south, and from Donji Kokoti in the west to Tuzi in the east, including the capital city of Podgorica. The total area is 248.5 km$^2$.

The total groundwater abstraction amounts in average 4,200 l/s. There are five water-sources which are cconnected to water supply system: Ćemovsko polje (410 l/s), Zagorič (545 l/s), Tuzi (12 l/s), Dinoši (70 l/s) and Vuksan Lekić (130 l/s). Groundwater is also abstracted for the industrial needs (Aluminium Plant, Q≈1,000 l/s) and irrigation ("Plantaže", Q≈2,000 l/s). Also, there are many private wells with unknown abstraction rates distributed all over the valley. Due to lack of this data below assessment should be used with caution. The assessed total groundwater renewable discharge is around 12,000 l/s, but direct infiltration and exploitable reserves are considerably lower, c. 6,200 l/s (> 50% is currently utilised), so it can be concluded that **the GGWB is under the quantitative pressure and at risk**.

The groundwater quality is poor on many locations over the valley, especially downstream the large sources of pollution (Aluminium Plant, agriculture areas and settlements which are not connected to sewage system). Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$ and $Ca^{2+}$ ions. Protection zones are delineated for the mentioned water sources used for water supply.

There are three large ecosystems which heavily depend of water from this GGWB: Skadar Lake, Morača River and Cijevna River, and there are also a few smaller streams.

According to the Vulnerability map, the classes "Very High" and "Exteremely High" vulnerability occupy around 90% of GGWB area. According to the map of industrial polluters polluters there are few potential point sources of pollution such as: Aluminium Plant, factory of wine and vineyards "Plantaže",

Processing of fruits and vegetables "Plodovi Crne Gore" and chemical industry "Hemko". The diffuse sources of pollution are represented by agricultural areas, red mud flotation lake of Aluminium Plant, local landfills, road network and settlements which are not connected to sewage system. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is high, the third highest in entire Montenegro: It is confirmed by PE Load assessment, which resulted with PE of 120,750. The ratio PE Load vs. Vulnerability is even 204.95, the largest in Montenegro. According to the assessment, it can be concluded that **the GGWB is under the qualitative pressure and at risk of pollution.**

Bearing in mind the significance of this GGWB, which represent one of the major groundwater reservoir in SE Europe, and a good reserve for Montenegro to combat with negative impacts of climate changes, the operational monitoring of groundwater for quality as well as quantity, should be established. The current monitoring network is not good enough (parameters are periodically measured on water sources connected to water-supply system and several other locations in Golubovci area at the piezometers). Very important will be monitoring of pumped amount of groundwater for the purpose of irrigation of large vineyard complex of "Plantaze", the largest wine producer in Montenegro. The river Cijevna and it alluvium seems to be in direct hydraulic connection with "Plantaze" field. It will be also important to follow up groundwater quality and concentration of pesticides and protective bio-chemical components, as well as migration of already polluted groundwater in Golubovci area from Aluminium Plant. The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary and remedial protection measures necessary for sustainable groundwater development can be envisaged and taken timely.

### 7.2.11 Groundwater body No. 11 “Prekornica - Bjelopavlići”

The group of groundwater bodies “Prekornica - Bjelopavlići” (ME_AB_GGW_C_2) is located in the central part of Montenegro. It is distributed from Zeta Valley in the southeast to Mijokusovići in the northwest, and from Frutak in the southwest to Brajovićka Ponikvica in the northeast. The total area is 418 $km^2$, of which 319 $km^2$ is karst.

The total groundwater abstraction amounts around 2200 l/s. The main water-sources are „Mareza“ (Q=2110 l/s) tapped for the capital city of Podgorica, „Žarića Jama“ (Q=35 l/s), „Brajovoća Jama“ (Q=32 l/s), „Slatina Springs“ (Q=15 l/s), „Viški Well“ (Q=10 l/s), „Iverak“ (Q=1 l/s). The assessed total groundwater resources are around 15,000 l/s. Considering actual groundwater extraction (mostly from tapped springs) of 2200 l/s, projected water demands which will raise to about 18% of renewable resources. It can be thus concluded that the **GGWB is not under the actual high quantitative pressure, but potentially may come at the risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for water sources “Mareza”, “Slatina” and “Iverak”, but are not respected very much in the water practice (e.g. Mareza settlements just over the spring site and without sewage water canalization).

The main ecosystem which depend of water from this GGWB is Zeta River, but there are also numerous smaller streams that receives water from the springs.

According to the Vulnerability map, the classes “Very High” and “High” vulnerability occupy around 79% of GGWB area. According to the map of industrial polluters there are few potential point sources of pollution such as: stone processing "Mermer", juice factory "Pirella", facory of coffee "Crnagoracoop", factory of animal feed in Spuž and milk factory "Lazine". The diffuse sources of pollution are represented by agricultural areas, local landfills and settlements which are not connected to sewage system. Also, the secondary road Podgorica-Glava Zete is one of the potential sources of pollution because the wastewater from road is not collected and treated. PE Load is assessed at 4000, while ratio PE Load vs. Vulnerability is 4.03. According to the assessment, it can be concluded that **the GGWB is not under the qualitative pressure and not at risk of pollution.**

Bearing in mind the significance of this GGWB, the operational monitoring of groundwater for quality as well as for quantity, should be established. The current monitoring network is not good enough (parameters are periodically measured just on water sources “Mareza”, “Žarića Jama”, “Brajovoća Jama”, “Slatina”, “Iverak”, “Viški Well”). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.12 Groundwater body No. 12 “Garač”

The group of groundwater bodies “Garač” (ME_AB_GGW_K_8) is located in the central part of Montenegro. It is distributed from Ilijina Strana in the northwest to Zelenika in the southeast, and from Lipa in the west to Bjelopavlićka Valley in the east. The total area is 338.4 $km^2$, of which 335.2 $km^2$ is represented by karst.

The total groundwater abstraction amounts around 200 l/s. The main water-sources are Oraška Jama (Q=120 l/s), Milojevića Spring (Q=60 l/s) and Vučiji Studenac (Q=20 l/s). The assessed groundwater resources are around 17,000 l/s, so it can be concluded that **the GGWB is not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for water sources "Oraška Jama" and "Milojevića Spring".

There are two ecosystems which depend of water from this GGWB: Zeta River and Sitnica (Matica) River.

According to the Vulnerability map, the classes "Very High" and "High" vulnerability occupy around 89 % of GGWB area. There are no known point sources of pollution in this area. The diffuse sources of pollution are represented by agricultural areas, local landfills and settlements which are not connected to sewage system. Also, the main road Podgorica-Nikšić is one of the potential source of pollution because the wastewater from road is not collected and treated. Taking into account the present sources of pollution (No PE Load), and assessed natural vulnerability of terrain, the risk of aquifer is still low. According to this assessment, it can be concluded that **the GWB is not under the qualitative pressure and not at risk.**

Bearing in mind the actual environmental situation of this GGWB, the surveillance monitoring of groundwater for both, quantity and quality should be established. The current monitoring network is very poor (parameters are periodically measured just on water sources "Oraška Jama" and "Milojevića Spring"). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.13 Groundwater body No. 13 "Vojnik"

The group of groundwater bodies "Vojnik" (ME_AB_GGW_K_9) is located in the western part of Montenegro. It is distributed from Nikšićko polje edge and Vidrovan in the south to Vojnik in the north, and from Goslić in the west to Gackove Grede in the east. The total area is 448.5 $km^2$, of which 423 $km^2$ is karst.

The total groundwater abstraction amounts around 200 l/s. The only one municipal water-source in the area of this GGWB. This is water source „Vidrovan" tapped for Nikšić. The assessed groundwater resources are around 18,400 l/s (Radulović M., 2000) or even greater 20,500 l/s (according to the assessed effective infiltration). Considering actual groundwater extraction of 200 l/s, only about 1% of renewable resources are currently utilized. It can be thus concluded that **the GGWB is in good status, not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water, including Vidrovan water source. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for the water source "Vidrovan".

There are two ecosystems which depend of water from this GGWB: Sušica River and Rastovac River. These two rivers create Zeta River which is distinguished as a surface water body.

According to the Vulnerability map, the classes “Very High” and “High” vulnerability occupy around 77% of GGWB area. There are no point sources of polution within the area of GGWB (TBD). The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Also, the main roads Nikšić-Žabljak and Nikšić-Plužine are potential sources of pollution because the wastewater from roads are not collected and treated. Taking into account the present sources of pollution (no PE Load), and assessed natural vulnerability of terrain, the risk of aquifer is still low. According to this assessment, it can be concluded that **the GWB is not under the qualitative pressure and not at risk.**

Bearing in mind the significance of this GGWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on water source “Vidrovan”). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.14 Groundwater body No. 14 “Nikšićko polje”

The group of groundwater bodies “Nikšić” (ME_AB_GGW_C_3) is located in the western part of Montenegro. It is distributed from Mijokusovići in the south to Vidrovan in the north, and from Miljanići (Banjani) in the west to Maganik in the east. The total area is 990.2 $km^2$, of which 938.2 $km^2$ is karst.

The total groundwater abstraction amounts around 200 l/s. The only one official water-source in the area of this GGWB is water source „Poklonci“. The assessed groundwater resources are around 40,000 l/s. Considering actual groundwater extraction (200 l/s), only about 0.5% of renewable resources are currently utilized. It can be thus concluded that **the GGWB is in good status, not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good in the area upstream of Nikšić, but it is disrupted on the downstream area, i.e. on Glava Zete Spring (one of the main discharge points which drain eastern part of Nikšić Polje catchment area, where main sources of pollution are distributed). After extreme rainfall events there is increase of turbidity and bacteria in water of most of springs. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for the water source “Poklonci”.

There are five ecosystems which depend of water from this GGWB: Zeta River, Gračanica River, and artificial reservoirs of Slano Lake, Krupac Lake and Liverovići Lake.

According to the Vulnerability map, the classes “Very High” and “High” vulnerability occupy around 69% of GGWB area. According to the map of industrial polluters there are few potential point sources of pollution such as: Iron Factory, Brewery “Nikšić”, Hospital “Brezovik”, Bauxite Mine in Župa, Fishpond in Rastovac, Mill "Nikšić”, Meat factory "Goranović". The diffuse sources of pollution are represented by agricultural areas, many local “wild” landfills across the polje, even municipal landfill which is located directly on karst above the polje and magistral road to Podgorica, local road network, in addition to settlements which are not connected to sewage system. Also, the main road Podgorica-Nikšić is one of the potential sources of pollution because the wastewater from road is not collected and treated. However, the environmental situation is likely to improve due to recently constructed and operational WWTP for communal waste water (since 2018). Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is high: It is confirmed by PE Load assessment, which resulted with PE of 73000. The ratio PE Load vs. Vulnerability is 65.72, which is the second highest in entire Montenegro. According to the assessment, it can be concluded that **the GGWB is under the qualitative pressure and at risk of pollution.**

Bearing in mind the significance of this GGWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on water source “Poklonci”). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary to ensure sustainable groundwater development of this important GGWBs can be taken efficiently and timely.

### 7.2.15 Groundwater body No. 15 “Trebišnjica (Bilećko Lake)”

The group of groundwater bodies of transboundary character “Trebišnjica (Bilećko Lake)” (ME_A_GGW_K_15) is located in the most western part of Montenegro. It is distributed from Jabuke in the south to Čarađe in the north, and from Miljanići (Banjani) in the east to Bilećko Lake in the west. The total area is 567.5 km$^2$, of which large majority or is karst (only 8 km$^2$ is not).

The total groundwater abstraction amounts around 51 l/s, only. On the territory of Montenegro, there are just few water-sources which are used for a water supply of villages, such as Zaslapnica Spring and Čarađe Spring. The assessed groundwater resources are around 20,000 l/s. Considering actual groundwater extraction of 51 l/s, only about 0.25% of renewable resources are currently utilized. It can be thus concluded that **the GGWB is in good status, not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are not delineated for the mentioned water sources.

There are two ecosystems which depend of water from this GGWB: Bilećko Lake (Trebišnjica River) and Zaslapnica River.

According to the Vulnerability map, the classes “Very High” and “High” vulnerability occupy around 83% of GGWB area, but there are no point sources of polution within the area of GGWB. The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network and settlements which are not connected to sewage system. Also, the main roads Nikšić-Trebinje, Vilusi-Bileća and Nikšić-Gacko are potential sources of pollution because the wastewater from roads are not collected and treated. Taking in account the present sources of pollution (no PE Load), and assessed natural vulnerability of terrain, the risk of aquifer is still low. According to this assessment, it can be concluded that **the GWB is not under the qualitative pressure and not at risk.**

Bearing in mind the significance of this GGWB, the surveillance monitoring for both, quantity and quality, should be established. The current monitoring network is very poor (actually there are no any monitoring point; there are just historical monitoring data for Zaslapnica Spring). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken timely.

### 7.2.16 Groundwater body No. 16 “Kuči”

The group of transboundary groundwater bodies “Kuči” (ME_AB_GGW_C_4) is located in the central and southeastern part of Montenegro. It is distributed from Zeta Valley in the west to Korita Kučka in the east, and from Brskut in the north to Skadar Lake in the south. The total area is 430.8 $km^2$, of which large majority or 424.2 $km^2$ is karst.

The total groundwater abstraction amounts around 180 l/s. There are two municipal water-sources in the area of this GGWB, water sources „Bioče“ and „Milješ“, and few small water sources used by local settlements (Kržanja, Vrbica, Fundina). The assessed groundwater resources are around 20,000 l/s. Considering actual groundwater extraction (180 l/s), only about 0.9% of renewable resources are currently utilized. It can be thus concluded that **the GGWB is in good status, not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water of most of springs. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are delineated for the water source “Bioče” and “Milješ”.

There are five ecosystems which depend of water from this GGWB: Skadar Lake, Cijevna, Ribnica, Morača and Mala River.

According to the Vulnerability map, the classes “Very High” and “High” vulnerability occupy around 74% of GGWB area. There are no large point sources of pollution in this area, but there are many small (e.g. septic tanks). The diffuse sources of pollution are represented by agricultural areas, local landfills, local road network, settlements which are not connected to sewage system. Also, the secondary road Dinoša-Šumica, which passes along the Cijevna River, is potential source of pollution because the wastewater from these roads is not collected and treated. Taking into account the present sources of pollution, and assessed natural vulnerability of terrain, the risk of aquifer contamination is not that high. It is confirmed by PE Load assessment, which resulted with PE of 1600. The ratio PE Load vs. Vulnerability is 1.05. According to the assessment, it can be concluded that **the GGWB is actually not under the qualitative pressure and not at risk of pollution, but precaution measures are required because potential threats.**

Bearing in mind the significance of this transboundary GGWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on water sources “Bioče” and “Milješ”). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken efficiently and timely.

### 7.2.17 Groundwater body No. 17 “Morača”

The group of groundwater bodies “Morača” (ME_AB_GGW_K_11) is located in the central part of Montenegro. It is distributed from Smokovac in the south to Gornja Morača in the north, and from Maganik Mountain in the west to Vjeternik Mountain in the east. The total area is 355.2 $km^2$.

There are no tapped water-sources within area of this GGWB, just a very small portion of water is utilised my small villages in the mountains. The assessed groundwater resources are around 15,000 l/s. Considering that are no groundwater abstraction, except for the purposes of several households, it can be concluded that **the GGWB is in good status, not under the quantitative pressure and not at risk.**

The groundwater quality is relatively good. After extreme rainfall events there is increase of turbidity and bacteria in water. Generally, the groundwater has low TDS (around 300 mg/l), with the highest concentration of $HCO_3^{2-}$, $Ca^{2+}$ ions. Protection zones are not delineated because there are no official water-sources in this area.

There are three ecosystems which depend of water from this GGWB: Morača, Mrtvica and Mala River.

According to the Vulnerability map, the classes "Very High" and "High" vulnerability occupy around 70% of GGWB area. There are no point sources of pollution in this area. The diffuse sources of pollution are represented by agricultural areas, local landfills, settlements which are not connected to sewage system. Also, the main road Podgorica-Kolašin and secondary road Bioče-Mateševo are potential sources of pollution because the wastewater from these roads is not collected and treated. Also, the highway section Smokovac–Mateševo which is under construction and planed objects along that road will represent the potential sources of pollution. Taking in account the present sources of pollution (no PE Load), and assessed natural vulnerability of terrain, the risk of aquifer is low. According to this assessment, it can be concluded that **the GWB is not under the qualitative pressure and not at risk.**

Bearing in mind the the actual environmental situation of this GGWB, the surveillance monitoring for both, quantity and quality, should be established. The current monitoring network does not exist. The proposed monitoring will provide parameters for more precise assessment of qualitative and quantitative status.

## 7.3 Summary of pressures on groundwaters and surface waters

The risk assessment of groundwaters and surface waters has identified water bodies that are deemed 'at risk', 'potentially at risk' and 'not at risk'. Table 7.4 summarizes the situation for all groundwater bodies (GWBs and GGWBs) and surface water bodies in the Adriatic River Basin.

The key types of mitigation measures for surface waters and groundwaters that are judged to be 'at risk' or 'possibly at risk' are identified and elaborated in Section 10.

### Table 7.4 Groundwater and surface water bodies at risk or potentially at risk in the Adriatic River Basin

| No. | GWB or SWB | Risk Assessment | Main Pressure(s) Based on Risk Assessment |
|---|---|---|---|
| **Groundwaters** | | | |
| 2 | Ulcinjsko polje | Quantity: At risk<br>Quality: Potentially at risk | Agriculture, tourism, salt water intrusion, continuation of using groundwater sources instead of regional water supply |
| 4 | Grbalj - Lustica | Quality: Potentially at risk | • Point sources<br>• Diffuse sources |

| No. | GWB or SWB | Risk Assessment | Main Pressure(s) Based on Risk Assessment |
|---|---|---|---|
| 8 | Orahovštica – Rijeka Crnojevića | Quality: Potentially at risk | • Point sources<br>• Diffuse sources |
| 9 | Karuc - Sinjac | Quality: Potentially at risk | Connection to adjacent GWB Zeta Valley |
| 10 | Zeta Valley | Quantity: At risk<br>Quality: At risk | • 50% exploitable reserves utilized<br>• Point Sources<br>• Diffuse sources |
| 11 | Prekornica - Bjelopavlići | Quantity: Possibly at risk | • 18% of exploitable resources utilized |
| 14 | Nikšićko polje | Quality: At risk | • Point sources<br>• Diffuse sources |
| | | | • |
| **Surface waters** | | | |
| 1 | Bojana | Possibly at risk | • Point source<br>• Diffuse source<br>• Other |
| 2 | Orahovštica | At risk | • Abstraction<br>• Other |
| 3 | Crmnička rijeka | Possibly at risk | • Abstraction<br>• Physical |
| 4 | Sutorina_1 | At risk | • Diffuse source<br>• Abstraction |
| 5 | Sutorina_2 | At risk | • Diffuse source<br>• Physical |
| 18 | Morača_5 | At risk | • Point source<br>• Diffuse source<br>• Other |
| 21 | Zeta_2 | At risk | • Point source<br>• Diffuse source<br>• Physical |
| 22 | Gračanica_1 | At risk | • Point source<br>• Diffuse source |
| 24 | Gračanica_2 | At risk | • Point source<br>• Physical |
| 27 | Zeta_3 | Possibly at risk | • Diffuse source<br>• Physical |
| 28 | Zeta_4 | At risk | • Point source<br>• Diffuse source<br>• Other |
| 29 | Ribnica | At risk | • Point source<br>• Diffuse source |

| No. | GWB or SWB | Risk Assessment | Main Pressure(s) Based on Risk Assessment |
|---|---|---|---|
| | | | • Physical |
| 30 | Morača_6 | At risk | • Point source<br>• Diffuse source<br>• Physical<br>• Other |
| 33 | Sitnica | At risk | • Abstraction<br>• Physical |
| 34 | Cijevna | At risk | • Diffuse source<br>• Abstraction<br>• Other |
| 35 | Morača_7 | At risk | • Point source<br>• Diffuse source<br>• Other |
| 37 | WB 2_North | At risk | • Point source<br>• Diffuse source<br>• Other |

# 8 ECONOMIC ANALYSIS OF WATER USE

## 8.1 Introduction

### 8.1.1 Purpose of the Economic Characterization

The purpose of this economic study is to construct the general economic profile of the Adriatic Basin in Montenegro, using existing available data and to provide an initial overview of the economic benefits and costs associated with the utilization of water resources in the Adriatic Basin. The results include key water uses and significant pressures on them and estimation of the future trends of the water demand.

Emphasis is placed on characterizing a broad range of water uses, including domestic, agricultural and industrial ones. This economic analysis of Water Use in the basin, along with other technical analyses of pressures and impacts related to the Adriatic Basin will lead to the identification of a program of measures and the development of the Basin Management Plan. The main economic elements which were investigated in this document are the following:

- Analysis of economic importance of water uses
- Trends in water demand
- Assessment of current level of cost recovery for water services.

Economic analysis is a key part of the implementation of the Water Framework Directive (WFD, Directive 2000/60/EC). The Directive itself only provides a broad overview of the required economic analysis. This is a requirement of Article 5 of the WFD, "Characteristics of the river basin district, review of the environmental impact of human activity and economic analysis of water use of the WFD", which states that each Member State shall ensure that for each river basin district or for the portion of an international river basin district falling within its territory:

- An analysis of its characteristics,
- A review of the impact of human activity on the status of surface waters and on groundwater, and,
- An economic analysis of water use is undertaken according to the technical specifications set out in Annexes II and III and that it is completed at the latest four years after the date of entry into force of this Directive."

Article 9 of the WFD relates to the recovery of costs for water supply services, whereby Member States shall take account of the principle of recovery of the costs of water supply services, including environmental and resource costs, having regard to the economic analysis conducted according to Annex III, and in accordance in particular with the polluter pays principle.

In order to implement the above requirements of the WFD, two Guidance documents were issued by EU and were duly considered in this report:

- Guidance Document No 1: Economics and the Environment – The Implementation Challenge of the Water Framework Directive, Produced by Working Group 2.6 – WATECO
- Assessment of Environmental and Resource Costs in the Water Framework Directive, Information sheet prepared by Drafting Group ECO2, Common Implementation Strategy, Working Group 2B

In keeping with the objectives set in the WFD and more specifically in the guidance documents mentioned above this report provides:

- Estimates of the economic impacts and values associated with the major uses of water resources at the Basin District levels, where "uses" include the abstractive uses associated with the agricultural, industrial, and domestic sectors;
- Projections of water demand, estimates that will serve in part as the baseline for future assessments of potential programs of measures under various impacts and pressures scenarios. This baseline scenario and the analysis of the dynamics of the basin will be developed assessing and forecasting key (non-water related) policy and economic drivers likely to influence pressures and thus water status. We will focus on foreseen trends related to:

    - General socio-economic indicators and variables
    - Key sector policies that could influence significantly the water uses identified
    - Production/Turnover of main economic sectors using water in the basin;
    - Land Planning and its effects on the spatial allocation of pressures;
    - Actual implementation of existing water sector regulations and directives;
    - Implementation of environmental policies likely to affect water.

- An identification of the current levels of water supply services costs and costs recovery in the Basin District, where "costs" include the expenditures for the provision of water supply services as defined in the WFD: "Water supply services" means all services which provide, for households, public institutions or any economic activity:

    (a) Abstraction, impoundment, storage, treatment and distribution of surface water or groundwater,
    (b) Waste-water collection and treatment facilities which subsequently discharge into surface water."

The assessment of the current levels of cost-recovery of water services will be the basis for the implementation of the Article 9 of the WFD and for ensuring transparency on costs, principles, subsidies, cross-subsidies, etc. Key elements which were investigated were:

- Status of key water services (e.g. number of persons connected/using the service);
- Costs of water services (final costs, environmental and resource costs);
- Institutional set-up for cost-recovery (prices and tariff structure, subsidies, cross-subsidy);
- Resulting extend of cost-recovery levels;
- Extent of contribution of key water uses to the costs of water services (link with pollution and use information collected for the analysis of pressures and impacts.

### 8.1.2 Water Use and Impact

The economic analysis examined the economic impacts of water use of domestic sector and selected key water-using subsectors of the agricultural and industrial sectors and other categories. The key water-using subsectors are defined as those in which water-using activities are critical due to the volume of water used.

Water demands comprise domestic consumption, industrial consumption, irrigation, fish farming and hydropower. The first three categories of uses involve an abstraction of water while the latter two in general do not consume water, they just to use it before it passes back into the system through gravity. Water use in the Adriatic Basin falls then into the following categories:

- Agricultural consumption
- Domestic consumption
- Industrial consumption
- Irrigation
- Fish farms and
- Hydropower

Abstractions from water bodies are undertaken for a number of purposes, including providing drinking water for households and use of water in agricultural and industrial processes.

### 8.1.3 Agricultural use of water

The most recent statistical yearbook for 2014 from MONSTAT was used to retrieve relevant information. However, in order to obtain the municipal-level agricultural data for the Adriatic Basin, the 2011 Agricultural census for Montenegro, based on field surveys carried out in May/June 2010, was used. This was the first agricultural census undertaken in Montenegro over the period of 50 years.

## Table 8.1 Arable land with field crops in the Adriatic Basin, 2011[196]

| Municipality | Total Agriculture Holdings | Total available agricultural land (Ha) | Total used agriculture land (ha) |
|---|---|---|---|
| Bar | 1,814 | 4,116 | **2,442.7** |
| Budva | 203 | 550 | **116** |
| Danilovgrad | 2,993 | 11,462 | **9,447.6** |
| Kotor | 362 | 2,557 | **1,964.8** |
| Nikšić | 6,886 | 38,265 | **17,736.8** |
| Podgorica | 7,276 | 26,720 | **17,789.2** |
| Tivat | 169 | 322 | **109.7** |
| Ulcinj | 1,731 | 4,439 | **2,707.9** |
| Herceg Novi | 522 | 1,645 | **578.5** |
| Cetinje | 895 | 4,763 | **928** |
| **Total** | **22,851** | **94,839** | **53,821.2** |

## Table 8.2 Irrigation water in the Adriatic Basin, 2011[197]

| Municipality | Agriculture land (ha) | Irrigated area (ha) | Irrigation water volume (m3/ year) |
|---|---|---|---|
| Bar | 2,442.7 | 100.6 | 123,302 |
| Budva | 116 | 8.3 | 36,31 |
| Danilovgrad | 9,447.6 | 164.5 | 1,545,728 |
| Kotor | 1,964.8 | 23.8 | 1,04 |
| Nikšić | 17,736.8 | 207 | 3,928,676 |
| Podgorica | 17,789.2 | 1,084.5 | 11,363,813 |
| Tivat | 109.7 | 0.9 | 773 |
| Ulcinj | 2,707.9 | 536.1 | 428,18 |
| Herceg Novi | 578.5 | 51.1 | 3,233 |
| Cetinje | 928 | 31.4 | 9,398 |
| **Total** | **53,821.2** | **2,208.2** | **17,440,453** |

[196] MONSTAT: STRUCTURE OF AGRICULTURAL HOLDINGS, Typology of Agricultural Holdings, Agricultural Census 2010

[197] MONSTAT : STRUCTURE OF AGRICULTURAL HOLDINGS, Typology of Agricultural Holdings, Agricultural Census 2010

According to the Agricultural Census, the largest number of irrigation points in Montenegro are from surface water, especially from rivers (67%). Groundwater sources account for 10% of the irrigation points. The most common method of irrigation is the "flood" type where water flows along surface furrows and infiltrates; next is the overhead sprinkler type of irrigation. Drop (or drip) irrigation methods, which use substantially less amounts of water are very few and are still not widely used in the area, primarily due to the cost of installation. Podgorica has the largest number of surface water irrigations points in Adriatic Basin; this is presumably partly due to the presence of Lake Skadar, a large surface water store.

Regarding water used by livestock, multiplying per unit use estimates by animal counts derived the animal farm water use values. For the purpose of economic analysis, the per unit water use was considered as shown in Table 8.3.

### Table 8.3 Daily animal water use

| Animal | Water use (l/day) |
|---|---|
| Cattle | 60 |
| Cow | 40 |
| Sheep/ goats | 5 |
| Milked sheep/ milked goats | 10 |
| Pigs | 5 |
| Horses | 35 |
| Poultry | 0.25 |

Based on the above considered unit values, the water demand of the existing animal farms is as shown in Table 8.4 below.

The agricultural use of water is obtained combining the water consumed by irrigation and by livestock. The total agricultural use of water is 18,698,528 m$^3$/ year, of which 17,440,453 m$^3$/year i.e. 93.3% is used for irrigation purposes while the remaining 1,258,081 m$^3$/year is used for livestock (Table 8.5). The agricultural use of water in the Adriatic Basin is summarized by municipality in Table 8.6.

## Table 8.4 Animal farm water use in the Adriatic Basin by animal, 2011[198]

| Animal | No. (000 heads) | L/day | Total m3/day | Water use (m3/ year) |
|---|---|---|---|---|
| Cattle | 24.35 | 60 | 1,460.7 | 533,155.5 |
| Cows | 17.84 | 40 | 713.48 | 260,420.2 |
| Sheep | 69.31 | 5 | 346.55 | 126,488.9 |
| Milked sheep | 41.21 | 10 | 412.08 | 150,409.2 |
| Goats | 24.15 | 5 | 120.76 | 44,075.6 |
| Milked goats | 14.87 | 10 | 148.66 | 54,260.9 |
| Pigs | 24.85 | 5 | 124.23 | 45,344 |
| Equidae | 1.61 | 35 | 56.49 | 20,618.9 |
| Poultry | 255.43 | 0.25 | 63.86 | 23,308 |
| **TOTAL** | **473.61** | | **3,446.80** | **1,258,081.1** |

## Table 8.5 Total water use for livestock in the Adriatic Basin by animal, 2011

| Municipality | Cattle/ Bovine | Cows | Sheep | Milked sheep | Goats | Milked goats | Pigs | Equidae | Poultry | Total m3/year |
|---|---|---|---|---|---|---|---|---|---|---|
| Bar | 1,677 | 1,234 | 3,121 | 2,319 | 2,333 | 1,810 | 687 | 233 | 12,955 | **85,179** |
| Budva | 126 | 70 | 466 | 433 | 326 | 201 | 189 | 4 | 1,227 | **8,048** |
| Danilovgrad | 2,488 | 1,865 | 10,137 | 6,551 | 3,020 | 1,446 | 3,470 | 161 | 50,305 | **147,896** |
| Kotor | 254 | 196 | 675 | 386 | 617 | 424 | 368 | 25 | 5,109 | **15,195** |
| Nikšić | 9,796 | 6,981 | 27,561 | 14,688 | 7,018 | 3,916 | 10,109 | 371 | 74,994 | **477,497** |
| Podgorica + Tuzi | 5,811 | 4,337 | 16,128 | 10,110 | 5,401 | 3,822 | 8,145 | 427 | 66,379 | **307,100** |
| Tivat | 54 | 37 | 261 | 127 | 206 | 97 | 80 | - | 3,804 | **3,885** |
| Ulcinj | 2,601 | 2,015 | 6,535 | 4,205 | 833 | 513 | 423 | 36 | 25,469 | **120,604** |
| Herceg Novi | 495 | 366 | 1,017 | 340 | 1,102 | 624 | 697 | 27 | 5,990 | **25,733** |
| Cetinje | 1,043 | 736 | 736 | 2,049 | 3,295 | 2,013 | 678 | 330 | 9,198 | **66,938** |
| **Total** | 24,345 | 17,837 | 69,309 | 41,208 | 24,151 | 14,866 | 24,846 | 1,614 | 255,430 | |
| **m3/day/head** | 1,460.7 | 1,070.22 | 4,158.54 | 2,472.48 | 1,449.06 | 891.96 | 1,490.76 | 96.84 | 15,326 | |
| **m3/year** | **533,155.5** | **260,420.2** | **126,488.9** | **150,409.2** | **44,075.58** | **54,260.90** | **45,343.95** | **20,618.85** | **23,307.99** | **1,258,081.1** |

[198] :MONSTAT : STRUCTURE OF AGRICULTURAL HOLDINGS, Livestock Resources, Agricultural Census 2010

### Table 8.6 Total agricultural use of water in Adriatic Basin

| Municipality | Irrigation water volume (m3/ year) | Livestock (m3/ year) | Total (m3/ year) |
|---|---|---|---|
| Bar | 123,302 | 85,179 | 208,481 |
| Budva | 36,310 | 8,048 | 44,358 |
| Danilovgrad | 1,545,728 | 147,896 | 1,693,624 |
| Kotor | 1,040 | 15,195 | 16,235 |
| Nikšić | 3,928,676 | 477,497 | 4,406,173 |
| Podgorica + Tuzi | 11,363,813 | 307,100 | 11,670,913 |
| Tivat | 773 | 3,885 | 4,658 |
| Ulcinj | 428,180 | 120,604 | 548,784 |
| Herceg Novi | 3,233 | 25,733 | 28,966 |
| Cetinje | 9,398 | 66,938 | 76,336 |
| **Total** | **17,440,453** | **1,258,081** | **18,698,528** |

## 8.1.4 Industrial use of water

The water used in the industrial/ commercial/ institutional (ICI) sector is for technological and hygiene purposes. It can be non-drinkable industrial water or drinking water and can be supplied by water utility companies or produced on self-service basis.

There are very limited data available to estimate the economic impact of this water in terms of annual turnover, income and employment of the ICI sector. In this case the only available data to estimate the impact is referring to the registered number of companies and the annual quantity of water supplied by the water utilities. Total number of active enterprises by municipality is shown in Table 8.7 below.

### Table 8.7 Active enterprises by district and legal form in the Adriatic Basin, 2014[199]

| Municipality | Farmers | Companies (Commercial users / legal entities) |
|---|---|---|
| Bar | 1814 | 2058 |
| Budva | 203 | 2308 |
| Danilovgrad | 2993 | 437 |
| Kotor | 362 | 930 |
| Nikšić | 6886 | 1300 |
| Podgorica + Tuzi | 7276 | 6200 |
| Tivat | 169 | 515 |
| Ulcinj | 1731 | 913 |
| Herceg Novi | 522 | 1440 |
| Cetinje | 895 | 390 |

In the early 1990s, contribution of industrial production in Montenegro's GDP was estimated at 35%, while this sector of economy employed more than 50,000 employees. Global economic trends in the past couple of decades dictated increased development of services and de-industrialization across the world. Montenegro largely shared this trend and in 2014 it had seen the share of its industrial production dropping at just below 11% with only 24,000 employees[200]. Consequently, the industrial water consumption has fallen considerably in Montenegro. The privatization of the Aluminum factory in Podgorica (KAP) which led to its closure in 2012 and considerable reduction of operations at Nikšić steel factory were the primary reasons for that. Table 8.8 below shows the aggregate industrial water use trends in 2014.

[199] MONSTAT : Annual Yearbook for Montenegro 2014

[200] According to the "Industrial policy of Montenegro by 2020" annual growth is projected at 3.4%

As opposed to the Danube River Basin where the number of bottled water companies is large and increasing over the past 10 years, the Adriatic River Basin has only one company in the business. This is the company "Bozja Voda" doo from Dobrska Zupa situated in Cetinje municipality. The company was established in 2004 and is producing still water in packages of 0.5 and 1.5 liters. Its estimated capacities do not significantly impact the total amount of industrial water use.

### Table 8.8 Annual Industrial Water Consumption in Adriatic Basin, 2014[201]

| Municipality | Total no of Dwellings | Dwelling only for industry | Dwelling with House and Industry | Total Combined Industry Dwellings | Water supplied to the ICI sector, by municipality ($m^3$/yr)* |
|---|---|---|---|---|---|
| Bar | 20,626 | 740 | 202 | 942 | 1,497,955 |
| Budva | 11,694 | 1,269 | 473 | 1,742 | 2,703,667 |
| Danilovgrad | 6,581 | 12 | 32 | 44 | 914,321 |
| Kotor | 10,324 | 253 | 57 | 310 | 1,432,625 |
| Nikšić | 24,613 | 32 | 81 | 113 | 649,351 |
| Podgorica | 68,346 | 256 | 269 | 525 | 9,377,347 |
| Tivat | 7,097 | 138 | 47 | 185 | 572,867 |
| Ulcinj | 8,866 | 583 | 161 | 744 | 756,472 |
| Herceg Novi | 15,326 | 394 | 115 | 509 | 3,183,828 |
| Cetinje | 7,116 | 8 | 67 | 75 | 844,076 |
| **Total** | **180,589** | **3,685** | **1,504** | **5,189** | **21,932,509** |

The volume of industrial, commercial and institutional (ICI) water was estimated considering the data provided by the local/regional water utilities and thus excludes the self-service data water which were not available. The above figures are based on the data available in the latest Annual report in the Water sector. However, it is important to note that the above figure includes the losses incurred in the water delivery process (i.e. non-revenue water). The amount of invoiced water is on average 40% of the gross figure supplied to the ICI sector. We will discuss the proportion of the NRW in the relevant sub-section below.

## 8.1.5 Tourism

Tourism is a vital economic activity in Montenegro. Direct contribution of Travel and Tourism to GDP of Montenegro in 2017 was €459.1 million or 11% of GDP. The global economic crisis initiated in 2008 has adversely affected its overall share in GDP. However, since 2009 there is a strong growth impulse. The official projections for 2018 are rather encouraging. With the estimated growth of 9%, total contribution of Tourism could reach €0.5 billion. According to the statistics provided by World Travel & Tourism Council (WTTC),

[201] GODIŠNJI IZVJEŠTAJ O STANJU U OBLASTI VODOSNABDIJEVANJA, UPRAVLJANJU OTPADOM I OTPADNIM VODAMA, REALIZACIJI PRIORITETNIH AKTIVNOSTI U KOMUNALNOJ DJELATNOSTI U 2014. GODINI, SA PREDLOGOM PRIORITETNIH PROJEKATA ZA IZGRADNJU KOMUNALNE INFRASTRUKTURE U 2016. GODINI I PREDLOGOM MJERA

[6] WTTC: Travel & Tourism Economic Impact 2018 Montenegro

Montenegro is ranked third globally in terms of real growth of direct and total contribution of Tourism to GDP. The value of the sector in terms of value added is projected to reach €752.6 million or 13.3% of GDP in 2028.[202] Finally, according to the same source, Montenegro is expected to reach 7.7% in the overall contribution to employment growth coming from Tourism, which makes it second country in the world in these terms.

It must be noted, however, that the estimations of the size of the sector might be undermined by the fact that there is a large number of unregistered visits of tourists staying in private accommodation, weekend houses or camping sites. If the data on this activity was captured properly the relative importance of Tourism would be dramatically higher. Table 8.9 provides a data on arrivals of tourist and overnight stays of tourists by municipality.

### Table 8.9 Tourism in Adriatic Basin (2017)[203]

| Municipality | Population (Number of Inhabitants) | Arrivals of tourists | | | Overnight stays of tourists | | |
|---|---|---|---|---|---|---|---|
| | | Foreign | Domestic | Total | Foreign | Domestic | Total |
| Bar | 42,048 | 164,274 | 10,828 | 175,102 | 1,630,468 | 43,169 | 1,673,637 |
| Budva | 19,218 | 821,795 | 26,648 | 848,443 | 4,731,639 | 92,879 | 4,824,518 |
| Danilovgrad | 18,472 | 2,912 | 132 | 3,044 | 13,149 | 360 | 13,509 |
| Kotor | 22,601 | 111,785 | 1,004 | 112,789 | 463,455 | 3,352 | 466,807 |
| Nikšić | 72,443 | 7,291 | 1,524 | 8,815 | 17,902 | 4,454 | 22,356 |
| Podgorica + Tuzi | 185,937 | 131,681 | 14,514 | 146,195 | 228,170 | 33,049 | 261,219 |
| Tivat | 14,031 | 90,379 | 6,005 | 96,384 | 850,213 | 19,329 | 869,542 |
| Ulcinj | 19,921 | 179,366 | 9,731 | 189,097 | 1,115,200 | 53,800 | 1,169,000 |
| Herceg Novi | 30,864 | 281,203 | 13,433 | 294,636 | 2,203,855 | 139,815 | 2,343,670 |
| Cetinje | 16,658 | 9,296 | 11,592 | 20,888 | 26,759 | 36,531 | 63,290 |
| **Total** | 442,193 | **1,799,982** | **95,411** | **1,895,393** | **11,280,810** | **426,738** | **11,707,548** |

Major touristic attractions are located along the seaside. Around 95% of tourists visiting Montenegro spend their time within the municipalities in the Adriatic River Basin. Budva municipality attracts the most tourists (848,443) with by far the largest official number of nights spent (4,824,518). Herceg Novi ranks second with 294,636 registered tourists and 2.34 million nights, while Ulcinj ranks third in the coastal region of the Adriatic River Basin with 189,097 tourists and 1.17 million nights spent. Apart from the seaside, notable touristic activity is recorded only in Podgorica with 146,195 tourists coming mainly for business purpose which is obvious from the significantly lower number of nights per visit compared to the coastal region.

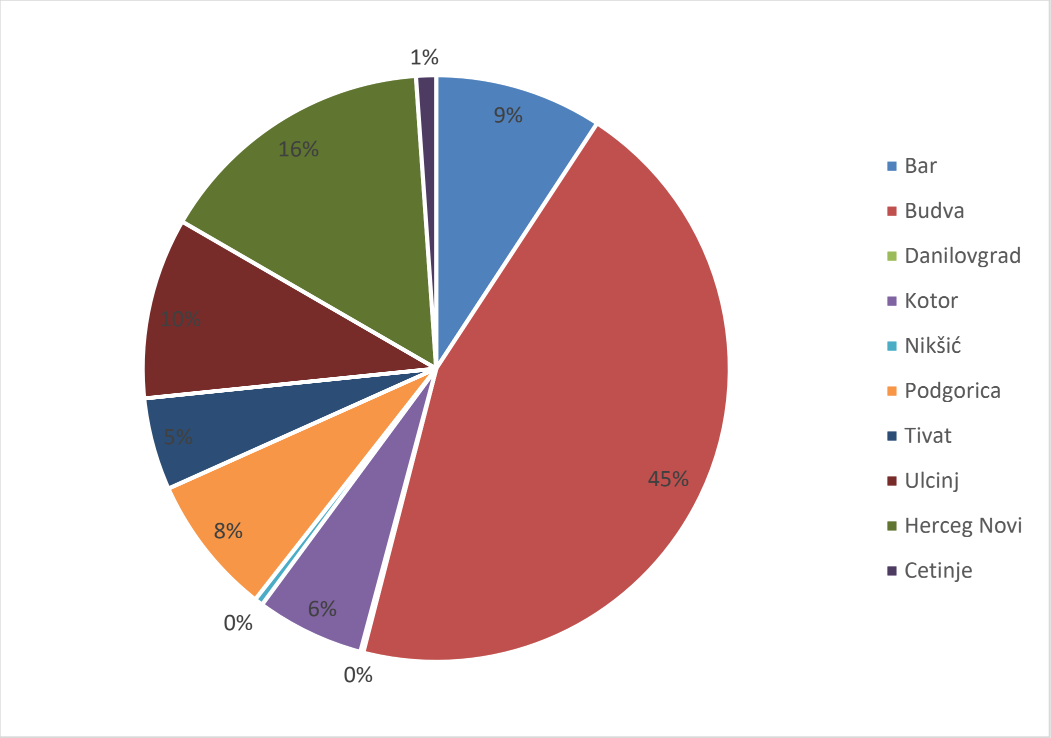
When referring to touristic activity in the River Basin, it must be emphasized that there are large discrepancies between the number of permanent inhabitants and number of tourists that visit certain coastline municipalities during summer. This puts tremendous pressure on water and wastewater infrastructure and

[202] WTTC: Travel & Tourism Economic Impact 2018 Montenegro

[203] MONSTAT: Survey on arrivals and overnights stays of tourists, total 2017.

must be duly taken into account. One obvious example is the Municipality of Budva which is one of the smallest municipalities in the Basin with only 19,218 inhabitants while the number of nights spent by the tourists reached 4,824,518 in 2017 which is equivalent to approximately 13,217 additional inhabitants. However, such number cannot be simply extrapolated to the existing number of inhabitants since majority of tourists come in summer months of July and August (514,538 and 579,944 in 2017, respectively[204]). This, in turn, puts additional pressure on the infrastructure.

### Figure 8.1 Arrivals of tourists by municipality in Adriatic Basin




The Statistical Yearbook for 2014 provides an indication of the number of dwellings associated with Industry at municipal level, but it does not show the amount of water use. Data on industrial consumption at municipal level is not available, but MONSTAT provides an indication of the dwellings that are in industrial use in each municipality (the dwellings are either for industrial use only or a combination of housing and industry combined). Some 5,189 dwellings were associated with industrial use – 2.87% of the total number located within the Adriatic River Basin. Industrial water use amount has been assumed to be 21.93 Mm3/year within the Adriatic Basin for this this report[205], with the largest consumers being Podgorica, Herceg Novi and Budva municipality. It is vital to emphasize that the share of tourist spending time in private accommodation, weekend houses or camping sites is unknown which may on one hand underestimate the ICI consumption which would have been higher otherwise, and on the other, inflate the private consumption figures presented in the next section.

[204] MONSTAT: Survey on arrivals and overnights stays of tourists, total 2017.

[205] GODIŠNJI IZVJEŠTAJ O STANJU U OBLASTI VODOSNABDIJEVANJA, UPRAVLJANJU OTPADOM I OTPADNIM VODAMA, REALIZACIJI PRIORITETNIH AKTIVNOSTI U KOMUNALNOJ DJELATNOSTI U 2014. GODINI, SA PREDLOGOM PRIORITETNIH PROJEKATA ZA IZGRADNJU KOMUNALNE INFRASTRUKTURE U 2016. GODINI I PREDLOGOM MJERA

### 8.1.6 Domestic use of water

Data on water consumption in Montenegro is not readily available at the municipal level, hence in order to obtain a reliable estimate of water use it was necessary to utilize data from different sources including primarily the latest available Annual Report on the Water sector from 2016. Combining the invoiced water volumes with the indicated losses in the water supply system we were able to arrive at the total quantity of water supplied. The specific per capita consumption indicated by our calculation was calculated at 445 l/c/d. At the same time the specific per capita consumption in the Adriatic River Basin is calculated at 217 l/c/d. According to our assessment, such divergence is attributable mainly to inflated water consumption for the domestic sector for the coast line (i.e. tourism-intensive) municipalities due to one or both of the following reasons: i) households providing accommodation services while not being registered as business entities (and thus misreporting their consumption under households rather than the ICI segment), and ii) large number of unregistered tourists' stays.

The current Strategy lists the range of losses encountered in the system to be between 24% and 85% for each of the municipalities, while the Annual report on Water Management reports that losses are precisely 60.8% for the entire territory of Montenegro.

Population estimates for the people living in the Adriatic Basin were taken from the 2011 census, which is available at municipal level. The 2011 Census data showing population levels for the main municipalities in the basin are shown in Table 8.10.

**Table 8.10 Domestic water use in Adriatic Basin[206]**

| Municipality | Population (Number of Inhabitants)[207] | Number of households | Water supplied to the households, by Municipality (m3/year) |
|---|---|---|---|
| Bar | 42,048 | 14,210 | 6,132,988 |
| Budva | 19,218 | 6,980 | 4,532,744 |
| Danilovgrad | 18,472 | 5,500 | 2,183,417 |
| Kotor | 22,601 | 7,650 | 4,588,129 |
| Nikšić | 72,443 | 21,680 | 5,357,143 |
| Podgorica + Tuzi | 185,937 | 57,350 | 24,587,146 |
| Tivat | 14,031 | 4,860 | 2,065,420 |
| Ulcinj | 19,921 | 5,810 | 4,928,610 |
| Herceg Novi | 30,864 | 11,130 | 10,290,566 |
| Cetinje | 16,658 | 5,750 | 4,411,435 |
| **Total** | **442,193** | **140,920** | **69,077,598** |

The calculated domestic total water production from centralized resources in the Adriatic Basin is thus 69.07 $Mm^3$/year. When considering typical European principles for domestic water consumption, these are

[206] MONSTAT: Statistical Yearbook for Montenegro 2014

[207] Population data referes to 2011 which is the latest year when official census was performed in Montenegro

extremely high values and reveal major issues with water losses that are present in Montenegro. Indeed, average NRW in Montenegro are at 60.8%, substantially higher than many European countries. While 10-25% is the overall norm.

The water for domestic use is supplied by the existing water utility companies or is obtained from own sources (self-service). Data on self-services, such as private water supplies and wastewater treatment (employing septic tanks) are difficult to identify as there is not a comprehensive dataset available on numbers of services, locations, volumes, etc.

### Table 8.11 Total Domestic Water consumption in Adriatic Basin[208]

| Municipality | Number of households[209] | HH Connected to Water Supply (%) | HH using Self-service water (%) | Domestic Water Supply (m3/year) | Self-Service Water Consumption (m3/year) | Total Domestic Water Supply (m3/year) |
|---|---|---|---|---|---|---|
| Bar | 14,210 | 97 | 3 | 6,132,988 | 183,989 | 6,316,977 |
| Budva | 6,980 | 99 | 1 | 4,532,744 | 45,327 | 4,578,071 |
| Danilovgrad | 5,500 | 87 | 13 | 2,183,417 | 283,844 | 2,467,261 |
| Kotor | 7,650 | 98 | 2 | 4,588,129 | 91,762 | 4,679,891 |
| Nikšić | 21,680 | 90 | 10 | 5,357,143 | 535,714 | 5,892,857 |
| Podgorica + Tuzi | 57,350 | 97 | 3 | 24,587,146 | 737,614 | 25,324,760 |
| Tivat | 4,860 | 99 | 1 | 2,065,420 | 20,654 | 2,086,074 |
| Ulcinj | 5,810 | 98 | 2 | 4,928,610 | 98,572 | 5,027,182 |
| Herceg Novi | 11,130 | 99 | 1 | 10,290,566 | 102,905 | 10,393,471 |
| Cetinje | 5,750 | 85 | 15 | 4,411,435 | 661,715 | 5,073,150 |
| **Total** | **140,920** | **95.5** | **4.5** | **69,077,598** | **2,762,096** | **71,839,694** |

As can be seen from the Table 8.11 above the total estimated quantity of water taken by the domestic sector amounts to 71.84 million $m^3$ per year of which 69.07 million is supplied by Public Utility Companies while the remaining 2.76 million $m^3$ is from self-serviced resources. Combined water supply (piped and through pump or other means) connection rates vary from 85% for Cetinje to 99% for Budva, Tivat and Herceg Novi. The relationship between the invoiced and NRW water in the relevant sub-sections is discussed below.

208 MONSTAT: Stanovi prema opremljenosti instalacijama, Popis stanovništva, domaćinstava i stanova u Crnoj Gori 2011. godine

209 The number of households and consequently connection to waterworks in Montstat analysis does not include tourist houses and their not-permanent residents. In this way percentage of connections is highly exaggerated, while number of water self-dependents reduced.

## 8.2 Non-abstractive use of water

### 8.2.1 Hydropower plants

The situation in the Montenegro energy sector is in correlation with the state of the economy in the country and the conditions of the energy sector in the region. Montenegro's economy suffers from serious consequences of deficits caused by the long-lasting import of electricity.

The main characteristics of the Montenegrin energy sector are:

- Consumers demand for electricity overcome the production possibilities EPCG both in energy and in power capacity;
- Complex electricity situation in the region in terms of securing the necessary amount of energy;
- Endemic congestion in the transmission grid, related to the import of electricity in Montenegro.
- Unreliable industrial operation (especially aluminum plant in Podgorica and steel works in Nikšić) significantly limits the planning of consumption of electricity.

During the period 2005-2013, the exiting power plants provided an average annual generation of approximately 2,840 GWh, with a total installed capacity of 854 MW (TPPs 218 MW, HPPs 636 MW – SHPPs included). The largest portion of electricity has been generated in HPPs; this causes an important dependence of the energy generation on the prevailing hydrological situation.

All water used in hydropower production is assumed to be returned to the rivers, with the exception of evaporation, there are no losses. At most up to 2% of the natural discharge may be lost – less than the accuracy of the discharge gauging stations. For the purpose of this analysis, we will then assume that 100% of water for hydropower use is returned to the system.

The structure of the gross average production and supply of electricity was the following: 22.9% Perućica HPP[210], 22.1% Pljevlja TPP, 19.5% Piva HPP, 0.5% SHPPs, 30.3% import/export of electricity and 4.7% exchange with Serbia (based on a contract related to Piva HPP)[211].

Within the Adriatic River Basin, HPP Perućica has been active since 1960. With average annual production of 900 GWh it is a most efficient HPP in Montenegro. Perućica has 7 units, with a total installed flow of 80m$^3$/s, which brings an installed power of 307 MW. The extension program envisages the installation of the eighth power unit of 58.5 MW, so the installed power capacity could increase up to 365.5 MW and additional electricity production around 13 GWh/year.

In addition to HPP Perućica, there are 2 small HPPs in the process of construction and 3 in the stage of planning (See Section 4.9.1).

### 8.2.2 Fish farming

Over the past years in Montenegro a number of trout fisheries were built within the Adriatic River Basin. Main characteristics of two largest fisheries in the Adriatic River Basin, located in Podgorica and Nikšić are given in a table below. In addition to these fisheries there are about 30 more on the territory of Montenegro with the size between 250 and 1000 m$^2$ (in total about 10,500 m$^2$) which we will not analyze further since there is no precise data about it.

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[210] 1 GWh = 1 million kWh; TPP = thermal power plant; HPP = hydropower plant; SHPP = small hydropower plant

[211] It should be noted that in January 2014, the contract between EPS Elektroprivreda Srbije (Serbia); and EPCG Elektroprivreda Crne Gore on the operation of Piva HPP has been terminated.

The assumpsion is that there are no water losses in the Adriatic Basin from fish farming. There are concerns from excessive nutrients entering the system from fish farms. All fish farms are mostly small, family owned concerns (or owned by small enterprises), producing 5–20 tones per year with the exception of four larger farms (two within the Adriatic Basin) that produce 60–150 tones per year, ran by private companies.

### Table 8.14 The main fisheries in the Adriatic Basin, 2011[212]

| Name of farm | Location | Area (m2) | Production (tonnes/year) | Water Requirement ($m^3$/24h) |
|---|---|---|---|---|
| Mareza | Podgorica | 4,000 | 150 | 67,000 |
| Rastovac | Nikšić | 2,100 | 60 | 35,000 |
| Other fisheries | | 10,500 | NA | 175,000* |
| **Total** | | **16,600** | **210** | **277,000** |

*The water requirement distributed proportionally based on the surface (10,500 $m^2$)

[212] STRATEGIJA UPRAVLJANJA VODAMA CRNE GORE - 2017

## 8.3 Summary of water use

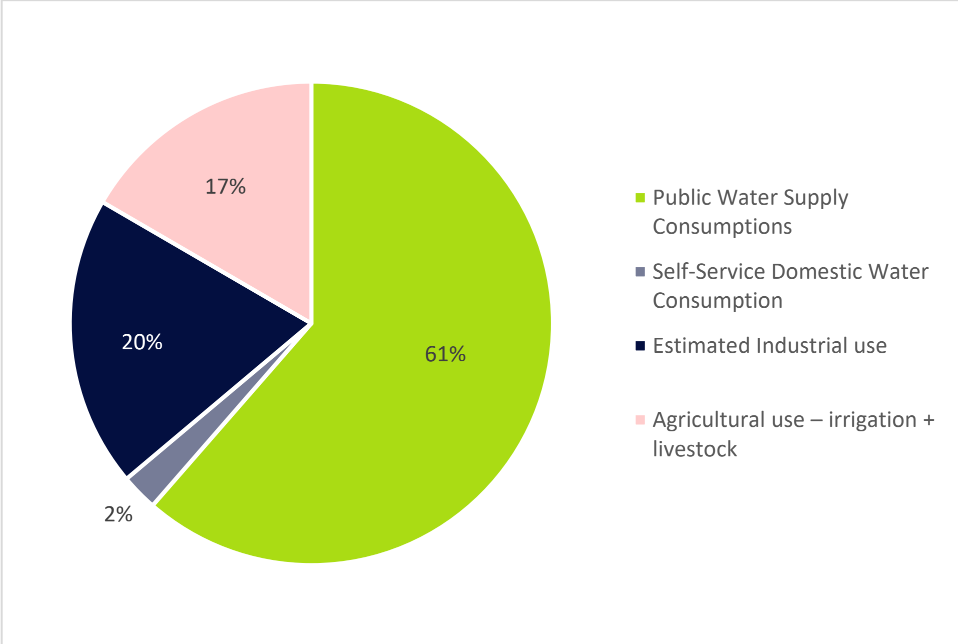
A summary of water use from the different sectors in the municipalities making up the Adriatic River Basin is presented in Table 8.15. Our estimates are that about 112.47 $Mm^3$/year of water is necessary to cover consumption needs for the domestic, industrial and agricultural sectors making up the municipalities in the Adriatic Basin.

### Table 8.15 Summary of water use in Adriatic Basin, 2014

| Municipality | Population (Number of Inhabitants) | Domestic use (m3/year) | Industrial use (m3/year) | Agricultural use – irrigation + livestock (m3/year) | Fish farming use (m3/year) | Hydropower (m3/year) | Total |
|---|---|---|---|---|---|---|---|
| Bar | 42,048 | 6,316,977 | 1,497,955 | 208,481 | In river flow | In river flow | 8,023,413 |
| Budva | 19,218 | 4,578,071 | 2,703,667 | 44,358 | In river flow | In river flow | 7,326,096 |
| Danilovgrad | 18,472 | 2,467,261 | 914,321 | 1,693,624 | In river flow | In river flow | 5,075,206 |
| Kotor | 22,601 | 4,679,891 | 1,432,625 | 16,235 | In river flow | In river flow | 6,128,751 |
| Nikšić | 72,443 | 5,892,857 | 649,351 | 4,406,173 | In river flow | In river flow | 10,948,381 |
| Podgorica + Tuzi | 185,937 | 25,324,760 | 9,377,347 | 11,670,913 | In river flow | In river flow | 46,373,020 |
| Tivat | 14,031 | 2,086,074 | 572,867 | 4,658 | In river flow | In river flow | 2,663,599 |
| Ulcinj | 19,921 | 5,027,182 | 756,472 | 548,784 | In river flow | In river flow | 6,332,438 |
| Herceg Novi | 30,864 | 10,393,471 | 3,183,828 | 28,966 | In river flow | In river flow | 13,606,265 |
| Cetinje | 16,658 | 5,073,150 | 844,076 | 76,336 | In river flow | In river flow | 5,993,562 |
| **Total** | **442,193** | **71,839,694** | **21,932,509** | **18,698,528** | | | **112,470,731** |

The structure of the domestic (Public WS + Self-service), agricultural and ICI uses of water can be represented as shown in Figure 8.2. Due to the low industrial/ commercial activity in the river basin, the ICI water consumption comprises only one third of the domestic consumption. This fact reduces the economic impact of the water in the region. Although, it must be noted that there is an obvious issue of ICI water consumption belonging mainly to tourism sector being misrepresented as water used by households due to reporting issues. The extent to which this is so cannot be precisely estimated.

**Figure 8.2 The Structure of water use (m3/year) in the Adriatic Basin**




## 8.4 Non-Revenue Water

Each water utility in the basin is facing serious problems regarding the water losses in the supply system. The average level of non-revenue water (NRW) in the basin is achieving the value of 60.27% which is a tremendous amount and puts a large financial pressure on the local utility companies as the water production and distribution takes up majority of resources – both human and financial. The level of NRW in each utility is shown in Table 8.16.

### Table 8.16 SUPPLIED versus INVOICED water use in Adriatic Basin

| Municipality | Water SUPPLIED by Municipality, total (m3/year) | Losses / NRW (%) - weighted average | Water INVOICED by Municipality (m3/year) - HOUSEHOLDS | Water INVOICED by Municipality (m3/year) – ICI sector | Water INVOICED by Municipality (m3/year) - TOTAL |
|---|---|---|---|---|---|
| Bar | 7,586,885 | 66% | 2,085,216 | 494,325 | 2,579,541 |
| Budva | 7,236,412 | 57% | 1,949,080 | 1,162,577 | 3,111,657 |
| Danilovgrad | 3,097,739 | 55.2% | 978,171 | 409,616 | 1,387,787 |
| Kotor | 6,020,754 | 76% | 1,101,151 | 343,830 | 1,444,981 |
| Nikšić | 6,006,494 | 38.4% | 3,300,000 | 400,000 | 3,700,000 |
| Podgorica | 33,964,492 | 48.4% | 12,679,591 | 4,835,898 | 17,515,489 |
| Tivat | 2,638,287 | 55% | 929,439 | 257,790 | 1,187,229 |
| Ulcinj | 5,685,082 | 71% | 1,429,297 | 219,377 | 1,648,674 |
| Herceg Novi | 13,474,348 | 80.2% | 2,037,532 | 630,389 | 2,667,921 |
| Cetinje | 5,255,511 | 83% | 749,944 | 143,493 | 893,437 |
| **Total** | **90,966,004** | **60.27%** | **27,239,421** | **8,897,295** | **36,136,716** |

## 8.5 The Value of Water

The value of water consumed by the domestic, agricultural, industrial users was estimated taking into account the quantity of water invoiced and the relevant tariffs applied by the service providers.

The figures used in this section reflect rather the effort of the suppliers to deliver the water than the real value of water abstracted from the natural resources. However, we consider a good mean to estimate the monetary impact of the consumption.

The use of natural resources is subject to fees, which, according to the Law on Nature Protection (OG 51/08, 21/09, 40/11, 62/13, 6/14), should be based on the user pays principle. Use of natural resources requires a permit/license. In the case of legal entities, user rights are, in general, awarded within the framework of concession agreements for areas such as water abstraction, mineral resource extraction and forest exploitation.

### 8.5.1 Value of domestic water

The annual value of water for domestic use in the case of centralized water supply was estimated by taking into account the existing water tariffs in the different municipalities of the Adriatic Basin district. Self-service water value is not included as there are no accurate data on the real consumption and no adequate methods are available to value this water.

**Table 8.17 The value of water for domestic use in the Adriatic Basin, year 2014[213]**

| Municipality | Public Water Supply (m3/year) | Water invoiced ($m^3$) | Tariff (Euro/$m^3$), excluding VAT | Domestic water value (Euro/year) |
|---|---|---|---|---|
| Bar | 6,132,988 | 2,085,216 | 0.86 | 1,793,286 |
| Budva | 4,532,744 | 1,949,080 | 1.12 | 2,182,970 |
| Danilovgrad | 2,183,417 | 978,171 | 0.61 | 596,684 |
| Kotor | 4,588,129 | 1,101,151 | 1.1 | 1,211,266 |
| Nikšić | 5,357,143 | 3,300,000 | 0.38 | 1,254,000 |
| Podgorica | 24,587,146 | 12,679,591 | 0.4 | 5,071,836 |
| Tivat | 2,065,420 | 929,439 | 0.86 | 799,317 |
| Ulcinj | 4,928,610 | 1,429,297 | 0.77 | 1,100,559 |
| Herceg Novi | 10,290,566 | 2,037,532 | 0.91 | 1,854,154 |
| Cetinje | 4,411,435 | 749,944 | 0.6 | 449,966 |
| **Total** | **69,077,598** | **27,239,421** | | **16,314,038** |

[213] Montenegro: Environmental Performance Review (Third Review) – 2015 - UNECE

### 8.5.2 Value of industrial, commercial and institutional water

The annual value of water for industrial, commercial and institutional (ICI) use in case of centralized water supply was estimated taking into account the existing water tariffs in the different regions of the Basin. Self-service water value is not included as no reliable data were available on this matter.

**Table 8.18 The annual value of water for Legal Entities (ICIs) in the Adriatic Basin, 2014**[214]

| Municipality | Water invoiced ($m^3$) | Tariff (€/$m^3$) | Legal Entities water value (Euro/year) |
|---|---|---|---|
| Bar | 494,325 | 1.61 | 795,863 |
| Budva | 1,162,577 | 2.25 | 2,615,798 |
| Danilovgrad | 409,616 | 1.07 | 438,289 |
| Kotor | 343,830 | 2.2 | 756,426 |
| Nikšić | 400,000 | 1.27 | 508,000 |
| Podgorica | 4,835,898 | 1.33 | 6,431,744 |
| Tivat | 257,790 | 1.93 | 497,535 |
| Ulcinj | 219,377 | 1.74 | 381,716 |
| Herceg Novi | 630,389 | 1.86 | 1,172,523 |
| Cetinje | 143,493 | 2.44 | 350,123 |
| **Total** | **8,897,295** | | **13,948,017** |

### 8.5.3 Agricultural use of water

The agricultural water, as a service provided, is mainly for irrigation purposes. The service is provided at a price of 0.004€/$m^3$[215].Considering the prices above, the value of irrigation can be assessed as shown in Table 8.19.

Taking and use of surface and ground waters for irrigation of agricultural or other land takes place in accordance with the conditions laid down by water permits. Owners or users of irrigation facilities and systems have to bear the cost for their management and maintenance commensurate to their utilization. The concession in a public water resource may be issued for taking waters for irrigation of agricultural land in a quantity above 175 $m^3$ per day. Any taking of waters for irrigation of agricultural land in a quantity less than 175 $m^3$ per day is subject to a permit issued by local self-governances.[216]

[214] Montenegro: Environmental Performance Review (Third Review) – 2015 - UNECE

[215] Montenegro: Environmental Performance Review (Third Review) – 2015 - UNECE

[216] PROGRAMME FOR THE DEVELOPMENT OF AGRICULTURE AND RURAL AREAS IN MONTENEGRO UNDER IPARD II 2014-2020 – Ministry of Agriculture and Rural Development of Montenegro - 2015

### Table 8.19 The value of water for agricultural use in the Adriatic Basin

| Municipality | Agriculture land (ha) | Irrigated area (ha) | Irrigation water volume ($m^3$/year) | Irrigation water value (€/year) |
|---|---|---|---|---|
| Bar | 2,442.7 | 100.6 | 123,302 | 493.21 |
| Budva | 116 | 8.3 | 36,310 | 145.24 |
| Danilovgrad | 9,447.6 | 164.5 | 1,545,728 | 6,182.91 |
| Kotor | 1,964.8 | 23.8 | 1,040 | 4.16 |
| Nikšić | 17,736.8 | 207 | 3,928,676 | 15,714.7 |
| Podgorica + Tuzi | 17,789.2 | 1,084.5 | 11,363,813 | 45,455.25 |
| Tivat | 109.7 | 0.9 | 773 | 3.09 |
| Ulcinj | 2,707.9 | 536.1 | 428,180 | 1,712.72 |
| Herceg Novi | 578.5 | 51.1 | 3,233 | 12.93 |
| Cetinje | 928 | 31.4 | 9,398 | 37.59 |
| **Total** | **53,821.2** | **2,208.2** | **17,440,453** | **69,761.81** |

## 8.5.4 Non-abstractive use of water

In 2007, water abstraction charges were calculated as a percentage of the "price" of the services or products for which the water abstracted was used. Thus, water used for electricity production was charged at 0.22 per cent of the average price per 1 kWh. Since 2009, a new approach to setting water abstraction charges has been used based on the Decision on the amount and method of calculating water charges and the criteria and method of determining the degree of water pollution. In general, total payments depend on the volume of water abstracted. Fees for use of water for electricity generation are based on the quantity of electricity (kWh) generated on the grid. There is also a separate charge rate per kW for the use of water for other energy purposes by power plants. Table 8.20 below summarize average annual income from energy.

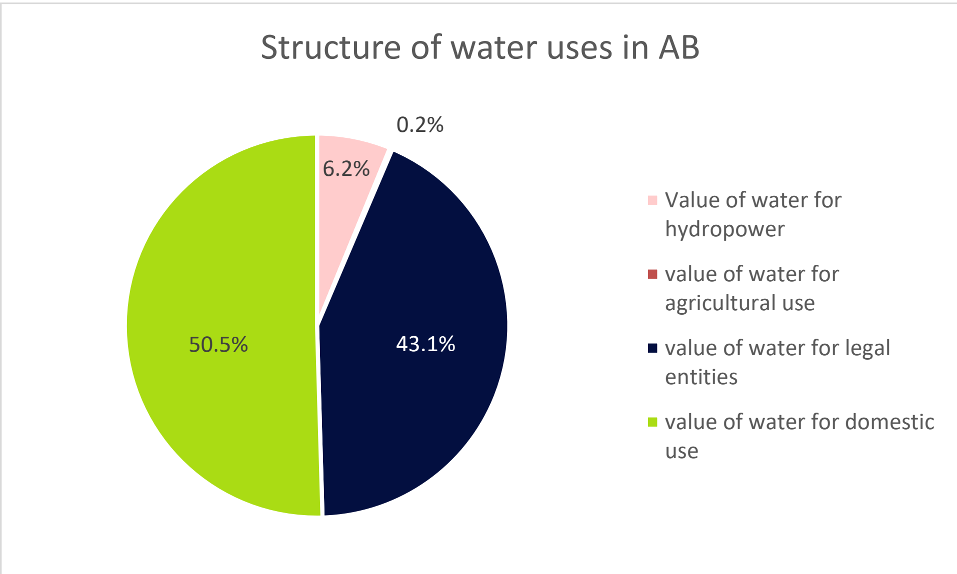
### Table 8.20 The annual income from hydropower in the Adriatic Basin[217]

| Watercourse | Name | Installed power (MW) | Annual Production GWh | Average Annual Income from Energy (Euro/year) |
|---|---|---|---|---|
| Gornja Zeta | HPP Perućica | 307 | 900 | 1,980,000 |

## 8.6 Summary of water use values

Taking the above data into consideration (i.e. domestic, legal entities, agricultural and non-abstractive water use), Figure 8.3 illustrates the structure of water in the Adriatic Basin.

### Figure 8.3 The structure of water uses values in the Adriatic Basin



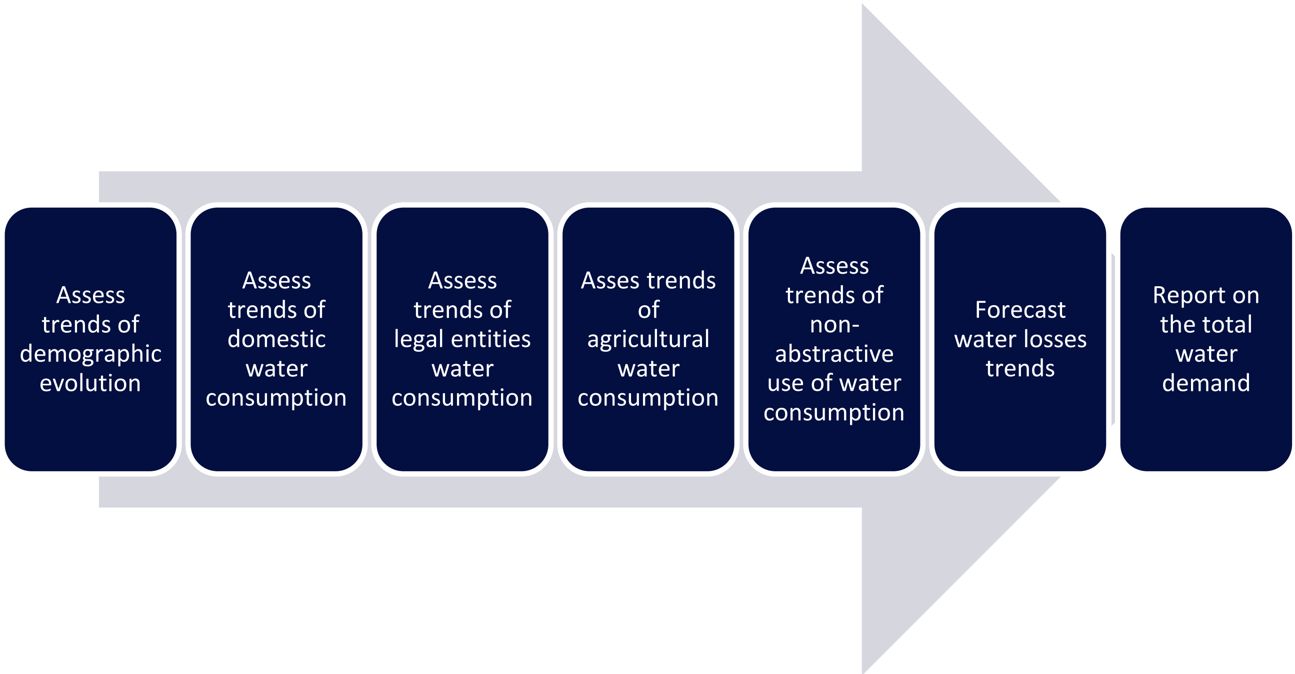

[217] STRATEGIJA UPRAVLJANJA VODAMA CRNE GORE - 2017

## 8.7 Trend Projections

In this section estimations are made regarding the future water consumptions as a base for abstracted water demand projections. The future trends are estimated for the water used to supply drinking water. Other types of water (industrial non-drinking water, irrigation water) are not currently considered, as reliable data were not available for forecasting purposes.

The forecasting process included the following main steps outlined in Figure 8.4. Assumptions were made at each step, which are explained at the relevant sub-sections. If there were official data on different trends, these data were used to inform the projections. In other cases, international best assumptions were considered. The results of the forecasting process are presented in the sub- sections below.

**Figure 8.4 The main steps in the process of forecasting**




In administrative terms, Montenegro is divided into municipalities that are, for planning and analysis purposes, divided into three regions: Northern, Central and Coastal. All municipalities that are part of Central region (Danilovgrad, Nikšić, Podgorica and Cetinje) and Coastal region (Bar, Budva, Kotor, Tivat, Ulcinj and Herceg Novi) are also part of Adriatic Basin.

Regarding territory, the largest administrative unit is the Municipality of Nikšić with 2,065 km$^2$, followed by the municipality of Podgorica with 1,441 km$^2$. The smallest complete municipal area is Tivat, with just 46 km$^2$.

Contrarily, Tivat is the municipality with the highest population density in Montenegro – 307 inhabitants/km$^2$, followed by municipalities – Budva (157 inhabitants/km$^2$), Herceg Novi (132 inhabitants/km$^2$) and Podgorica (130 inhabitants/km$^2$).

## 8.8 Existing demographic situation and projections

According to the calculation made in 2017[218], around 454,455 people live within the Adriatic Basin. Birth rates are generally 11.5/1000 inhabitants while deaths were 8.7/1000 inhabitants, implying an overall increase of population in the basin.

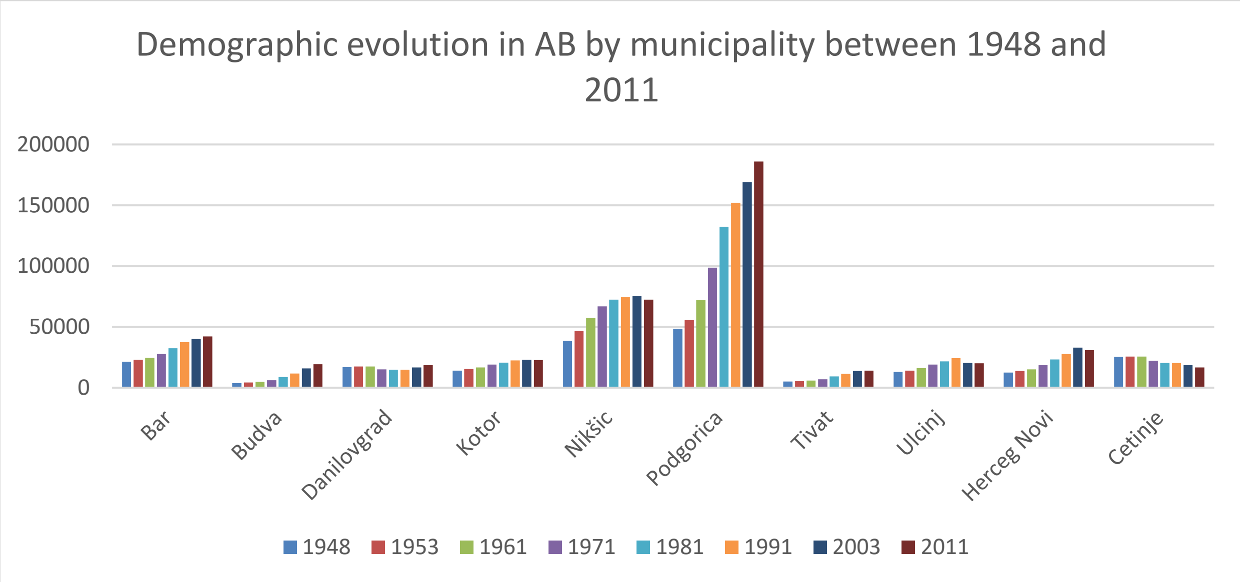
### Table 8.21 Estimated population in the Adriatic Basin in mid 2017

| Municipality | Population (Number of Inhabitants) | N⁰ of Settlements | Municipal Surface Area km² |
|---|---|---|---|
| Bar | 43,693 | 77 | 598 |
| Budva | 20,982 | 40 | 122 |
| Danilovgrad | 18,307 | 80 | 501 |
| Kotor | 22,651 | 52 | 335 |
| Nikšić | 70,042 | 106 | 2,065 |
| Podgorica | 197,589 | 141 | 1,441 |
| Tivat | 14,774 | 12 | 46 |
| Ulcinj | 20,106 | 37 | 255 |
| Herceg Novi | 30,690 | 27 | 235 |
| Cetinje | 15,621 | 85 | 910 |
| **Total** | **454,455** | **657** | **6,508** |

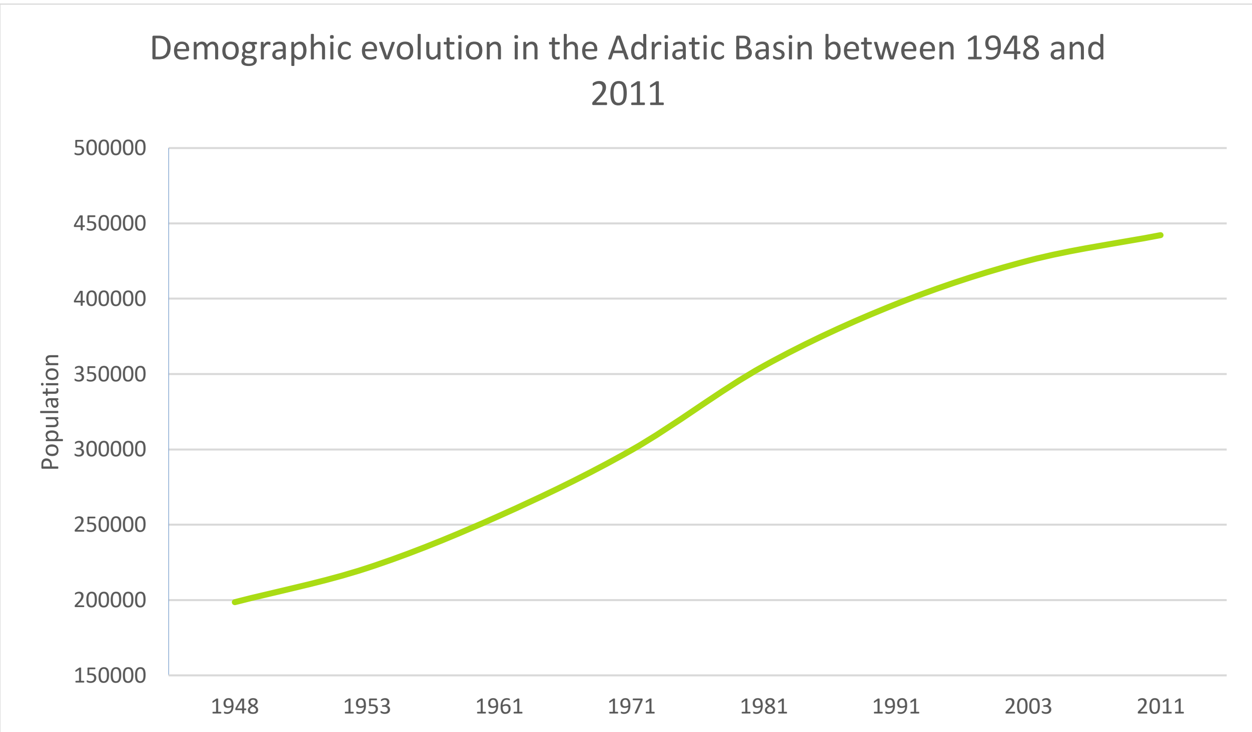
In the period from 1948 to 2011, the population of the municipalities in the Adriatic Basin increased steadily, reaching the value of 442,193 inhabitants in 2011 (according to the 2011 Census), except Cetinje municipality where decreasing trend is present from 1953 Census.

[218] Monstat, Estimated number of the population by municipalities mid year - 2017

### Figure 8.5 Demographic evolution in the Adriatic Basin by municipality between 1948 and 2011




### Figure 8.6 Demographic evolution in the Adriatic Basin between 1948 and 2011[219]




[219] MONSTAT : Statistical Yearbook for Montenegro 2014

Monstat survey containing population projections until 2060, considers population projection based on the assumptions on mortality, fertility and migration trends from 2011 – 2061. Projections and growth indexes were given separately for all 3 regions in Montenegro (Northern, Central and Coastal), as well for the whole territory. Projections were considered in 5 scenarios:

1. Low fertility Scenario,
    a. Key assumption: 2061 aggregate growth indexes are 108.8 for Coastal and 112.2 for Central region.
2. Mean fertility Scenario
    a. Key assumption: 2061 aggregate growth indexes are 120.7 for Coastal and 124.9 for Central region.
3. High fertility Scenario:
    a. Key assumption: 2061 aggregate growth indexes are 130.5 for Coastal and 135.4 for Central region.
4. Constant mortality Scenario
    a. Key assumption: 2061 aggregate growth indexes are 112 for Coastal and 114.2 for Central region.
5. Zero migration balance Scenario
    a. Key assumption: 2061 aggregate growth indexes are 93.4 for Coastal and 102 for Central region.

In the next step the 2011 Census population data are utilized to create an index for the whole Adriatic River Basin. Since Central region contains 293,509 inhabitants (i.e. 66.3% of the Adriatic River Basin) and Coastal region has 148,683 (i.e. 33.7% inhabitants of the Adriatic River Basin), indexes for Adriatic Basin are as demonstrated in Table 8.22.

### Table 8.22 Demographic projections – Adriatic Basin (Central and Coastal regions of Montenegro)[220]

| Projection variant | Hypothesis | | | Growth index (2061) |
|---|---|---|---|---|
| | Fertility | Mortality | Migrations | |
| Low fertility | Low | Expected | Expected | 111.05 |
| Mean fertility | Mean | Expected | Expected | 123.48 |
| High fertility | High | Expected | Expected | 133.75 |
| Constant mortality | Mean | Constant | Expected | 113.46 |
| Zero migration balance | Mean | Expected | Zero migration balance | 99.1 |

These scenarios do not take into consideration NRW, which is assumed to improve in the future. Opposite to the Northern region of Montenegro, the demographic trend in Adriatic Basin is positive. All scenarios presented in Table 8.22 (except Zero migration balance) as a result have an increase of population.

220 MONSTAT: Projekcije stanovništva Crne Gore do 2060. godine sa strukturnom analizom stanovništva Crne Gore

Demand from irrigation could increase, but there is no data to suggest this and the amount of agricultural land suitable for irrigation is also extremely limited. Climate change could have an impact on the future demand with longer periods of drought. Hydropower could also influence water use, but the water is likely to be retained within the river system.

## 8.9 Domestic, ICI and agricultural water consumption trends

The domestic water consumption trends were considered in relation with the evolution of the number of inhabitants in the region as outlined in the previous section. Other driving factors considered include: i) the coverage rate of water services and ii) per capita water consumption.

The domestic and legal entities (industrial, commercial and institutional) water consumption from centralized sources in the next years were forecasted considering the following assumptions:

- The base year for the projections was considered to be the year 2011;
- The demographic growth was considered to be as forecasted with the 5 scenarios detailed in the previous section;
- It is assumed the coverage rate of water services will be 100% at the end of the year 2031 (currently at 83%);
- The per capita water supplied is considered to be constant at about 445 l/c/d[221] in the year 2031 and 2061;
- The increase of industrial water demand is determined by changes in economic (tourism) activity, detailed above;
- Agricultural water demand will be considered to be constant until the year 2061, as no any data are available regarding changes in this area

The industrial, commercial and institutional (legal entities) water consumption trends are driven by the changes in economic activity (tourism, new industries, new technologies, volume of production, employment, etc.). As already discussed, tourism is the main generator of economic activity in Montenegro. Overall expectations, based on strategic orientation of the country are that this sector will grow steadily in the coming years. Hence, we expect it to be the main driver of water demand. As already mentioned, our expectation is that other segments of the ICI sector (i.e. other than tourism) will have neutral net effect on water demand.

The precise share of tourism in the ICI sector is difficult to estimate for the reasons outlined above, so for the purpose of this exercise we assumed it to be 40 percent of the total water use of ICI sector. On the other hand, the assumed overall increase in water demand coming from tourism is determined at the following levels:

- 2% from 2011 as the base year until 2030 – high-growth period
- 1% from 2031 until 2046 – stable-growth period
- 0.5% from 2046 until 2061 – decreasing growth period

Based on the above assumptions, the following trends in domestic, industrial and agricultural water consumption were identified in the basin as shown in Table 8.23.

[221] As discussed above, this figure may include a high portion of water supplied to ICI because of the flaws in reporting framework.

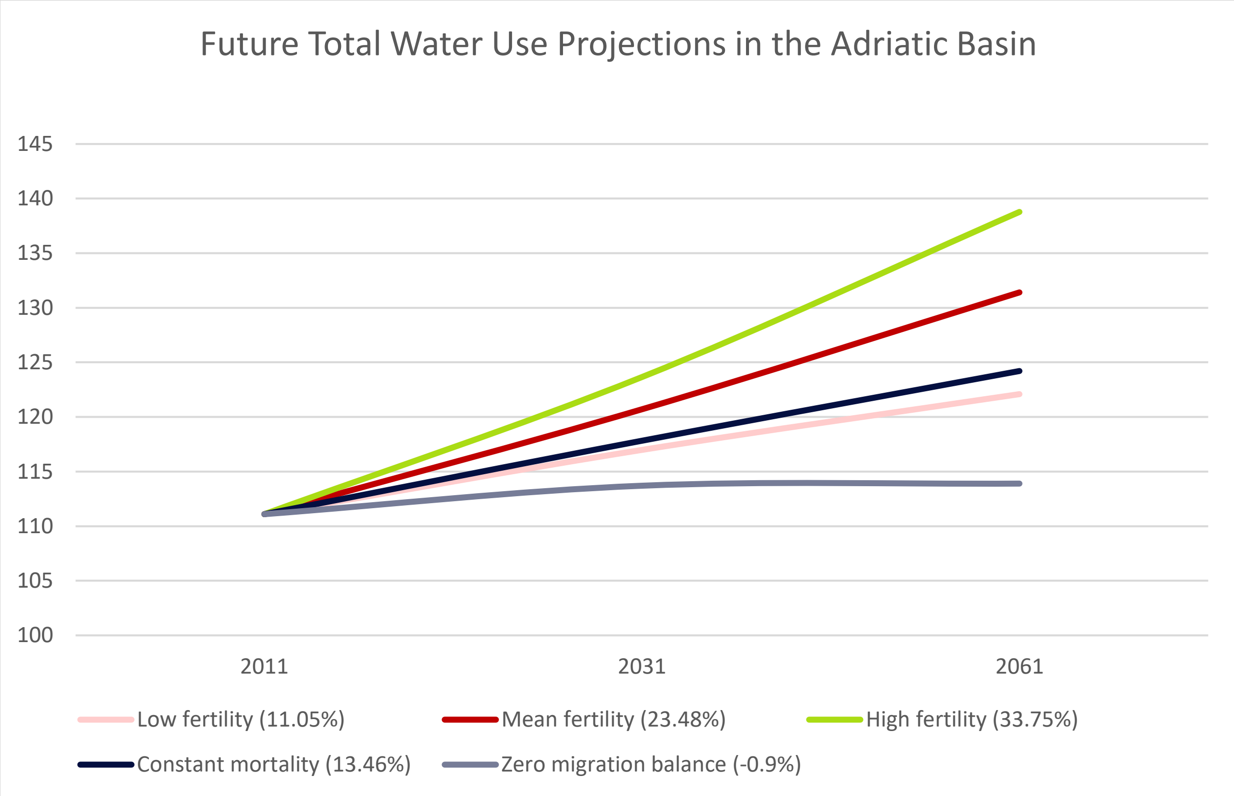
### Table 8.23 Future Total Water Use Projections in the Adriatic Basin

| Scenario | Domestic ($Mm^3$/year) | | | Industrial ($Mm^3$/year) | | | Irrigation ($Mm^3$/year) | | | Total Water Use ($Mm^3$/year) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2011** | **2031** | **2061** | **2011** | **2031** | **2061** | **2011** | **2031** | **2061** | **2011** | **2031** | **2061** |
| **Low fertility (11.05%)** | 71.8 | 74.82 | 79.34 | 21.9 | 24.76 | 25.35 | 17.4 | 17.4 | 17.4 | 111.1 | 116.98 | 122.09 |
| **Mean fertility (23.48%)** | 71.8 | 78.54 | 88.66 | 21.9 | 24.76 | 25.35 | 17.4 | 17.4 | 17.4 | 111.1 | 120.7 | 131.41 |
| **High fertility (33.75%)** | 71.8 | 81.49 | 96.03 | 21.9 | 24.76 | 25.35 | 17.4 | 17.4 | 17.4 | 111.1 | 123.65 | 138.78 |
| **Constant mortality (13.46%)** | 71.8 | 75.66 | 81.46 | 21.9 | 24.76 | 25.35 | 17.4 | 17.4 | 17.4 | 111.1 | 117.82 | 124.21 |
| **Zero migration balance (-0.9%)** | 71.8 | 71.54 | 71.15 | 21.9 | 24.76 | 25.35 | 17.4 | 17.4 | 17.4 | 111.1 | 113.7 | 113.4 |

Most of the available surveys and reports suggest that the actual water use within the Adriatic Basin will be somewhere between the Mean Fertility and High Fertility Scenarios, with overall water use varying between 117.8-120.8 $Mm^3$/year in 2031 and 127.9-135.3 $Mm^3$/year in 2061. Animal farm water use (1.2 Mm3/year in 2011) is excluded from these estimations.

The trend is increasing due to the increase of domestic and ICI consumption as the agricultural consumption was considered to be constant during the period. As this assumption was taken in the lack of better available data, if any agricultural developments will be recorded in the basin, the projection has to be reviewed properly. It is also worth underlining that although it may not be fully achieved, the 100 percent coverage rate is an assumption which is based on the general strategic orientation of the country and will require significant funds depending on the distances and type of terrain that needs to be covered by the network extension. This may have increasing effect on the total per capita consumption but in the lack of accurate estimates, we decided to keep the figures constant as we do not expect much variation.

**Figure 8.7 Trends in domestic, ICI and agricultural water consumption in the Adriatic Basin**




## 8.10 Non-abstractive water consumption trends

### 8.10.1 Hydropower

The situation in the Montenegro energy sector is promising and the potential for new hydropower schemes is high. However, severe environmental dispositions have reduced considerably the portfolio of implementable projects. Out of the many planned new HPPs in Adriatic RB, the only one currently in the pipeline is the extension program of the main HPP in basin – HPP Perućica, which would increase installed power capacity and add significantly to electricity production. The extension program of HPP Perućica foresees the installation of the eighth power unit of 57.5 MW.

### 8.10.2 Fish farming

The main issue facing fish farming is seasonal shortage of water during the summer months. It is extremely likely that there are many other suitable sites in the Adriatic River Basin; and some farms possess the potential to increase their current capacity as long as water resources are available. However, fish farms can have negative impact on aquatic ecosystems through water pollution due to high amounts of nutrients and through the introduction of invasive fish. In addition, as mentioned in the Montenegro's Fisheries Development Strategy and Capacity Building for Implementation of the EU Common Fisheries Policy, 2006, improvements of the fisheries management is necessary in order to reduce the impact of this activity. Indeed, the equipment needs to modernize in order to reduce the water losses and the water pollution. The practice should be improved in order to be more efficient (reduction of the period of growing, adapted spawning period, quality of the feeding regimes, increase of the varieties of the brood stock).

## 8.11 Water returns

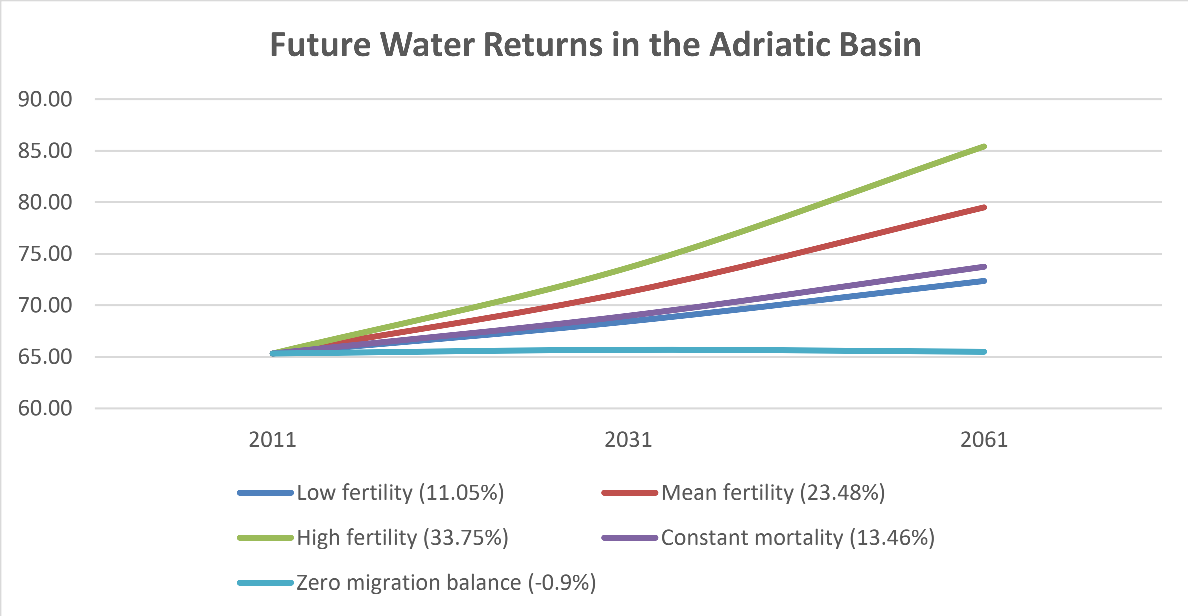
The assumption regarding water returns to the basin (through surface water or to the groundwater) are as follows:

- 80% of domestic water use is returned to the system as wastewater
- 20% of industrial water use is returned to the system as wastewater
- 20% of irrigation water is returned to the system but only for 5 months of the year, from May to September.
- 100% of water for fish farming is returned to the system
- 100% of water for hydropower use is returned to the system

### Table 8.24 Future Water Returns in the Adriatic Basin

| Scenario | Domestic (Mm³/year) | | | Industrial (Mm³/year) | | | Irrigation (Mm³/year) | | | Total Water Returns (Mm³/year) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2031 | 2061 | 2011 | 2031 | 2061 | 2011 | 2031 | 2061 | 2011 | 2031 | 2061 |
| Low fertility (11.05%) | 57.47 | 60.01 | 63.82 | 4.38 | 4.95 | 5.07 | 3.48 | 3.48 | 3.48 | 65.33 | 68.44 | 72.37 |
| Mean fertility (23.48%) | 57.47 | 62.87 | 70.96 | 4.38 | 4.95 | 5.07 | 3.48 | 3.48 | 3.48 | 65.33 | 71.30 | 79.51 |
| High fertility (33.75%) | 57.47 | 65.23 | 76.87 | 4.38 | 4.95 | 5.07 | 3.48 | 3.48 | 3.48 | 65.33 | 73.66 | 85.42 |
| Constant mortality (13.46%) | 57.47 | 60.56 | 65.2 | 4.38 | 4.95 | 5.07 | 3.48 | 3.48 | 3.48 | 65.33 | 68.99 | 73.75 |
| Zero migration balance (-0.9%) | 57.47 | 57.26 | 56.95 | 4.38 | 4.95 | 5.07 | 3.48 | 3.48 | 3.48 | 65.33 | 65.69 | 65.50 |

## Figure 8.8 Projections of future water returns in the Adriatic Basin



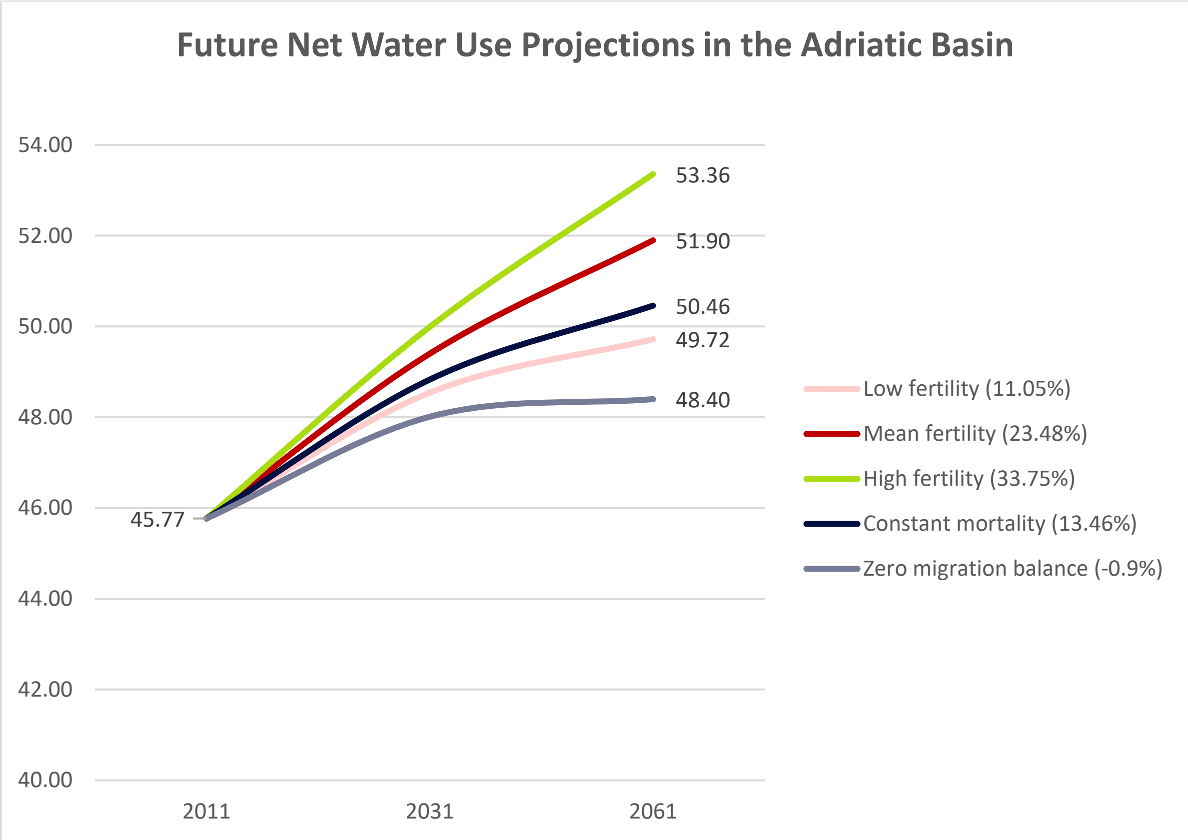

## 8.12 Net Water Use

Net water use is arrived by subtracting the water returns (Table 8.24) from the gross water use (Table 8.23). The results are shown in the Table 8.25 below. If we assume that the actual net water use evolution will lie somewhere between the "Mean fertility scenario" and the "High fertility scenario", net water use should vary between 50.6 – 51.2Mm³/year in 2031 and 52.6 – 54.1Mm³/year in 2061. Animal farm water use is still excluded from these estimations. In the next sections of this chapter we will consider only Mean and High fertility scenarios, which we highlighted as the most probable for the Adriatic RB.

### Table 8.25: Future Net Water Use Projections in the Adriatic Basin

| Scenario | Domestic (Mm³/year) | | | Industrial (Mm³/year) | | | Irrigation (Mm³/year) | | | Net Water Use (Mm³/year) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2031 | 2061 | 2011 | 2031 | 2061 | 2011 | 2031 | 2061 | 2011 | 2031 | 2061 |
| Low fertility (11.05%) | 14.33 | 14.81 | 15.52 | 17.52 | 19.81 | 20.28 | 13.92 | 13.92 | 13.92 | 45.77 | 48.54 | 49.72 |
| Mean fertility (23.48%) | 14.33 | 15.68 | 17.7 | 17.52 | 19.81 | 20.28 | 13.92 | 13.92 | 13.92 | 45.77 | 49.40 | 51.90 |
| High fertility (33.75%) | 14.33 | 16.26 | 19.16 | 17.52 | 19.81 | 20.28 | 13.92 | 13.92 | 13.92 | 45.77 | 49.99 | 53.36 |
| Constant mortality (13.46%) | 14.33 | 15.1 | 16.26 | 17.52 | 19.81 | 20.28 | 13.92 | 13.92 | 13.92 | 45.77 | 48.83 | 50.46 |
| Zero migration balance (-0.9%) | 14.33 | 14.28 | 14.2 | 17.52 | 19.81 | 20.28 | 13.92 | 13.92 | 13.92 | 45.77 | 48.01 | 48.40 |

**Figure 8.9 Projections of future net water use in the Adriatic Basin**



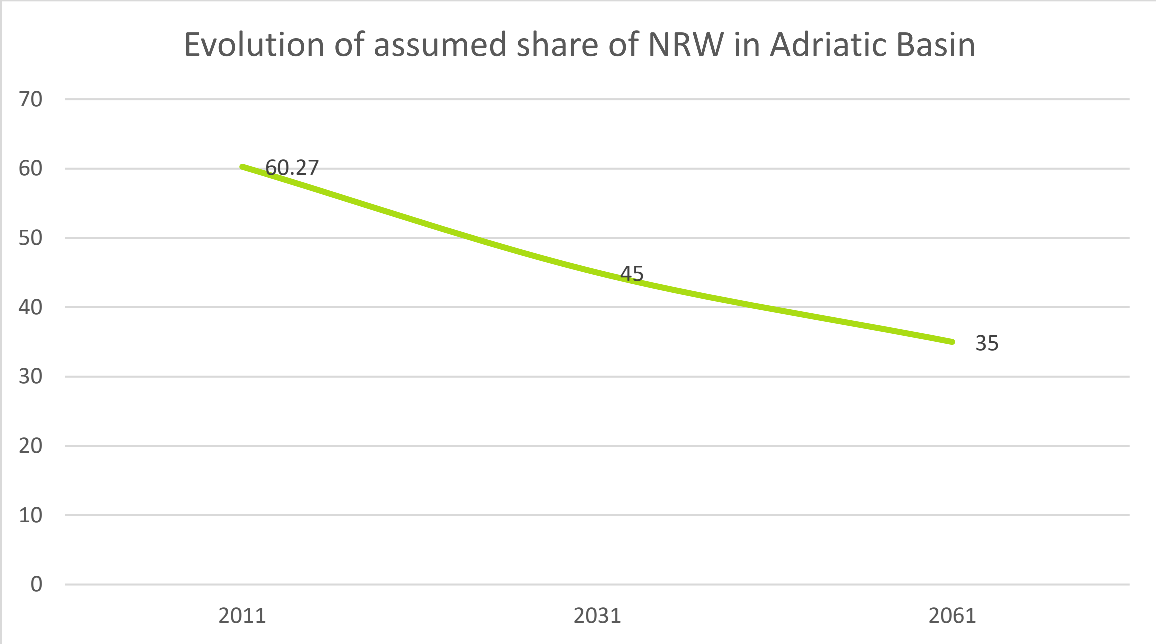

## 8.13 Non-Revenue Water

This net water use projection assumes that the level of Non-Revenue Water will remain constant over the projection period. As we mentioned earlier, the main reasons for this large gap are deficiencies in the water transport network (technical losses) as well as unregistered and illegal connections to the network, and inaccurate metering of water consumption (administrative losses). Illegal connections to the water supply system seem to be a major problem. The average share of non-revenue water is estimated at 60.27 % in the Adriatic Basin.

Assuming no investment is done in Water Supply infrastructures until 2061 (the NRW values), the estimated projections of future net water use in the Adriatic Basin will remain as above. However, it is highly unlikely that the water losses will remain steady in the Adriatic Basin, as they are extremely large and reveal the major issues that will be addressed rather sooner than later. Therefore, we will assume that the Central Government together with local partners (i.e. Municipalities and utility companies) will engage in investment activity which will gradually bring down the water losses and thus decrease the net water use in the Adriatic Basin. Investments will be implemented to improve the proportion of water successfully invoiced to the consumers and decrease both technical and administrative losses.

In a lack of reliable data regarding precise objectives linked to the reduction of losses in transmission (and distribution) network and improvement of metering of water consumption, we assume that NRW will be limited to 45% in 2031 and 35% in 2061. Again, it is important to emphasize that these assumptions are only valid provided that intensive and large-scale investments programs related to NRW are implemented and appropriate works are carried out.

**Figure 8.10 Assumed trajectory of the share of NRW**



## 8.14 Total water demand trends in the basin

Total water demand is assumed to be the sum of the water consumption (domestic, legal entities and agricultural) and the water losses in the supply system. We expect quite sizeable decrease in the total net water demand of water in the Adriatic Basin, within the 2031 – 2061-time horizon.

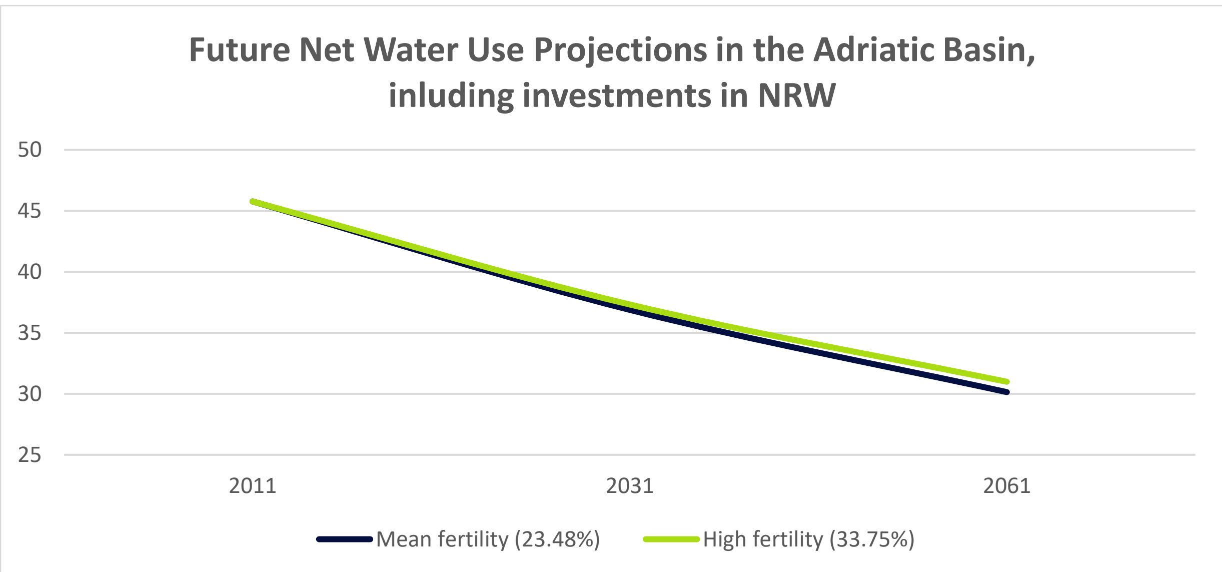
These are the key assumptions behind this expectation:

- Mean fertility (i.e. 23.48%) or High fertility (i.e. 33.75%) population growth assumptions will materialize – as explained in the previous section, we consider these two demographic trends to be the most realistic among the set of five possible ones;
- There will be no major ICI investments in the region requiring large water consumption;
- Domestic consumer behavior will not change significantly;
- The Water Utilities will adopt and implement appropriate measures to control and to reduce the physical and administrative water losses.

### Table 8.26 Future Net Water Use Projections in the Adriatic Basin, including NRW investments assumptions

| Scenario | Net Water Use (Mm³/year) | | |
|---|---|---|---|
| | **2011** | **2031** | **2061** |
| **Mean fertility (23.48%)** | 49.25 | 36.88 | 30.14 |
| **High fertility (33.75%)** | 49.25 | 37.32 | 30.99 |

### Figure 8.11 Projections of future net water use in the Adriatic Basin, including investments from Public Water Utilities in NRW



As expected, the NRW volume is so big that even small reductions command large changes in the net water use for the Adriatic Basin. Our projection was based on the population growth in the basin, where increasing trend is present from 1948 to date. In fact, the High fertility scenario projected net water use to be 49.25 $Mm^3$/year while it now stands at 37.32 $Mm^3$/year with the envisaged reduction of NRW from 60.27% to 45% going from 2011 to 2031. Further, in 2061, within the same scenario net water use is projected to be at 30.99 $Mm^3$/year which reflects further reduction of the share of NRW to 35%. Finally, in the Mean fertility scenario (assuming population growth of 23.48% for the period of 50 years) the projected net water use is 36.88 $Mm^3$/year in 2031 and 30.14 $Mm^3$/year in 2061.

## 8.15 Cost Recovery of Water Services

The approach that is proposed here for analyzing and reporting on cost recovery is as stated in the "Guidance Document No 1: Economics and the Environment – The Implementation Challenge of the Water Framework Directive"[222.]

### 8.15.1 Identified water services in the Basin District

Water services are defined in Article 2 of the WFD as: "all services which provide, for households, public institutions or any economic activity: (a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater; (b) wastewater collection and treatment facilities, which subsequently discharge into surface water."

Water supply and wastewater drainage and collection have been recognized by all local government units as the most important utility services. Subject services were given special attention in all local government units as the foundation of utility service, regardless of whether they are provided within separately formed utility enterprises or within mixed enterprises. Mixed utility enterprises usually have operational units in charge of water supply and wastewater drainage issues and waste management issues.

According to the provisions of the Law on Utility Services ("OG“, no. 12/95), utility services include, among other, as follows: water supply, wastewater treatment and drainage, maintenance and use of landfills, and maintenance of riverbeds, etc. The line authority of the local government unit stipulates the method and requirements of organizing and using utility services.

Water services are seen as intermediaries between the natural environment and actual water use. In the Adriatic Basin, the following water services were identified as follows:

- Drinking water supply for households, companies and institutions, which includes:
    - Abstraction
    - Storage
    - Treatment
    - Distribution

- Sewerage services for households, companies and institutions, which includes:
    - Wastewater collection
    - Wastewater treatment facilities

222 http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

## 8.16 Water and wastewater services providers

The organization of public utility services, such as municipal waste collection and disposal and water supply and sewerage services is the responsibility of local self-governments, which have delegated the provision of these services to a municipal public utility company. In most municipalities, the originally established multiservice public utility companies were broken up during the past decade and separate companies were established that specialize in either water supply and wastewater services or waste management.[223].

Municipalities in the Central and Coastal region of Montenegro, region covering the Adriatic Basin, have public enterprises in charge of water supply and sewerage exercising water supply and wastewater management activities.

Utility services in Montenegro provide 53 enterprises founded by the local government units and around 50 private companies and other entities. In other words, provision of utility services for around 630,000 inhabitants is in the hands of at least 100 entities. Majority of utility services are provided by the enterprises founded by the local government units in line with ordinances delegating subject activities indefinitely. According to estimates given in the document "Priority Activities in Utility Services-Reform Agenda", inefficiency of enterprises in charge of water supply and wastewater management in Montenegro is a major problem. On average, each 1000 users are served by 10.28 workers. For comparison, number of employees of water supply and sewage enterprises in Germany per 1000 users is around 4[224].

Difficulty is that the process of utility service provision is not under supervision or influence of an independent regulatory state authority. Possible effect of merging subject enterprises would be higher reliability with fewer capacities[225].

Local self-governments are legally responsible not only for the provision of utility services. They also regulate the activities in the sector, including, notably, the setting of tariffs for utility services. The overall economic and financial performance of municipal waste and water supply companies in Montenegro has remained, in general, a matter of concern, given that own revenues are hardly sufficient to cover operating costs. This reflects, notably, the local policy considerations that are influencing tariff setting, but also the fact that public utility companies are overstaffed.

Data on self-services, such as agricultural abstraction and private water supplies and wastewater treatment (employing septic tanks or cesspools) are difficult to identify as there is not a comprehensive dataset available on numbers of services, locations, volumes, etc.

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[223] Annual report on conditions in the sphere of water supply, waste and wastewater management, implementation of priority activities in utility services with a proposal of priority utility infrastructure projects and recommended measures

http://www.gsv.gov.me/biblioteka/nacrti-zakona (5/5/2015)

[224] Government of Montenegro, MSDT, Podgorica, September 2013, p. 6.

[225] World Bank: SUPPORT TO WATER RESOURCES MANAGEMENT IN THE DRINA RIVER BASIN: MONTENEGRO – IWRM STUDY AND PLAN –BACKGROUND PAPER -VOLUME 1 – MAIN REPORT - 2016

### Table 8.27 Water and wastewater service providers in the Adriatic Basin

| Municipality | Water supply Company | Wastewater Company |
|---|---|---|
| Bar | "VODOVOD I KANALIZACIJA" BAR | |
| Budva | "VODOVOD I KANALIZACIJA" BUDVA | |
| Danilovgrad | "VODOVOD I KANALIZACIJA" DANILOVGRAD | |
| Kotor | "VODOVOD I KANALIZACIJA" KOTOR | |
| Nikšić | "VODOVOD I KANALIZACIJA" NIKŠIĆ | |
| Podgorica | "VODOVOD I KANALIZACIJA" PODGORICA | |
| Tivat | "VODOVOD I KANALIZACIJA" TIVAT | |
| Ulcinj | "VODOVOD I KANALIZACIJA" ULCINJ | |
| Herceg Novi | "VODOVOD I KANALIZACIJA" HERCEG NOVI | |
| Cetinje | "VODOVOD I KANALIZACIJA - CETINJE" CETINJE | |
| | Regionalni Vodovod Crnogorsko Primorje | |

## 8.17 Water users

Water use is defined in Article 2 as: “water services together with any other activity identified under Article 5 and Annex II having a significant impact on the status of water. This concept applies for the purposes of Article 1 and of the economic analysis carried out according to Article 5 and Annex III, point (b).” Article 9 of the Directive specifies that the water uses should include at least households, agriculture and industry.

Key data that can be collected:

- Population covered by the water service, including coverage rate and number of water connections (Table 8.28)
- The number of industrial, commercial and institutional water and wastewater connections (Table 8.29)

### Table 8.28 Population covered by the public water services in the Adriatic Basin, 2014[226]

| Municipality | Population (inhabitants) | Number of households | Households Connected to Public Water Supply (%)[227] | Population Served by Public WS services | Urban Households Connected to Public Sewerage System (%) | Population Served by Public WW services |
|---|---|---|---|---|---|---|
| Bar | 42,048 | 14,210 | 97 | 40,787 | 65 | 40,787 |
| Budva | 19,218 | 6,980 | 99 | 19,026 | 100 | 19,026 |
| Danilovgrad | 18,472 | 5,500 | 87 | 16,071 | 40 | 16,071 |
| Kotor | 22,601 | 7,650 | 98 | 22,149 | 45 | 22,149 |
| Nikšić | 72,443 | 21,680 | 90 | 65,199 | 46 | 65,199 |
| Podgorica | 185,937 | 57,350 | 97 | 180,359 | 60 | 180,359 |
| Tivat | 14,031 | 4,860 | 99 | 13,891 | 40 | 13,891 |
| Ulcinj | 19,921 | 5,810 | 98 | 19,523 | 75 | 19,523 |
| Herceg Novi | 30,864 | 11,130 | 99 | 30,555 | 75 | 30,247 |
| Cetinje | 16,658 | 5,750 | 85 | 14,159 | 55 | 14,159 |
| **Total** | **442,193** | **140,920** | **95** | **421,718** | **59** | **421,409** |

Almost all urban households (95%) of the Adriatic River Basin are connected to Public Water Supply.

Only 59% of urban areas (and only 44% of total area) are covered by sewage collection systems. However, there are a lot of discrepancies between different available studies and reports about these data. According to the information provided, a part of the sewage is collected and disposed untreated into the sea. The total amount of untreated wastewater discharged mainly to the sea through submarine outfalls is reported to be 27,000 $m^3$/d. It is assumed that this figure also includes the wastewater produced from rural areas with population less than 2000[228].

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[226] MONSTAT: Stanovi prema opremljenosti instalacijama, Popis stanovništva, domaćinstava i stanova u Crnoj Gori 2011. godine

[227] The number of households and consequently connection to waterworks in Montstat analysis does not include tourist houses and their not-permanent residents. In this way percentage of connections is highly exaggerated, while number of water self-dependents reduced.

[228] INVENTORY OF MUNICIPAL WASTEWATER TREATMENT PLANTS OF COASTAL MEDITERRANEAN CITIES WITH MORE THAN 2,000 INHABITANTS (2010) - MEDITERRANEAN ACTION PLAN – United Nations Program for Environment

## Table 8.29 Legal Entities and Agricultural water users in Adriatic Basin, 2014

| Municipality | Population (inhabitants) | Legal Entities Water Connections | Agricultural Water Connections | | Legal Entities Sewerage Connections |
|---|---|---|---|---|---|
| | | | Maintained by public utility company | Maintained by local consumers | |
| Bar | 42,048 | 1,935 | 9 | 13 | 913 |
| Budva | 19,218 | 1,850 | 0 | 7 | 2 |
| Danilovgrad | 18,472 | 347 | 0 | 5 | NA |
| Kotor | 22,601 | 1,003 | 1 | 3 | 282 |
| Nikšić | 72,443 | 1,300 | 3 | 3 | 359 |
| Podgorica | 185,937 | 5,780 | 2 | 8 | 1,224 |
| Tivat | 14,031 | 515 | 2 | 0 | 295 |
| Ulcinj | 19,921 | 853 | 2 | 3 | 45 |
| Herceg Novi | 30,864 | 1,464 | 0 | 19 | 570 |
| Cetinje | 16,658 | 350 | 2 | 4 | 4,470 |
| **Total** | **442,193** | **15,397** | **21** | **65** | **8,160** |

## 8.18 Financial Costs of the Water Services

The financial data regarding the costs of water and wastewater services were gathered from the water utility companies operating in the basin. The following financial costs data were available to be collected:

- Operating and maintenance costs. These costs are those that relate to providing the service and include, amongst others, employment costs, energy costs, material costs and the costs of employing third parties. Maintenance costs relate to keeping the assets in serviceable condition throughout their economic life.
- Capital costs. These are the costs of the principal and interest payments (and cost of capital as appropriate) associated with expenditure on assets that is externally financed through loans, bonds, equity and also other financial mechanisms. These costs also include the annual depreciation of the existing fixed assets operated by the water utilities.
- Administrative costs. These relate the interests and other financial expenses paid by the utilities to run their water business.
- Taxes & subsidies: These include the general and other specific taxes paid by the water companies. Later analysis of cost recovery based on the economic rather than financial costs would need to remove general taxes and other transfers.

Due to the structure of the financial statements (i.e. Income Statements) of the local utility companies it was not possible to differentiate between the financial costs related to water and wastewater services. In addition, most of the utility companies across the Adriatic River Basin render communal services to its citizens other than water and wastewater related ones. These services are not reported separately from each other so we estimated the water related portion by assuming that 60 percent of the business operations and thus revenues and expenditures belong to this line of services.

All financial data were obtained from the official register of financial statements provided by the Tax Administration of Montenegro. All financial data shown below refers to the end of 2017.

### Table 8.30 Financial costs for water and wastewater services in the Adriatic Basin (2017)

| Water & WWServices | Bar | Budva | Danilovgrad | Kotor | Nikšić | Podgorica | Tivat | Ulcinj | Herceg Novi | Cetinje | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Operating and Maintenance costs** | | | | | | | | | | | |
| Labour cost | 1,021,757 | 2,014,484 | 496,027 | 640,352 | 995,666 | 3,665,929 | 509,687 | 715,022 | 1,097,312 | 412,652 | **11,568,888** |
| Material costs (incl. Chemicals) | 321,440 | 357,542 | 271,379 | 231,638 | 442,881 | 1,482,027 | 146,203 | 212,032 | 327,830 | 511,918 | **4,304,891** |
| other costs | 252,927 | 1,052,088 | 74,645 | 253,801 | 757,960 | 933,265 | 172,323 | 64,842 | 328,355 | 167,543 | **4,057,748** |
| **Capital Costs** | | | | | | | | | | | |
| Capital Costs | 473,156 | 549,016 | 24,796 | 89,462 | 159,131 | 1,482,762 | 68,561 | 376,105 | 106,273 | 10,887 | **3,340,149** |
| **Administrative Costs** | | | | | | | | | | | |
| Other financial expenses | 2,471 | 56,615 | 24,220 | 3,294 | 3,203 | 124,541 | 0 | 26,504 | 14,455 | 125,093 | **380,395** |
| **Taxes and Subsidies** | | | | | | | | | | | |
| Taxes and duties | 4,358 | -50,750 | 1,742 | -120,832 | 676 | 46,049 | 11,494 | 9,124 | -21,523 | 0 | **-119,662** |
| **Total Financial Cost** | **120,162** | **634,581** | **1,005,889** | **588,571** | **292,931** | **7,734,572** | **908,267** | **1,403,629** | **1,592,599** | **396,220** | **23,532,409** |

## 8.19 Environmental and resource costs

Resource costs are defined as the opportunity costs of using water as a scarce resource in a particular way (e.g. through abstraction or wastewater discharge) in time and space. They equal the difference between the economic value in terms of net benefits of present or future water use (e.g. allocation of emission or water abstraction permits) and the economic value in terms of net benefits of the best alternative water use (now or in the future). Resource costs only arise if alternative water use generates a higher economic value than present or foreseen future water use.

Environmental costs consist of the environmental damage costs of aquatic ecosystem degradation and depletion caused by a particular water use (e.g. water abstraction or the emission of pollutants). A distinction can be made between damage costs to the water environment and to those who use the water environment. Interpreted in terms of the concept of total economic value, one could argue that the environmental damage costs refer to non-use values attached to a healthy functioning aquatic ecosystem, while the costs to those who use the water environment refer to the corresponding use values.

Adriatic River Basin, and especially the coastal zone of Montenegro is one of the most valuable national resources. The area has a high development potential which is of vital importance for the development of Montenegrin society. However, it is also characterized by complex relations between human activities and environment that often result in pronounced pressures on natural resources[229].

According to the World Bank, the Southeast Region of Europe will be severely impacted by global warming. Climate change variability, mainly reflected by temperature increase, extreme weather events such as droughts and flash floods, low precipitation, and sea level rise, highly impact the situation of the area, putting its households and agricultural land in danger. Sea level rise and storms can lead to severe flooding of the coastal areas and increase the salinity of freshwater bodies, affecting the ecosystem. Flood events also often occur at the lower Drin River of the Lake Skadar / Shkoder watershed, highly influencing the Buna / Bojana watershed. In 2010, severe floods were reported in the lower Drin - Buna / Bojana River and Lake Skadar / Shkoder due to heavy precipitation combined with strong winds at the outflow of the Lake[230].

Moreover, the hydrological regime of Buna / Bojana watersheds is affected by the main economic activities including tourism, agriculture and livestock along the rivers. Anthropogenic activities in the region, mainly through uncontrolled coastal development, population growth, increased economic activities, and poor management of urban waste and wastewater are adding additional pressures on the watershed affecting both nature and human wellbeing. Regarding economic activities, agriculture was previously one of the main activities in the area. Unsustainable agricultural methods led to degraded water quality and significantly increased water consumption.

Construction has expanded due to increased urban development after the 1990's, affecting mainly the coastal zone and urban centers. The poor sustainable planning strategy in Montenegro has led to landscape and nature degradation of the area. In addition, basic infrastructure and municipal services are poor and are unable to meet the needs of the rapid spatial transformation. Drainage channels are also blocked and badly maintained causing frequent flooding in the watersheds. The potable water

[229] National strategy for integrated coastal zone management – CAMP Montenegro - 2015

[230] Albania and Montenegro: Creating an Integrated Water Resources Plan for the Buna / Bojana Watershed Resources Plan for the Buna / Bojana – Global Water Partnership (GWP) - 2017

sources and wastewater treatment plants are too few to meet the demand of the increasing population. Moreover, waste management systems are inadequate and unsustainable[231].

The existing state of exploitable reserves in the groundwater deposits during dry period as well as a poor state of hydro-technical infrastructure point to the need to invest in water and wastewater infrastructure. Another source of concern are the protection zones which have not been defined for all the springs used to supply the coastal region with water. Permanent and significant intermittent water flows are characterized by a very high vulnerability. Šasko Lake is extraordinarily valuable and it is also characterized by a high vulnerability; Skadar Lake is highly vulnerable too. Zones of smaller torrential flows across the entire Adriatic River Basin area can be categorized as medium vulnerable.

Pollution above the allowable limits has been registered in Bojana and Sutorina rivers. Pollution load in Bojana river is already high at the very source, but due to a large amount of water its quality parameters remain within the prescribed limits until the lower part of its flow where excess concentrations of some pollutants have been recorded[232].

In the same way than in the Adriatic River Basin, a part of water pollution is due to the untreated wastewater discharges in the river. Small quantity of water in riverbeds for major part of the year exacerbates their susceptibility to pollution. Unfortunately, the value of the environmental costs can again not be estimated because of the unavailability of relevant data. In the cost recovery analysis, these costs were not considered. If and when trusted data will be available, the environmental costs will be estimated and included in the economic cost recovery analysis. Data on groundwater pollution is incomplete, but the available ones allow for conclusion that groundwater sources are in principle not critically endangered by the existing waste disposal sites (with the exception of Pode near Herceg Novi which can have an impact on Morinjski springs). There is a lack of trustworthy data on pollution caused by wastewater effluents on groundwater.

Some of the main points of concern regarding water pollution in the Adriatic River Basin are listed here below:

- Excess marine pollution in the Boka Kotorska Bay and in Ulcinj area (to a lesser extent in Budva and Bar); sediment pollution with heavy metals at certain locations (Bijela Shipyard, former overhaul institute – now Porto Montenegro, several ports)[233]
- Occasional deviation of water quality of the rivers Bojana and Sutorina from prescribed norms for envisaged classes Quality of water springs, peloid deposits and springs of thermal mineral waters is endangered
- Irrational water consumption in the water supply systems (high network losses, use of potable water for other purposes)
- Pollution of soil, groundwater and sea as well as diminishing of the coastal zone attractiveness due to inadequate disposal of solid waste; non-rehabilitated waste disposal sites represent critical spots of soil pollution

Fish farms have negative impact on the water quality of the rivers due to great amount of nutrients that they generate and also on the water quantity in some places (the drying of the small tributaries) due to water derivation without guarantee of a sufficient environmental flow. It is needed to improve fish farming process and build nutrient precipitators in fish farms in order to prevent water pollution.

[231] Albania and Montenegro: Creating an Integrated Water Resources Plan for the Buna / Bojana Watershed Resources Plan for the Buna / Bojana – Global Water Partnership (GWP) - 2017

[232] National strategy for integrated coastal zone management – CAMP Montenegro - 2015

[233] National strategy for integrated coastal zone management – CAMP Montenegro - 2015

Measures will have to be implemented to modernize equipment to reduce water loss and to promote fish growth efficiency.

Future demand requirements for 2031 and 2061 have been estimated based upon five scenarios. The evidence suggests that the demands for domestic consumption in the basin will increase compared with today due to the population growth trend in the basin. We believe the actual water use within the Adriatic Basin will be somewhere between the Mean fertility and High fertility Scenarios, with overall water use around 111.1 $Mm^3$/year at present day, to 117.8-120.8 $Mm^3$/year in 2031 and 127.9-135.3 $Mm^3$/year in 2061. Taking into consideration the returns in the system then the net future Water Use for the Montenegrin part of the basin over the 20 and 50-year timeframe varies from 50.6-51.2 $Mm^3$/year in 2031 to between 52.6 $Mm^3$/Year and 54.1 in 2061.

Environmental flow (EF) is considered the minimal quantity of water necessary to maintain healthy, natural ecosystems and the minimal flow required for habitats, migration and water quality factors. The World Bank describes the environmental flow as “the quality, quantity, and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems which provide goods and services to people”. The EU WFD does not use explicitly the term of “environmental flows”. It requires the states of the community to guarantee a good ecological status in surface and underground water bodies.

The adopted EF in Montenegro is a compromise between the guarantee of maintaining ecological river function (quality and quantity of the water) and the socio-economic use of the water resources (domestic use, irrigation, hydropower, etc.). Adriatic River Basin area is characterized by a high level of precipitation (with unfavorable seasonal oscillations), but also a high runoff. Due to relatively fast infiltration through the porous surface, water balance is unfavorable, and there is a lack of water in critical periods (vegetative and tourist season periods). Except for the river Bojana, all rivers have fast and short courses with major fluctuations in the flow and are often of torrential character. Hydrologic observations and continuous measurements over a longer period of time (around 20 years) exist only for the rivers Bojana, Željeznica and Sutorina, as well as for the Reževića river (for the latter the latest observation of water level has been carried out only over a period of 16 years. Even though groundwater drinking water reserves of karst aquifers are significant, they are insufficient for water supply, mostly due to unfavorable precipitation pattern and a steep increase in water demand during the summer period. Salt water intrusion also contributes to problems with using local groundwater springs for water supply[234].

Identified key drivers were:

- Water supply for the population,
- Water supply for agriculture (irrigation & livestock),
- Water supply for industry,
- Tourism industry,
- Environmental conservation,
- Fisheries.

In the future, some actions will be required to better control the environmental flow:

- WWTP are needed at the main centers of population and for industry in order to reduce the pollution loads in the rivers;

[234] National strategy for integrated coastal zone management – CAMP Montenegro - 2015

- Manage protected natural assets as rivers, ecologically valuable habitats and ecosystems of the Adriatic River Basin zone sustainably;
- Build new sanitary landfill away from groundwater protection zones and from riverbeds;
- Close existing landfills and move them away from riverbanks and flood plains.

## 8.20 Cost recovery mechanisms

In Montenegro, regulation is intended to ensure that the price of water and wastewater is appropriate relative to the economic value and quality of the service. The primary piece of legislation in the field is the Law on Financing Water Management (OG 065/08, amended subsequently). The Law defines the sources of water management financing, methodology for calculation and purpose of the fees for the use of water resources of the country. The Law effectively promotes the "beneficiary-pays" and "polluter-pays" principles in defining the framework for setting the volume of the corresponding financial compensation for the use of water.

The Law defines the sources of financing for water management at the country level and relates the fees to the volume of caught, used or supplied water in m3, per kg of produced fish, per kWh of produced electrical energy or kW of installed capacity.

In 2007, water abstraction charges were calculated as a percentage of the "price" of services or products for which the water abstracted was used. Thus, water used for electricity production was charged at 0.22% of the average price 1 kWh. Water abstraction for bottling of mineral water was charged at 3% of the average price of mineral water. Since 2009, a new approach to setting water abstraction charges has been used based on the Decision on the Amount and Method of Calculating Water Charges and the Criteria and Method of Determining the Degree of Water Pollution. In general, total payments depend on the volume of water abstracted. Fees for use of water for electricity generation are based on the quantity of electricity (kWh) generated on the grid. There is also a separate charge rate per kW for the use of water for other energy purposes by power plants. Total revenues from these water resource use charges amounted to €1.9 million in 2012. Industrial use and hydropower generation accounted for some 60% of these revenues; public water companies accounted for another 35%[235].

Provisions of this Law and the above Decision do not relate to the price-setting mechanism for municipal water supply and management companies. Each municipal council brings their own decision in the form of a Local Council Act on the level of prices for natural and legal entities. This is one of the reasons for the large variation in the level of water tariffs observed along the Adriatic Basin. As we saw above, household tariffs go from 0.38 EUR/$m^3$ in Nikšić to 1.12 EUR/m3 in Budva. Normally, this would indicate that there are different costs associated with water production across the basin and that these costs simply have to be compensated by the tariffs. However, judging by the thorough elaboration of the issue within the Water Management Strategy this is only partially true. The fact is that local utility companies are still heavily subsidized and that water service is still perceived as a common good (i.e. social category) which should not take up a significant part of either household or company budget. The actual levels of tariffs that are applied by the Water Utilities in the Adriatic Basin are shown in Table 8.31.

[235] Montenegro: Environmental Performance Review (Third Review) – 2015 - UNECE

The Water Management Strategy refers to the issue of lack of financial sustainability and points to the following issues:

- Consistent failure of revenues to cover for the costs incurred in the water production and system maintenance process
- Large losses in the water supply system. Currently they are circulating around 61%.
- Price of water and specifically the "cross-subsidization" issue (i.e. much higher prices for industry than for households). The ratio of industry-to-households tariffs goes to as much as 270% in some cases.
- Low collection rates. They are between 60% and 75%.
- Suboptimal (i.e. excess) level of employees and lack of financial resources for capital maintenance
- Ownership issues in the water and wastewater business. While the municipalities are owners of the local utility companies, the Government owns the water supply system and sewerage network which is a source of ambiguity in terms of who is responsible for investing in the infrastructure.

### Table 8.31 Tariffs applied by the water utilities in the Adriatic River Basin, 2014[236]

| Municipality | Water services (€/m$^3$) | | Wastewater services (€/m$^3$) | | TOTAL WATER & SEWERAGE PRICE (€/m$^3$) | | REVENUE COLLECTION (%) |
|---|---|---|---|---|---|---|---|
| | Households | Legal Entities | Households | Legal Entities | Households | Legal Entities | |
| Bar | 0.86 | 1.61 | 0.26 | 0.48 | 1.12 | 2.09 | 88 |
| Budva | 1.12 | 2.25 | 0.22 | 0.44 | 1.34 | 2.69 | 87 |
| Danilovgrad | 0.61 | 1.07 | 0.46 | 0.64 | 1.07 | 1.71 | 99.34 |
| Kotor | 1.1 | 2.2 | 0.56 | 0.56 | 1.66 | 2.76 | 95.98 |
| Nikšić | 0.38 | 1.27 | 0.19 | 0.64 | 0.57 | 1.91 | 79.55 |
| Podgorica | 0.4 | 1.33 | 0.2 | 0.66 | 0.6 | 1.99 | 82 |
| Tivat | 0.86 | 1.93 | 0.26 | 0.58 | 1.12 | 2.51 | 97 |
| Ulcinj | 0.77 | 1.74 | 0.26 | 0.77 | 1.03 | 2.51 | 76 |
| Herceg Novi | 0.91 | 1.86 | 0.14 | 0.3 | 1.05 | 2.16 | 99.73 |
| Cetinje | 0.6 | 2.44 | 0.18 | 0.73 | 0.78 | 3.17 | 89.4 |

Average water tariffs for private households are significantly lower than those for legal entities, which only partly reflects differences in the corresponding supply costs. In 2014, the average municipal household tariff for water supply and sewerage in Adriatic basin amounted to €1.03 per m$^3$, while the average tariff for legal entities was at €2.35. Tariffs have nearly doubled in nominal terms since 2005,

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[236] GODIŠNJI IZVJEŠTAJ O STANJU U OBLASTI VODOSNABDIJEVANJA, UPRAVLJANJU OTPADOM I OTPADNIM VODAMA, REALIZACIJI PRIORITETNIH AKTIVNOSTI U KOMUNALNOJ DJELATNOSTI U 2014. GODINI, SA PREDLOGOM PRIORITETNIH PROJEKATA ZA IZGRADNJU KOMUNALNE INFRASTRUKTURE U 2016. GODINI I PREDLOGOM MJERA

which has also translated into a substantial increase in real terms - taking into account the average increase in the Consumer Price Index by some 30 per cent in 2012 compared with 2005. The average costs of water supply and sewerage services mask only modest tariff levels for sewerage services, given the widespread lack of wastewater treatment facilities.

Table 8.32 below reveals the revenues of the water utility companies. As well as the expenditures, revenues were extracted from the 2017 Income Statements downloaded from the public registry held at the Tax Administration.

### Table 8.32 Revenues from water services in the Adriatic Basin, 2017

| Municipality | Revenue from water & wastewater services (€) |
|---|---|
| Bar | 2,128,111 |
| Budva | 4,923,145 |
| Danilovgrad | 799,681 |
| Kotor | 1,507,024 |
| Nikšić | 2,311,916 |
| Podgorica + Tuzi | 7,775,686 |
| Tivat | 1,423,672 |
| Ulcinj | 1,133,462 |
| Herceg Novi | 1,988,120 |
| Cetinje | 674,466 |
| **Total** | **24,665,281** |

## 8.21 Cost recovery of financial and economic costs

The overall cost recovery of costs is the extent to which the costs of providing the water service are covered by charges to water users and other cost recovery mechanisms.

The Cost recovery rate is estimated in this report as:

**Cost recovery rate = total revenues / total costs x 100 [%]**

The cost recovery rates are estimated both for financial as well as for economic costs for drinking water and wastewater services in the Adriatic River Basin.

The rate of the cost recovery of financial costs considers all the financial costs incurred by the service providers and all the revenues, including subsidies.

Each water utility in the Adriatic River Basin, having different financial data, reports a different financial cost recovery rate. Table 8.33 below shows the aggregate financial cost-recovery at the level of the whole Basin.

### Table 8.33 Financial cost recovery in the Adriatic Basin, 2015

| | |
|---|---|
| Financial Costs– Water and Wastewater | **23,532,409** |
| Financial Revenues– Water and Wastewater | **24,665,281** |
| **Financial Cost recovery rate (%)** | **104.81 %** |

We can see that the financial cost recovery is at sustainable levels – at nearly 105%. However, this is can be largely attributed to rather abundant subsidies in the sector. On the other hand, economic analysis requires that any country-specific market distortions are accounted for and that taxes and subsidies are removed from the calculation of the financial cost and revenue estimates. This is necessary so the financial costs calculated above are converted to social economic cost based on social opportunity value which is the basis for deriving economic performance indicators.

The analysis of the recovery of economic costs for the water and wastewater services was performed based on the above financial costs with the following adjustments:

- The material and energy costs were considered net of 20% VAT
- Subsidies are excluded. Since subsidies are generally accounted for as operating revenues, it was not possible to extract them out directly from the financial figures. We analyzed in detail the 2017 Budgets of the three largest municipalities (i.e. Budva, Herceg Novi and Ulcinj) and based on that we made an informed assumption of subsidies to be at 25% of operating revenues, on average.
- Labor cost were considered net of the social contributions. Total adjustment was 34.3%. Detailed breakdown is as follows:
  - Pension and disability insurance: 20.5%
  - Health insurance: 12.8%
  - Unemployment insurance: 1%
- Different taxes and subsidies were not considered in the economic cost recovery
- Financial revenues were decreased to be net of 20% VAT
- Resource and environmental costs were considered with 0 values.

The results of the economic costs recovery analysis are shown in Table 8.34 below.

### Table 8.34: Economic cost recovery in the Adriatic Basin, 2015

| Economic Costs | |
|---|---|
| **Expenditure item** | **Operating and Maintenance costs** |
| Labor cost | 7,577,622 |
| Material costs (incl. Chemicals) | 3,443,913 |
| other costs | 3,246,198 |
| | **Capital Costs** |
| Capital Costs | 2,672,119 |
| | **Administrative Costs** |
| **Other expenses** | 304,316 |
| | **Taxes and Subsidies** |
| Taxes and duties | 0 |
| **Total Economic Cost** | **17,244,168** |
| **Economic Revenues** | |
| **Total Economic Revenues** | **14,799,169** |
| **Economic Cost Recovery Rate** | |
| **85.8%** | |

The result of the adjustment of financial figures to reflect the economic context is that the cost-recovery percentage dropped from 104.8% to 85.8% which calls for more efficient use of water resources on one side and upward corrections of water and wastewater tariffs accompanied by gradual decrease of the subsidies on the other.

## 8.22 Conclusions

This section represents an analytical effort aimed at gathering relevant data on the Montenegro Adriatic Basin and putting into the economic context. The report refers to the details of both abstractive (i.e. agricultural, industrial and domestic) and non-abstractive (e.g. hydropower plants and fish farming) use of water. The report makes an estimate of the value of water for both of these categories and performs an estimate of trend projections regarding net water use for the Adriatic Basin. This section of the report offers a summary with key observations and the resulting recommendations for future actions. They include:

There are tremendous losses incurred in the water supply system all across the Adriatic Basin. Current estimates based on the latest Report on Water Sector show that non-revenue water (i.e. the difference between the volume of water supplied and invoiced to the customers) stands at 60.27%. The main reasons for this large gap are deficiencies in the water transport network (technical losses) as well as unregistered and illegal connections to the network, and inaccurate metering of water consumption (administrative losses). Such high level (i.e. European average is in the range between 10% and 25%) puts enormous pressure on local utility companies and represents the main underlying reason for the lack of financial and economic sustainability of the system. Naturally, **both central and local governments are strongly advised to take measures in order bring the share of non-revenue water to a level which will ensure long-term sustainability of the water supply system in the Adriatic Basin.**

These measures are primarily investment related and may require significant financial resources. . Authorities should take measures to boost their capacities to absorb and make the most of the international donor (e.g. EU/IPA) and financial community (i.e. IFI) assistance in the field. However, there are measures which require trivial or no financial resources but could contribute considerably to reduction of non-revenue water volumes (e.g. those regarding reduction of illegal connections to the system).

Since 2009, Montenegro started implementing a new price setting framework in the domain of non-abstractive water. The details of this framework are set forth by the Decision on the Amount and Method of Calculating Water Charges and the Criteria and Method of Determining the Degree of Water Pollution. Depending on the specific purpose, total payments depend mainly on the volume of water abstracted. Fees for use of water for electricity generation are based on the quantity of electricity (kWh) generated on the grid. There is also a separate charge rate per kW for the use of water for other energy purposes by power plants.

However, provisions of this Decision do not relate to the main source of water use in Montenegro which is for domestic and ICI purposes. Thus, as a key recommendation and concluding point, **there is an urgent need to alter current water and wastewater tariff-setting policy to meet the requirements of the Water Framework Directive**. The present arrangements impose charges to water and sewerage users that do not recover the costs of these services. As we have seen the financial cost recovery is at sustainable levels 105%. However, this is primarily due to sizeable inflows in the form of subsidies from the budget revenues – either through direct transfers from the local government or indirect subsidies in the infrastructure granted by the central government. On the other hand, when subsidies are factored out and financial flows are adjusted to reflect their economic value, the cost recovery drops to 85.8% which is significantly below the required full-cost recovery level of 100%. It is thus obvious that such pricing policy undermines one of the key principles outlined in the WFD - Article 9 in particular.

Currently, price setting takes place within the framework of the Law on Financing Water Management but the final decision is based on individual municipality's rationale which is mostly driven by immediate social and political circumstances. The future methodology for price setting should be based on a comprehensive approach where financial and economic aspects should play central role in order to ensure full recovery of costs of water resources incurred by utility companies and society as a whole.

# 9 ENVIRONMENTAL OBJECTIVES AND EXEMPTIONS

## 9.1 Introduction

The WFD requires that Member States implement the necessary measures to prevent the deterioration of the status of all bodies of surface water and that the following environmental objectives are achieved:

- Good ecological/chemical status of surface water bodies;
- Good ecological potential and chemical status of HMWBs and AWBs;
- Good chemical/quantitative status of groundwater bodies.

An overview of the surface water and groundwater status has been established for the Adriatic River Basin based on pressure and risk analysis and in-field surveillance monitoring (Sections 4 and 7).

The clarification of the environmental objectives for the river basin provides a clear focus for management with regard to attaining the agreed goals[237], which are in line with the UN Sustainable Development Goals[238]. The approach to the development of the environmental objectives has been driven by water users which contribute to the pressures and impacts in the river basin and which are concerned about the implications of measures under the WFD onto their uses.

Article 4 of the WFD sets out the “environmental objectives” mainly in Article 4 (1) and provides that the most stringent shall apply. For heavily modified and artificial water bodies, Article 4 (1) set out “specific objectives” for these specific water bodies. In Article 4 (3), strict criteria for the designation of artificial or heavily modified water bodies are described. Thereafter, a number of “exemptions” from the Art. 4 (1) objectives are introduced, which describe the conditions and the process in which they can be applied. Finally, Article 4 (8) and (9) provide general “minimum requirements” when applying the exemptions or designating heavily modified or artificial waters. There are two principles that are applicable to all exceptions:

- Exemptions for one water body must not compromise achievement of the environmental objectives in other water bodies
- At least the same level of protection must be achieved as provided for by existing Community law (including those elements to be repealed)

The main environmental objectives in the WFD include the following elements for surface waters, groundwaters and protected areas:

- No deterioration of status for surface and groundwaters and the protection, enhancement and restoration of all water bodies
- Achievement of good status, i.e. good ecological status (or potential) and good chemical status for surface waters and good chemical and good quantitative status for groundwaters

[237] Environmental objectives under the Water Framework Directive, Water Directors’ meeting on 20 June 2005 in Mondorf-les-Bains
[238] https://sustainabledevelopment.un.org/sdgs

- Progressive reduction of pollution of priority substances and phase-out of priority hazardous substances in surface waters and prevention and limitation of input of pollutants in groundwaters
- Reversal of any significant, upward trend of pollutants in groundwaters
- Achievement of standards and objectives set for protected areas in Community legislation.

## 9.2 Management objectives for the Adriatic River Basin

Taking into consideration of the main environmental objectives outlined in the WFD above, a set of management objectives have been developed, which are also based on the objectives outlined in the national water management strategy[239].

In order to achieve the environmental objectives, it is important that they are clearly measurable and understandable by all sectors of society, i.e. all stakeholders including the public. The proposed environmental (management) objectives/actions and indicators for the Adriatic River Basin are presented in Table 9.1.

### Table 9.1 Proposed environmental objectives, actions and indicators for the Adriatic River Basin

| Environmental Objective/Actions | Measurable Units[240] |
|---|---|
| **1. To promote the sustainable use of water resources, their fair distribution among users, maximizing economic benefits in respect of environmental conditions and sustainable management principles** | |
| Continuous improvement in the water supply | % of population served in urban areas |
| | % of population served in rural areas |
| Improved collection of wastewaters | % of population served in urban areas |
| | % of population served in rural areas |
| Sustainable development aquaculture in specified zones | % of active economy in specified zone |
| **Improved enforcement of protection measures on water bodies that already represent protected areas** | % of protected areas achieving ahigh ecological status |
| **2. Preservation and achievement of minimal "good" ecological and chemical status for surface water bodies that have "less than good", "poor" or "very poor" status. (rivers, lakes and highly modified water bodies)** | |
| **Protection of rivers and other water bodies in accordance with the national legislation** | % of improvement of water quality |

[239] Stra Tegija Upra Vljanja Vodama Crne Gore, December 2015

[240] Base year would be regarded as 2022. The meaureable units would be calculated by 2022. The percentage change in the objectives/actions would be measureable every 6 years, i.e. from 2022 at the start of the EU's 3rd 6 year RBMP cycle.

| Environmental Objective/Actions | Measurable Units[240] |
|---|---|
| Improvement of monitoring for all water bodies | % of monitoring stations at agreed locations providing relevant data for operation monitoring |
| Improvement of ecological status and chemical quality for all surface water body types | % reduction of discharges of untreated wastewater from towns with >2,000 population equivalents (point sources) |
| | % of population connected to the waste water treatment plant |
| | Construction of impermeable septic tanks for % of population not in wastewater collection network |
| | % reduction of discharges of untreated wastewater from industrial and agricultural installations (point sources) |
| | % reduction of diffuse source N and P loading to surface water and groundwater bodies |
| Introduction of good agricultural practices – assessment, monitoring and management | % of compliance cases of water quality indicators for nutrients (diffuse sources) |
| Reduction of contamination from use of pesticides in agriculture | % of contamination reductio |
| Reduction of illegal use of inert and river gravels | % reduction of companies carrying out illegal activities on river beds |
| **3. Prevention of pollution in order to avoid a deterioration of groundwater quality and to attain a good chemical status in GWBs** | |
| Elimination/reduction of the amount of hazardous substances and nitrates entering groundwater bodies | % of contamination reduction |
| Increase of wastewater treatment efficiency in order to avoid GW pollution from urban and industrial pollutions sources | % reduction of discharges of untreated wastewater from towns with >2,000 population equivalents (point sources) |
| **4. Reducing the harmful effects of floods on human health, the environment, cultural heritage and the economy** [241] | |
| Reducing the number of residents affected by flooding | % of population affected |
| **5. Preservation and/or reduction of the rate of erosion affecting rivers** | |
| Highly endangered areas | % of land affected |

[241] Implementation of the Floods Directive is the focus of EU assistance project, which will run from 2019-2022

## 9.3 Exemptions according to WFD articles 4(4), 4(5) and 4(7)

When discussing the designation of a specific water body for an exemption it should be taken into account that the WFD is an environmental directive and exempting a water body from its objectives should not be the rule but rather an exception.

It is important that before considering the application of exemptions for a certain water body, all relevant requirements from existing EU legislation for the protection of water have to be fulfilled. Nevertheless "exemptions" are an integral part of the environmental objectives set out in Article 4 of the WFD and in the planning process (Table 9.2).

### Table 9.2 The meaning of Article 4.7 of the WFD

| Conditions | Requirements |
|---|---|
| 1. Failure to achieve good groundwater status, good ecological status or, where relevant, good ecological potential or to prevent deterioration in the status of a body of surface water or groundwater is the result of new modifications to the physical characteristics of a surface water body or alterations to the level of bodies of groundwater.<br><br>2. Failure to prevent deterioration from high status to good status of a body of surface water is the result of new sustainable human development activities. | a) all practicable steps are taken to mitigate the adverse impact on the status of the body of water;<br><br>b) the reasons for those modifications or alterations are specifically set out and explained in the river basin management plan and the objectives are reviewed every six years;<br><br>c) the reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development;<br><br>(d) the beneficial objectives served by those modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option. |

Montenegro will be expected to report to the EU for each water body for which the environmental objective will not be recorded as ‘good status’ by 2021. The reasons for not achieving good status must be clear and must considered all ‘horizontal issues’ that influence the failure to achieve a good status.

The use of exemptions in relation to horizontal issues is outlined in Table 8.3. These issues take into account the following aspects: the scale of the individual water body and its location, the location of water bodies within protected areas, the identification of uncertainties for appropriate action, technical feasibility of providing a solutions, an understanding of disproportionate costs to fix the problem, the cost of measures under related EU legislation, the affordability of the measures required, the best environmental options, and the context of transboundary coordination.

As a minimum, the public should be given insight in the reasons for applying exemptions (e.g. as mentioned in Article 4(a) i, ii and iii) per water body for which an exemption is applied. Public information and consultation is not only an obligation of WFD Article 14 and other legislation, also Article 4(4) and 4(5) and the related recitals require that the following information must be provided in the river basin management plan (See Table 9.3 below).

Information from an already carried out SEA or EIA should be used as much as possible in exemptions tests. However, a formerly carried out EIA is not a blank cheque for application of the WFD exemptions.

The assessment of whether the criteria and conditions set out in Article 4.7 are met needs to be carried out in the planning stage. Thus, it makes sense to incorporate such an evaluation into the environmental impact assessment which has to be done for most of these types of projects. However, even if certain projects are not covered by the EIA Directive, Article 4.7 may apply. For plans and programmes affecting the environmental objectives of the WFD, the evaluation in accordance to WFD Article 4.7 should be incorporated into the SEA. In summary, the planning of "new modifications" requires the carrying out of an assessment of the environmental impacts which demonstrates, at least, that the criteria and conditions of Article 4.7, but also 4.8 and 4.9, are met.

### Table 9.3 Horizontal Issues that are taken into account in the selection of a water body exemption from its environmental quality objective

| Issue | Considerations |
|---|---|
| Scale of the water body or group of water bodies | Particular consideration for transboundary surface water bodies surface and groundwaters or groups of groundwater bodies. |
| Protected areas | Exemptions from the WFD environmental objectives cannot be used to deviate from objectives and obligations set by other pieces of EU legislation. |
| Management of uncertainties | Uncertainties can include: (i) whether, and to what extent, a water body is adversely impacted and what and/or who causes the impact; (ii) the impact of policies already in place or planned and various trends and developments, including innovation and technical change; (iii) the effectiveness of measures in addressing an adverse impact on a water body (note that this will have an effect on the certainty of the benefits as well); (iv) the assessment of the achievement of good status9; (v) the costs associated with measures; (vi) the benefits resulting from improvements to the status of water bodies, particularly the calculation of the non-marketable benefits. |
| Technical infeasibility | Technical infeasibility is justified if: (i) no technical solution is available; (ii) it takes longer to fix the problem than there is time available; (iii) here is no information on the cause of the problem; hence a solution cannot be identified. |
| Disproportionate costs | This is a political judgement informed by economic information, and an analysis of the costs and benefits of measures is necessary to enable a judgement to be made on exemptions. For all cases where an exemption is applied, all measures that can be taken without involving disproportionate costs should still be taken to reach the best status possible. |
| Requirements of related EU legislation | The costs of measures required under existing EU legislation already agreed at the time of the adoption of the Directive cannot be considered when deciding on disproportionate costs. |
| Affordability | Affordability (or ability to pay for a certain measure) can be one element for justifying the decision on a time extension (i.e. application of Article 4.4), if based on a clear explanation, which includes (i) the non-availability of relevant alternative financing mechanisms which would not result in affordability issues, (ii) the consequences of non-action in deciding on an extension of the deadline, (iii) the steps to resolve the affordability issues in the future. |

| Issue | Considerations |
| --- | --- |
| Alternative means | In Article 4.5 this refers to alternatives to serve the environmental and socioeconomic needs served by a certain human activity, which are a significantly better environmental option not entailing disproportionate costs.<br><br>In Article 4.7 it is indicated that it is necessary to demonstrate that the beneficial objectives served by the modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option. |
| Transboundary context | In cases where the reasons for not achieving good status cannot be resolved by a Member State since they are outside the competence and jurisdiction of the Member State, the WFD includes the provision of Article 12 on the involvement of the Commission to solve the issue. |

### 9.3.1 Designation of a water bodies as an exemption

Based on the quality status of the surface water and groundwater bodies, a further assessment has been carried according the logical scheme outlined in Table 9.4 to determine if there is clear justification for exemption from meeting the required environmental quality objectives[242].

Table 9.4 shows that out of the 41 surface water bodies, 15 can be considered for exemption but solely based on the need for extended deadlines in order to reach good status, i.e. until 2027. One surface water body, Gračanica_2, which is dependent on the outflow from the Liverovići reservoir, is judged to require an extended period until 2033 to meet the required quality objectives.

Only one surface water body, Zeta_2, will not be unable to reach the good ecological potential by 2033 since the river is canalized and used for electricity production. In this case an exemption would be required.

The situation is similar for groundwater bodies judged to be at risk or potentially at risk of not meeting the environmental objectives. One groundwater body, Zeta Valley, is judged not to be able to meet its objective until 2033 due to point and diffuse source pollution arising from the industrial and agricultural activities. However, in the case of the industrial activities and the potentially resultant pollution, cost effective mitigation measures are the responsibility of the industry. It must be borne in mind that the resultant economic benefits of both the industrial and agriculture activities have to weighed up carefully with the socio-economic dependence of the important groundwater body.

[242] WFD guidance Document No. 20: Exemptions to the environmental objectives, Section 3.3.2, Figure 2.

### Table 9.4 Assessment of the need for exemptions for surface and groundwater water bodies from achieving good status[243]

| No. | GWB or SWB | Good Status Achieved by 2021 | | Good Status Achieved by 2027 | | Good Status Achieved by 2033 | |
|---|---|---|---|---|---|---|---|
| | | Technically Feasible | Disproportionately Expensive | Technically Feasible | Disproportionately Expensive | Technically Feasible | Disproportionately Expensive |
| **Groundwater Bodies** | | | | | | | |
| 2 | Ulcinjsko polje | Yes | Yes | Yes | No | | |
| 4 | Grbalj - Lustica | Yes | Yes | Yes | Yes | | |
| 8 | Orahovštica – Rijeka Crnojevića | Yes | Yes | Yes | No | | |
| 9 | Karuc - Sinjac | Yes | Yes | Yes | No | | |
| 10 | Zeta Valley | Yes | Yes | Yes | Yes | Yes | No |
| 11 | Prekornica - Bjelopavlići | Yes | Yes | Yes | No | | |
| 14 | Nikšićko polje | Yes | Yes | Yes | No | | |
| | | | | | | | |
| **Surface Water Bodies** | | | | | | | |
| 1 | Bojana | Yes | Yes | Yes | No | | |
| 2 | Orahovštica | Yes | Yes | Yes | No | | |
| 3 | Crmnička rijeka | Yes | Yes | Yes | No | | |
| 4 | Sutorina_1 | Yes | Yes | Yes | No | | |
| 5 | Sutorina_2 | Yes | Yes | Yes | No | | |
| 18 | Morača_5 | Yes | Yes | Yes | No | | |

[243] 'Good Status 'should be interpreted as references to 'good ecological potential' and 'good chemical status' when referring to a heavily modified or artificial water body.

| No. | GWB or SWB | Good Status Achieved by 2021 | | Good Status Achieved by 2027 | | Good Status Achieved by 2033 | |
|---|---|---|---|---|---|---|---|
| | | Technically Feasible | Disproportionately Expensive | Technically Feasible | Disproportionately Expensive | Technically Feasible | Disproportionately Expensive |
| 21 | Zeta_2 | No | Yes | No | Yes | No | Yes |
| 22 | Gračanica_1 | Yes | Yes | Yes | No | | |
| 24 | Gračanica_2 | Yes | Yes | Yes | Yes | Yes | No |
| 27 | Zeta_3 | Yes | Yes | Yes | No | | |
| 28 | Zeta_4 | Yes | Yes | Yes | No | | |
| 29 | Ribnica | Yes | Yes | Yes | No | | |
| 30 | Morača_6 | Yes | Yes | Yes | No | | |
| 33 | Sitnica | Yes | Yes | Yes | No | | |
| 34 | Cijevna | Yes | Yes | Yes | No | | |
| 35 | Morača_7 | Yes | Yes | Yes | No | | |
| 37 | WB 2_North | Yes | Yes | Yes | No | | |

# 10 PROGRAMME OF MEASURES

## 10.1 Introduction

The WFD requires that, within each RBD, a Programme of Measures (PoM) is established to address the significant issues identified and to allow the achievement of the objectives established under Article 4. The Directive further specifies that the PoM shall include as a minimum 'basic measures' and, where necessary to achieve objectives, 'supplementary measures'.

Basic measures as a minimum must comprise:

- Measures required to implement existing Community water legislation and other environmental legislation (set out in Article 10 and in Part A of Annex VI of the WFD shown in Table 10.1 below).
- Measures to implement Article 9 (cost recovery).
- Measures to promote efficient and sustainable water use.
- Measures to protect drinking water quality and to reduce the level of treatment required.
- Measures to control abstraction from surface and groundwater.
- Measures to control recharging of groundwater.
- Measures to control point source discharges.
- Measures to prevent or control inputs of diffuse pollutants.
- Measures to address any other significant impacts on status, in particular the hydromorphological condition.
- Measures to prohibit direct discharges to groundwater.
- Measures to eliminate or reduce pollution by Priority Substances.
- Measures to prevent accidental pollution.

### Table 10.1 Related legislation for inclusion in developing the PoMs

| The Bathing Water Directive (76/160/EEC) |
|---|
| The Birds Directive (79/409/EEC) |
| The Drinking Water Directive (80/778/EEC) as amended by Directive (98/83/EC). |
| The Major Accidents (Seveso) Directive (96/82/EC). |
| The Environmental Impact Assessment Directive (85/337/EEC) |
| The Sewage Sludge Directive (86/278/EEC). |
| The Urban Waste Water Treatment Directive (91/271/EEC). |
| The Plant Protection Products Directive (91/414/EEC) |
| The Nitrates Directive (91/676/EEC). |
| The Habitats Directive (92/43/EEC) |
| The Integrated Pollution Prevention Control Directive (96/61/EC) |

Supplementary measures are those measures designed and implemented in addition to the basic measures where they are necessary to achieve the Environmental Objectives of the WFD as established in Article 4 and Annex V. Supplementary measures can include additional legislative powers, fiscal measures, research, educational campaigns that go beyond the basic measures and are deemed necessary for the achievement of objectives listed in Section 8.

According to Article 11(5), additional measures may be necessary when a water body is unlikely to achieve the objectives under Article 4, after the adoption of the measures under the first RBMP. If the implementation of an additional measure lasts longer than one river basin management planning cycle this measure becomes either a basic or supplementary measure.

Measures should be targeted in terms of their type and extent to ensure that pressures are addressed and that this will deliver improvements towards achieving good status or potential in individual water bodies. The measures should be designed based on the assessment of the actual status of the water body, supplemented with the information from the analysis of pressures and impacts affecting the water body.

### 10.1.1 Role of Key Types of Measures

The concept of Key Types of Measures (KTMs) was developed in 2012 to simplify reporting. KTMs are groups of measures to identified in the PoMs which target the same pressure or purpose. The individual measures included in the PoM (being part of the RBMP) are grouped into KTMs for the purpose of reporting. The same individual measure can be part of more than one KTM because it may be multi-purpose, but also because the KTMs are not completely independent.

KTMs are expected to deliver the bulk of the improvements through reduction in pressures required to achieve WFD Environmental Objectives. A KTM may be one national measure but it would typically comprise more than one national measure. For example, the Nitrates Action Plan may be enough to reduce diffuse nutrient pollution from agriculture to levels consistent with the achievement of good ecological status or potential. In this case, KTM No.2 (see list below in Table 9.2) may be associated with one Article 11.3.a basic measure (i.e. implementation of the Nitrates Directive). Basic measures under Article 11.3.h (binding rules for the control of diffuse pollution) and supplementary measures (Article 11.4) may also be required to achieve WFD Environmental Objectives: in the latter case, KTM No.2 would then be associated with at least 3 national measures.

It is expected that the Montenegro will be able to report their PoMs by associating their national measures with the predefined KTMs. Given the fact that the predefined KTMs cover the main water management issues in the EU, the suggestion of additional KTMs by Montenegro is not expected.

To provide information on the relative contribution of Article 11.3.a and 11.3. b of the WFD to basic measures and supplementary measures to KTMs and the achievement of WFD Environmental Objectives, Montenegro is required to report on the national measures associated with the KTMs.

### 10.1.2 Predefined KTMs

Predefined Key Types of Measure (KTM) for the 2016 reports are based on the KTMs that were previously defined from EU Member State progress reports on implementation of programme of measures, together with new measures reported by Member States in 2012 and commonly reported significant pressures not previously incorporated by predefined KTMs.

It is expected that Montenegro will be able to report their measures in terms of predefined KTMs. Montenegro is expected to "bundle" their national measures (usually much more detailed than the KTMs) to report them in an aggregated way as KTMs. Quantitative indicators are reported at the level of KTMs.

The 25 predefined KTMs according to WFD reporting guidance are listed in Table 10.2.

### Table 10.2 Predefined Key Types of Measures (KTM) to tackle significant pressures[244]

| KTM No. | Description of KTM |
|---|---|
| 1 | Construction or upgrades of wastewater treatment plants |
| 2 | Reduce nutrient pollution from agriculture |
| 3 | Reduce pesticides pollution from agriculture |
| 4 | Remediation of contaminated sites (historical pollution including sediments, groundwater, soil) |
| 5 | Improving longitudinal continuity (e.g. establishing fish passes, demolishing old dams) |
| 6 | Improving hydromorphological conditions of water bodies other than longitudinal continuity (e.g. river restoration, improvement of riparian areas, removal of hard embankments, reconnecting rivers to floodplains, improvement of hydromorphological condition of waters, etc) |
| 7 | Improvements in flow regime and/or establishment of ecological flows |
| 8 | Water efficiency, technical measures for irrigation, industry, energy and households |
| 9 | Water pricing policy measures for the implementation of the recovery of cost of water services from households |
| 10 | Water pricing policy measures for the implementation of the recovery of cost of water services from industry |
| 11 | Water pricing policy measures for the implementation of the recovery of cost of water services from agriculture |
| 12 | Advisory services for agriculture |
| 13 | Drinking water protection measures (e.g. establishment of safeguard zones, buffer zones etc) |
| 14 | Research, improvement of knowledge base reducing uncertainty |
| 15 | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances |
| 16 | Upgrades or improvements of industrial wastewater treatment plants (including farms) |
| 17 | Measures to reduce sediment from soil erosion and surface run-off |
| 18 | Measures to prevent or control the adverse impacts of invasive alien species and introduced diseases |
| 19 | Measures to prevent or control the adverse impacts of recreation including angling |
| 20 | Measures to prevent or control the adverse impacts of fishing and other exploitation/removal of animal and plants |
| 21 | Measures to prevent or control the input of pollution from urban areas, transport and built infrastructure |
| 22 | Measures to prevent or control the input of pollution from forestry |
| 23 | Natural water retention measure |

[244] According to WFD Reporting Guidance 2016, Section 10.13, pp.234

| KTM No. | Description of KTM |
|---|---|
| 24 | Adaptation to climate change |
| 25 | Measures to counteract acidification |

## 10.2 Proposed measures

All specific measures for water bodies identified to be of an unacceptable status, i.e. moderate status or below are summarized below in Table 10.3. A further 8 basic and 9 supplementary measures relating directly to the Skadar Sub-Basin are presented in Table 10.4. Information on **each measure is provided after the summary of measures shown in Tables 10.3 and 10.4**, which includes: the location, the water body in question, possible restrictions to be taken into account, i.e. within protected areas or flood areas, a short description of the measure, the relevant project investor, the indicative investment costs, the possible maintenance costs, the necessity for permits, the relevant authorities, the current status of implementation (if any), and the relative impact of the measure.

A total of 25 basic measures are proposed, with the addition of 23 supplementary measures, all of which are grouped according to priority, indicated as either as high (1), medium (2) or low (3). Of the basic measures, 16 measures as high priority, which include but are not limited to, i) WWTP construction and/or rehabilitation and construction of sewerage networks, and ii) solid waste management and waste transfer stations which will alleviate current and future pressures to the river network and groundwaters.

The supplementary measures are proposed in order to clearly define known problems that affect surface waters and groundwaters. Such measures mainly cover the need to define solutions for contaminated sites and discharges from industrial and agricultural point sources.

In general, both in the preparation of the Plans (in accordance with the Law on Waters) and in their implementation, the Water Directorate are the key institution. The individual measures AB MNE 1-50 and SL MNE 1-17 below indicate the compentent authority for each specific measure together with other relevant authorities.

### Table 10.3 List of measures proposed for the Adriatic River Basin

| ID (preliminary) | Measure | Priority[245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| AB MNE 01 | Construction of wastewater treatment plants for Bojana Delta settlement | 1 | x | | SWB: Bojana<br>GWB: Ulcinjsko polje | Bar/Ulcinj | 2.0M |
| AB MNE 02 | Reduce nutrient and pesticide pollution from agriculture | 2 | x | | SWB: Bojana<br>GWB: Ulcinjsko polje | Bar/Ulcinj | 30k |
| AB MNE 03 | Control the adverse impacts of recreation including fishing in the Bojana river | 2 | x | | SWB: Bojana<br>GWB: Ulcinjsko polje | Bar/Ulcinj | 45k |
| AB MNE 04 | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Orahovštica SWB | 1 | x | | SWB: Orahovštica<br>GWB: Orahovštica – Rijeka Crnojevića | Bar | 4.4M |
| AB MNE 05 | Drinking water protection measures on Orahovštica pumping station | 1 | x | | SWB: Orahovštica<br>GWB: Orahovštica – Rijeka Crnojevića | Bar | 0.1M |

[245] Priorities are classified as either 1- high priority, 2 – medium priority or 3 – low priority

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| | | | | | | | |
| AB MNE 06 | Improving longitudinal continuity on Crmnička rijeka surface WB | 2 | x | | Crmnička rijeka | Bar | 0.1M |
| AB MNE 07 | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Crmnička river WB | 3 | | x | Crmnička rijeka | Bar | 20k |
| AB MNE 08 | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Sutrina_1 WB | 3 | | x | Sutorina_1 | Herceg Novi | 20k |
| AB MNE 09 | Improving longitudinal continuity on Sutorina_2 WB | 2 | x | | Sutorina_2 | Herceg Novi | 0.25M |
| AB MNE 10 | Improving hydromorphological conditions of Sutorina_2 WB (other than longitudinal continuity) | 1 | x | | Sutorina_2 | Herceg Novi | 2.5M |
| AB MNE 11 | Construction of wastewater treatment plant and extension of sewerage network for Podgorica municipalities | 1 | x | | SWB: Morača_5, Morača _6, and Ribnica<br>GWB: Zeta Valley | Podgorica | 45M |
| AB MNE 12 | Rehabilitation of the Red Sludge Ponds of the KAP Aluminum Plant | 1 | x | | SWB: Morača_5 and Morača_6<br>GWB: Zeta Valley | Podgorica | Unknown |
| AB MNE 13 | Improving longitudinal continuity on Morača_5 WB | 1 | x | | SWB: Morača_5 and Morača_6 | Podgorica | 0.4M |

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| | | | | | GWB: Zeta Valley | | |
| AB MNE 14 | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Morača_5 WB | 2 | | x | SWB: Morača_5<br>GWB: Zeta Valley | Podgorica | 80k |
| AB MNE 15 | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances in Morača River | 1 | | x | SWB: Morača_5, Morača_6 and Morača_7<br>GWB: Zeta Valley | Podgorica | 0.14M |
| AB MNE 16 | Upgrades or improvements of industrial wastewater treatment plants (including farms) in Podgorica municipality | 1 | | x | SWB: Morača_5<br>GWB: Zeta Valley | Podgorica | 0.25M |
| AB MNE 17 | Improvement of communal waste management in Podgorica | 1 | x | | SWB: Morača_5, Morača_6 and Morača_7 Ribnica<br>GWB: Zeta Valley | Podgorica | 6M |
| AB MNE 18 | Control the adverse impacts of recreation including fishing on Morača river | 2 | x | | SWB: Morača_5, Morača_6 and Morača_7<br>GWB: Zeta Valley | Podgorica | 15k |
| AB MNE 19 | Construction of wastewater treatment plant for Nikšić municipalities | 1 | x | | SWB: Zeta_2<br>GWB: Zeta Valley | NIkšić | 6.7M |

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| AB MNE 20 | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances in Zeta_2 WB | 1 | | x | SWB: Zeta_2<br>GWB: Zeta Valley | NIkšić | 85k |
| AB MNE 21 | Improvement of communal waste management in NIkšić | 1 | x | | SWB: Zeta_2 and Gračanica_2<br>GWB: Zeta Valley and Nikšićko polje | NIkšić | 16.57M |
| AB MNE 22 | Reducing pollution from agriculture | 2 | | x | SWB: Gračanica_1<br>GWB: Nikšićko polje | NIkšić | 0.15M |
| AB MNE 23 | Upgrades or improvements of dump waters from bauxite mines | 1 | | x | SWB: Gračanica_1 and Gračanica_2<br>GWB: Nikšićko polje | NIkšić | 60k |
| AB MNE 24 | Remediation of contaminated sites along the Gračanica_2 WB | 1 | | x | SWB: Gračanica_2<br>GWB: Nikšićko polje | NIkšić | 60k |
| AB MNE 25 | Improvements in flow regime and/or establishment of ecological flows on Gračanica_2 WB | 1 | | x | SWB: Gračanica_2<br>GWB: Nikšićko polje | NIkšić | 40k |

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| AB MNE 26 | Improving hydromorphological conditions of Gračanica_2 WB (other than longitudinal continuity) | 1 | x | | SWB: Gračanica_2<br>GWB: Nikšićko polje | NIkšić | 2M |
| AB MNE 27 | Upgrades or improvements of industrial wastewater treatment plants (including farms) along Gračanica_2 WB | 1 | | x | SWB: Gračanica_2<br>GWB: Nikšićko polje | NIkšić | 0.16M |
| AB MNE 28 | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Zeta_3 WB | 2 | | x | SWB: Zeta_3<br>GWB: Prekornica - Bjelopavlići | NIkšić | 20k |
| AB MNE 29 | Control the adverse impacts of recreation including fishing on Zeta river | 2 | x | | SWB: Zeta_3 and Zeta_4<br>GWB: Prekornica - Bjelopavlići | Nikšić/<br>Danilovgrad | 55k |
| AB MNE 30 | Construction of wastewater treatment plant and extension of the sewer network in Danilovgrad municipality | 1 | x | | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 5.15M |
| AB MNE 31 | Reduction of pollution from agriculture in Bjelopavlići plain | 2 | | x | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 0.1M |

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| AB MNE 32 | Improving longitudinal continuity on Zeta river | 2 | x | | SWB: Zeta_3 and Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 50k |
| AB MNE 33 | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Morača_5 WB | 2 | | x | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 40k |
| AB MNE 34 | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances in Zeta_4 WB | 1 | | x | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 0.18M |
| AB MNE 35 | Improvement of communal waste management in Danilovgrad | 1 | | x | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 0.1M |
| AB MNE 36 | Reduce nutrient pollution from agriculture (Improvement of aquaculture in order to reduce nutrient and organic matter loading) in region of Opasanica / Verušica WB | 1 | x | | SWB: Zeta_3 and Zeta_4<br>GWB: Prekornica - Bjelopavlići | Danilovgrad | 15k |
| AB MNE 37 | Improving hydromorphological conditions of Ribnica WB (other than longitudinal continuity) | 1 | x | | Ribnica | Podgorica | 0.3M |

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| AB MNE 38 | Improving hydromorphological conditions of Morača_6 WB (other than longitudinal continuity) | 1 | | x | SWB: Morača_6<br>GWB: Zeta Valley | Podgorica | 30k |
| AB MNE 39 | Improving waste water treatment in Golubovci Town | 1 | | x | SWB: Morača_6 and Morača_7<br>GWB: Zeta Valley | Podgorica | 30k |
| AB MNE 40 | Prevention and control the adverse impacts of invasive alien species and introduced diseases | 2 | | x | SWB: Morača_6 and Morača_7<br>GWB: Zeta Valley | Podgorica | 20k |
| AB MNE 41 | Reduce pollution from agriculture in Lješkopolje | 2 | | x | Sitnica | Podgorica | 20k |
| AB MNE 42 | Improving longitudinal continuity on Sitnica WB | 2 | x | | Sitnica | Podgorica | 80k |
| AB MNE 43 | Reduce pollution from agriculture along CIjevna WB | 2 | | x | SWB: CIjevna<br>GWB: Kuči, Zeta Valley | Tuzi | 0.1M |
| AB MNE 44 | Improving longitudinal continuity on Cijevna surface WB | 2 | x | | SWB: CIjevna<br>GWB: Kuči, Zeta Valley | Tuzi | 0.3M |
| AB MNE 45 | Water efficiency, implementation of technical measures for irrigation and households water sharing in Cijevna river WB | 1 | | x | SWB: CIjevna<br>GWB: Kuči, Zeta Valley | Tuzi | 20k |
| AB MNE 46 | Improvement of wastewater treatment in Tuzi municipality | 1 | x | | SWB: WB 2_North | Tuzi | 10M |

| ID (preliminary) | Measure | Priority [245] | Type of Measure | | Related Water Body | Municipality | Indicative Costs (EURO) |
|---|---|---|---|---|---|---|---|
| | | | Basic | Supplementary | | | |
| | | | | | GWB: Kuči, Zeta Valley | | |
| AB MNE 47 | Prevention and control the adverse impacts of invasive alien species and introduced diseases | 2 | | x | SWB: WB 2_North<br>GWB: Kuči, Zeta Valley | Tuzi | 30k |
| AB MNE 48 | Control the adverse impacts of recreation including fishing on Skadar Lake | 2 | | x | SWB: WB 2_North<br>GWB: Kuči, Zeta Valley | Tuzi | 30k |
| AB MNE 49 | Gradual canalization of waste water of rural and touristic areas along Adriatic Coast | 1 | x | | Adriatic Coast | 7 coastal municipalities | 250K |
| AB MNE 50 | Reduction of sea water intrusion in Ulcinj and Bar coastal zones | 2 | | x | SWB: Bojana, Sasko lake: GWB: Ulcinj polje, Mozura-Pastrovici | Ulcinj, Bar | 150K |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Construction of wastewater treatment plants for Bojana Delta settlement</th><th>ID<br>AB MNE 01</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Ulcinj</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Bojana GWB: Ulcinjsko polje</td></tr>
<tr><td>Watercourse</td><td colspan="3">Bojana</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Basic measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">No wastewater treatment for the Bojana Estuary settlements exists and therefore those waters arrive unprocessed in recipient SWB or in the GWB.</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM1</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td colspan="2">☐ Yes</td><td>☒ No</td></tr>
<tr><td>Flood Area</td><td colspan="2">☒ Yes</td><td>☐ No</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Decrease of WB loading with organic compounds and nutrients</td></tr>
<tr><td colspan="5">In area of Bojana estuary there are numerous restaurants and private houses which are built on pillars above the river water. Many of them empty the waste waters directly in Bojana River while some has septic tanks built behind in river bank sandy soil. Even those with septic tanks sometimes empty them directly in to river water. Building of an effective sewage network with a treatment station or even the installation of impermeable septic tanks, which are of essential importance in order to protect this river from loading of organic matter and nutrients. This measure is related to construction of sewer pipesline with wastewater treatment or for impermeable septic tanks depending on the solution for which stakeholders find is the best.</td></tr>
<tr><td colspan="2">Project Investor</td><td colspan="3">Public company for management of marine coastal area (JPMD), Ulicnj municipality</td></tr>
<tr><td colspan="2">Investment Costs</td><td colspan="3">2M EURO</td></tr>
<tr><td colspan="2">Maintenance Costs</td><td colspan="3">0.15 - 0.2 M EURO / Year</td></tr>
<tr><td colspan="2">Necessity of Permit Procedure</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Competent Water Authority</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other Relevant Authorities</td><td colspan="3">Ministry of Sustainable Development and Tourism (MSDT); Public company for management of marine coastal area (JPMD); Environmental Protection Agency; Water Administration (WA); Ulcinj municipality</td></tr>
</table>

| | |
|---|---|
| Status of Implementation | No status |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters into the groundwater basin as well as in recipient WB |
| Priority (first / second / third) | First |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Reduce nutrient and pesticide pollution from agriculture in lowland area of Ulcinj hinterland.</th><th>ID<br>AB MNE 02</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Ulcinj</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Bojana GWB: Ulcinjsko polje</td></tr>
<tr><td>Watercourse</td><td colspan="3">Bojana</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Basic measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Nutrient and organic matter loading from the surrounding agriculture fields</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM2</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Reduction of Nutrient and organic matter loading from the agriculture fields</td></tr>
<tr><td colspan="5">In the Ulcinj hinterland there is a large fertile plane where intensive agriculture occurs. Since this plane is low and partly flooded by Bojana River or some other smaller brooks, which flow in to Bojana River, the result is that fertilizers and chemical compounds enter this SWB either by surface or by ground water (although the chemical compounds enter into ground water from the surface, the compounds can return into SWB through many springs within this area). Therefore, it is of essential importance to regulate and control the usage of these agricultural supplements especially the pesticides. The first step toward regulation on usage of chemical in agriculture is implementation of register of those who buy and use chemicals for treatment of soil and plants.</td></tr>
<tr><td colspan="2">Project Investor</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD), Ulcinj municipality</td></tr>
<tr><td colspan="2">Investment Costs</td><td colspan="3">30,000 EURO</td></tr>
<tr><td colspan="2">Maintenance Costs</td><td colspan="3">Unknown</td></tr>
<tr><td colspan="2">Necessity of Permit Procedure</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td colspan="2">Competent Water Authority</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other Relevant Authorities</td><td colspan="3">Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration (WA)</td></tr>
<tr><td colspan="2">Status of Implementation</td><td colspan="3">No status</td></tr>
<tr><td colspan="2">Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="3">High</td></tr>
<tr><td colspan="2">Other Remarks</td><td colspan="3">This measure is relatively easy to implement with introduction of ID Card for the Purchase of Agrochemicals</td></tr>
<tr><td colspan="2">Priority (first / second / third)</td><td colspan="3">Second</td></tr>
</table>

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Control the adverse impacts of recreation including fishing in the Bojana river</th><th>ID<br>AB MNE 03</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Ulcinj</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Bojana GWB: Ulcinjsko polje</td></tr>
<tr><td>Watercourse</td><td colspan="3">Bojana</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Basic measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Development of intensive eco - tourism and illegal fishing</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM19</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☒Yes</td><td colspan="2">☐ No</td></tr>
</table>

| | |
|---|---|
| **Description of the Measure** | **Regulation of tourism and nature-based activities and strict enforcement of Low on freshwater fishery and aquaculture** |

Lately the Ulcinj and Bojana river (estuary) become fast developing center for summer tourism. As such tourism makes strong pressure on nature resources and it has impact on surface WB. Precise regulation together with study of risks and mitigation measures action plan (implementation of such plan) will help Ulcinj municipality to achieve proclaimed sustainability goal and will reduce pressure on related WB. All fishery related research in Montenegro have noticed a constant decrease of fish abundance which could not be corelated to any other cause than poaching. Illegal fishing is the main cause of decreasing of fish population abundance in Bojana river. Therefore, strict enforcement of Law on Freshwater Fishery and Aquaculture as well as production of strict 6-year plan for fish population management will improve present situation.

| | | |
|---|---|---|
| Project Investor | Ulcinj municipality, Ministry of Agriculture and Rural Development (MARD) | |
| Investment Costs | Production of study on tourism risks and mitigation measures with action plan – 15,000 EURO; Implementation of mitigation measures with action plan – 15,000 EURO; Production of 6 – year plan for fish population management – 15,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); Environmental Protection Agency; Water Administration (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Medium | |
| Other Remarks | Bringing of tourism development and fishery in sustainable frame will not only improve the WB status but It will also make those activities sustainable on long term and provide opportunity for additional income (sport / recreational fishing) | |
| Priority (first / second / third) | Second | |

| Characteristics | | Water efficiency[246], implementation of technical measures for irrigation, industry, energy and households water sharing in Orahovštica WB | | ID AB MNE 04 |
|---|---|---|---|---|
| **Location** | Municipality | Cetinje | | |
| | Water body | SWB: Orahovštica; GWB: Orahovštica – Rijeka Crnojevića | | |
| | Watercourse | Orahovštica | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of pumping station for Cetinje municipality water supply causes a problem during summer and autumn period since it leaves only small amount of water in riverbed , which is wholly insufficient for the ecology | | |
| | Key Type of Measure | KTM8 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Optimization of water abstraction and apply some additional water supply source for Cetnje municipality** |
|---|---|
| On the river Orahovštica, near this WB sourcing region there is pumping station of Cetnje water supply company. In summer and autumn months during low water flow regime, almost all water being extract from this river which critically jeopardize this WB ecosystem. In addition, this pump station pump water almost 500 m in altiutude and on long distance which makes this process expensive. Therefore, finding an alternative and/or additional solution for Cetinje municipality in order to diversify water supply will have positive effect for the SWB status. | |
| Project Investor | Municipality of Cetinje |
| Investment Costs | Production of detail analysis of alternative for Cetinje municipality water supply – 0.4 M EURO; Construction of alternative source of Cetinje municipality water supply – 4 M EURO |
| Maintenance Costs | 0.5 M EURO/year |
| Necessity of Permit Procedure | ☒ Yes ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); Environmental Protection Agency; Water Administration (WA) |
| Status of Implementation | No Status |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant |
| Other Remarks | Introduction of alternative water supply source for Cetinje municipality will allow this SWB to recover it ecological status |

[246] Water efficiency is defined as reducing water wastage by measuring the amount of water required for a particular purpose and the amount of water used or delivered

| | |
|---|---|
| Priority (first / second / third) | First |

| Characteristics | | Drinking water protection measures on Orahovštica pumping station | | ID AB MNE 05 |
|---|---|---|---|---|
| **Location** | Municipality | Bar | | |
| | Water body | SWB: Orahovštica; GWB: Orahovštica – Rijeka Crnojevića | | |
| | Watercourse | Orahovštica | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Waste water from upstream settlement | | |
| | Key Type of Measure | KTM13 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Baseline Study for the Implementation of a Third Water Protection Zone "Orahovštica"** | |
|---|---|---|
| The establishment of the third water protection zone is a legal obligation to the user of the water springs for public water supply. A baseline study is necessary to define define the whole catchment area of this water supply zone and identify the possible impacts to the water quality. The aim of the protection is to avoid deterioration in order to reduce the level of purification treatment required in the production of drinking water. | | |
| Project Investor | Municipality of Cetinje | |
| Investment Costs | 0.1 M EURO | |
| Maintenance Costs | No maintenance | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Protection of catchment area is necessary for the ensuring of good drinking water quality | |
| Priority (first / second / third) | First | |

| Characteristics | | Improving longitudinal continuity on Crmnička rijeka surface WB | | ID<br>AB MNE 06 |
|---|---|---|---|---|
| **Location** | Municipality | Bar | | |
| | Water body | Crmnička rijeka | | |
| | Watercourse | Crminička rijeka | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of small barrier for irrigation system | | |
| | Key Type of Measure | KTM5 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☒ Yes | ☐ No | |

| **Description of the Measure** | **Removing of barriers in order to ensure longitudinal connectivity** |
|---|---|

On Crmnička river watercourse there are several barriers made of stone and concrete which prevent connectivity in biological terms. The old irrigation system has not been functional for a few decades so there is no need for barriers which are constructed with aim to fill the irrigation system with water.

| | | |
|---|---|---|
| Project Investor | Bar municipality | |
| Investment Costs | 0.1 M EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration (WA)<br>Bar Municipalty | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | Establishment (improvement) and maintenance of longitudinal river connectivity is of essential importance for preservation river ecosystem functionality | |
| Priority (first / second / third) | Second | |

| Characteristics | | Water efficiency measures for irrigation, industry, energy and households water sharing in Crmnička river WB | | ID<br>AB MNE 07 |
|---|---|---|---|---|
| **Location** | Municipality | Bar | | |
| | Water body | Crmnička river | | |
| | Watercourse | Crmnička river | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Within this WB, waters are used for agriculture, and households there is no current plan for such water usage, which is significant during summer months. | | |
| | Key Type of Measure | KTM8 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☒ Yes | ☐ No | |

| **Description of the Measure** | **Detail plan and analysis of balance of water usage in region of Crmnička rijeka** | |
|---|---|---|
| Due to agriculture and some households needs there is unknown water mass usage and unknown balance of this usage. In order to secure water balance, it is of importance to know who, when, where and how much water is using from this WB | | |
| Project Investor | Bar municipality | |
| Investment Costs | Production of cadaster of water users within Crmnička rijeka WB – 10,000 EURO<br>Production of detail analysis of water usage in Crmnička rijeka WB – 10,000 EURO | |
| Maintenance Costs | No mitigation measures | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); Environmental Protection Agency; Water Administration (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Low | |
| Other Remarks | This measure will enable precise insight and will give necessary basis for establishing of water efficiency. | |
| Priority (first / second / third) | Third | |

| Characteristics | | Water efficiency measures for irrigation, industry, energy and households water sharing in Sutrina_1 WB | | ID<br>AB MNE 08 |
|---|---|---|---|---|
| **Location** | Municipality | Herceg Novi | | |
| | Water body | Sutorina_1 | | |
| | Watercourse | Sutorina | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Within this WB waters are used for agriculture, and households. There is no plan for such water usage, which is significant during summer months. | | |
| | Key Type of Measure | KTM8 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Detail plan and analysis of balance of water usage in region of Sutorina_1 WB** | |
|---|---|---|
| Due to small scale agriculture and some households needs there is unknown water mass usage and unknow balance of this usage. In order to secure water balance, it is of importance to know who, when, where and how much water is using from this WB | | |
| Project Investor | Herceg Novi municipality | |
| Investment Costs | Production of cadaster of water users within Sutorina_1 WB – 10,000 EURO<br>Production of detail analysis of water usage in Sutorina_1 WB – 10,000 EURO | |
| Maintenance Costs | No mitigation measures | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Low | |
| Other Remarks | This measure will enable precise insight and will give necessary basis for establishing of water efficiency. | |
| Priority (first / second / third) | Third | |

| Characteristics | | Improving longitudinal continuity on Sutorina_2 WB | | ID<br>AB MNE 09 |
|---|---|---|---|---|
| **Location** | Municipality | Herceg Novi | | |
| | Water body | Sutorina_2 | | |
| | Watercourse | Sutorina | | |
| | Surrounding Area | Rural/Urban | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of small barriers | | |
| | Key Type of Measure | KTM5 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Removing of barriers in order to ensure longitudinal connectivity** | |
|---|---|---|
| On Sutorina_2 WB there are several barriers made of stone and concrete which prevent connectivity in biological terms. | | |
| Project Investor | Herceg Novi municipality | |
| Investment Costs | 0.25 M EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD); Water Administration (WA) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | Establishment (improvement) and maintenance of longitudinal river connectivity is of essential importance for preservation river ecosystem functionality | |
| Priority (first / second / third) | Second | |

<table>
<tr><th colspan="3">Characteristics</th><th>Improving hydromorphological conditions of Sutorina_2 WB (other than longitudinal continuity)</th><th colspan="2">ID<br>AB MNE 10</th></tr>
<tr><td rowspan="4">Location</td><td colspan="2">Municipality</td><td colspan="3">Herceg Novi</td></tr>
<tr><td colspan="2">Water body</td><td colspan="3">Sutorina_2</td></tr>
<tr><td colspan="2">Watercourse</td><td colspan="3">Sutorina</td></tr>
<tr><td colspan="2">Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td colspan="2">WFD Measure according to Art. 11</td><td colspan="3">Basic measure</td></tr>
<tr><td colspan="2">Key Aspect/Pressure</td><td colspan="3">In order to prevent flooding events this WB is channelized and placed in concrete riverbed</td></tr>
<tr><td colspan="2">Key Type of Measure</td><td colspan="3">KTM6</td></tr>
<tr><td rowspan="2">Restrictions</td><td colspan="2">Protected Area</td><td colspan="2">☐ Yes</td><td>☒ No</td></tr>
<tr><td colspan="2">Flood Area</td><td colspan="2">☐ Yes</td><td>☒ No</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="4">Bringing Sutorina_2 river in to natural status in terms of riverbed</td></tr>
<tr><td colspan="6">With need to prevent flooding of surrounding flat plane, the Sutorina River is placed in to concrete riverbed. This measure is not easy to implement but with some intervention in riverbed it is possible to recover the original shape and functionality, whilst also avoiding flooding</td></tr>
<tr><td colspan="2">Project Investor</td><td colspan="4">Herceg Novi municipality</td></tr>
<tr><td colspan="2">Investment Costs</td><td colspan="4">2.5 M EURO</td></tr>
<tr><td colspan="2">Maintenance Costs</td><td colspan="4">No maintenance costs</td></tr>
<tr><td colspan="2">Necessity of Permit Procedure</td><td colspan="2">☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Competent Water Authority</td><td colspan="4">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other Relevant Authorities</td><td colspan="4">Ministry of Sustainable Development and Tourism (MSDT); EPA; Water Administration (WA)</td></tr>
<tr><td colspan="2">Status of Implementation</td><td colspan="4">No Status</td></tr>
<tr><td colspan="2">Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="4">Significant</td></tr>
<tr><td colspan="2">Other Remarks</td><td colspan="4">This WB status depend on this measure and if it will be applied properly Sutorina_2 WB will be removed from HMWB status to GOOD status</td></tr>
<tr><td colspan="2">Priority (first / second / third)</td><td colspan="4">First</td></tr>
</table>

| Characteristics | | Construction of wastewater treatment plant and extension of sewerage network for Podgorica municipalities | ID AB MNE 11 |
|---|---|---|---|
| **Location** | Municipality | Podgorica | |
| | Water body | SWB: Morača_5, Morača _6, and Ribnica<br>GWB: Zeta Valley | |
| | Watercourse | Morača | |
| | Surrounding Area | Urban/Rural | |
| | WFD Measure according to Art. 11 | Basic measure | |
| | Key Aspect/Pressure | Wastewater treatment for Podgorica municipality is inadequate and inappropriate and therefore those waters comes unprocessed in recipient WB | |
| | Key Type of Measure | KTM1 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | **Decrease of WB loading with organic compounds and nutrients** |
|---|---|

The existing wastewater treatment plant in Podgorica was built as the first phase of three equal phases, and each stage was designed for a PE of 55,000.

The second and third phases were never built, nor the sludge treatment facilities. The plant currently receives wastewater from about 80,000 population plus industrial and institutional/commercial flows and is thus substantially overloaded.

The configuration of the existing plant is as follows: The WWTP of Podgorica is located about 300 m downstream of the children hospital of Podgorica on the right bank of the Morača River. It has been designed in 1973 to be built in 3 phases. The construction of a part of the civil works (pre-treatment, chlorination, administration buildings and laboratory) as well as the process line for the first phase was finished in 1978. Due of financing, the plant has never been equipped for the phases 2&3. Parts of the equipment for the first phase were never installed neither.

The construction of the new wastewater treatment plant will have a capacity of about 187,600 PE and should be extended until 2045 to 235,000 PE.

In addition, it will have facilities for treatment of municipal sewage sludge.

Currently, the sewer network of Podgorica has a length of 205 km. The secondary system has a length of 170 km. The extension of the sewer network should be done in 3 phases:

- Phase 1: Extension of the secondary network - 12.5 km (9 000 inhabitants)
- Phase 2: New sewer network in the settlements of Donja Gorice, and Dorjeh Koketa (partly) – 12.3 km

Phase 3: New sewer network in western and north-western part of the municipality- 14.3 km

| | | |
|---|---|---|
| Project Investor | Podgorica municipality | |
| Investment Costs | 35M EURO for WWTP and 10M EURO for extension of sewer system | |
| Maintenance Costs | 1.5M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |

| | |
|---|---|
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>EPA<br>Water Administration (WA)<br>Podgorica Municipalty |
| Status of Implementation | Tendering Design |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters into the groundwater basin as well as in recipient WB |
| Priority (first / second / third) | First |

| Characteristics | | Rehabilitation of the Red Sludge Ponds of the KAP Aluminum Plant | | ID<br>AB MNE 12 |
|---|---|---|---|---|
| **Location** | Municipality | Podgorica | | |
| | Water body | SWB: Morača_5 and Morača_6<br>GWB: Zeta Valley | | |
| | Watercourse | Morača | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Priority substances present in red sludge pond | | |
| | Key Type of Measure | KTM4 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Rehabilitation of the Red Sludge Ponds of the KAP Aluminium Plant** |
|---|---|

The project “Industrial Waste Management and Cleaning within the KAP for rehabilitation” has identified two ponds of red sludge and solid waste near the banks of Morača River which require measures for rehabilitation.

Currently, the change of the DUP "Industrial Zone of the Aluminum Plant Podgorica" from 2008 is in progress.

The reservoirs are owned by the company "WEG-collector". The Environmental Protection Agency (EPA) under the Ministry of Sustainable Development and Tourism (MSDT) has announced the Request for Expressions of Interest (ReoI), for the selection of consultants for the preparation of the Main Remediation Project in for the selected sites within 2019.

The selected consulting firm will carry out a revision of the project of geological exploration, supervision of the conduct of geological research and revision of the research study. It is planned that tendering for the Detailed Design is expected to be completed by summer 2019.

| | | |
|---|---|---|
| Project Investor | Podgorica municipality | |
| Investment Costs | Not known | |
| Maintenance Costs | Not known | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Sustainable Development and Tourism (MSDT) | |
| Other Relevant Authorities | Ministry of Agriculture and Rural Development (MARD); EPA; Water Administration (WA); Podgorica Municipalty | |
| Status of Implementation | Feasibility Study | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Preventing of leakage of priority substances in surface of ground WB is of priority importance | |
| Priority (first / second / third) | First | |

| Characteristics | | Improving longitudinal continuity on Morača_5 WB | | ID AB MNE 13 |
|---|---|---|---|---|
| **Location** | Municipality | Podgorica | | |
| | Water body | SWB: Morača_5 and Morača_6<br>GWB: Zeta Valley | | |
| | Watercourse | Morača | | |
| | Surrounding Area | Rural/Urban | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of small barriers | | |
| | Key Type of Measure | KTM5 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Removing of barriers in order to ensure longitudinal connectivity** | |
|---|---|---|
| On very border between Morača_5 and Morača_6 WBs there is stone made dam built for slowing down of water in order to pump it out for Aluminum plant needs, and which it breaks riverine connectivity. Nowadays this dam and pumping station is nonfunctional and there is no obstacle for the removal. | | |
| Project Investor | Aluminium plant and Podgorica municipality | |
| Investment Costs | 0.4M EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>Podgorica Municipalty | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Establishment (improvement) and maintenance of longitudinal river connectivity is of essential importance for preservation river ecosystem functionality | |
| Priority (first / second / third) | First | |

| Characteristics | | Water efficiency measures for irrigation, industry, energy and households water sharing in Morača_5 WB | ID<br>AB MNE 14 |
|---|---|---|---|
| Location | Municipality | Podgorica | |
| | Water body | SWB: Morača_5<br>GWB: Zeta Valley | |
| | Watercourse | Morača | |
| | Surrounding Area | Urban/Rural | |
| | WFD Measure according to Art. 11 | Supplementary measure | |
| | Key Aspect/Pressure | Within this WB waters are used for agriculture, industry, households there are no plan for such water usage, which is significant during summer months. | |
| | Key Type of Measure | KTM8 | |
| Restrictions | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | **Detail plan and analysis of balance of water usage in Podgorica municipality** | |
|---|---|---|
| Due to agriculture, industry, households and craft activities within Podgorica municipality there is unknown water mass usage and unknow balance of this usage. In order to secure water balance, it is of importance to know who, when, where and how much water is using from this WB | | |
| Project Investor | Podgorica municipality | |
| Investment Costs | Production of cadaster of water users within Morača_5 WB – 40,000 EURO<br>Production of detail analysis of water usage in MOrača_5 WB – 40,000 EURO | |
| Maintenance Costs | No mitigation measures | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | medium | |
| Other Remarks | This measure will enable precise insight and will give necessary basis for establishing of water efficiency. | |
| Priority (first / second / third) | Second | |

| Characteristics | | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances in Morača river | ID<br>AB MNE 15 |
|---|---|---|---|
| **Location** | Municipality | Podgorica | |
| | Water body | SWB: Morača_5, Morača_6 and Morača_7<br>GWB: Zeta Valley | |
| | Watercourse | Morača | |
| | Surrounding Area | Urban/Rural | |
| | WFD Measure according to Art. 11 | Supplementary measure | |
| | Key Aspect/Pressure | Emission and discharge of Priority Hazardous Substances | |
| | Key Type of Measure | KTM15 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | **Identification and reduction of emissions, discharges and losses of Priority Hazardous Substances Decrease in to Morača_5, Morača_6 and Morača_7 WB** | |
|---|---|---|
| The Aluminum plant is the main pollutant within this WBs, ether during usual operation or during regular repair maintenance periods. The first step required is the identification of PHS in their waste waters. The next step will involve possible solutions with an action plan. | | |
| Project Investor | Aluminum plant | |
| Investment Costs | Identification of PHS in Aluminium plant waste waters – 40,000 EURO<br>Studies on possible solutions with action plan – 0.1 M EURO | |
| Maintenance Costs | 0.1 – 0 15 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | The solutions have to be developed in close collaboration with company engineers and be designed to maximize reduction and if it is possible, to completely exclude PHS from the dump waters. | |
| Priority (first / second / third) | First | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Upgrades or improvements of industrial wastewater treatment plants (including farms) in Podgorica municipality</th><th>ID<br>AB MNE 16</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Podgorica</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Morača_5<br>GWB: Zeta Valley</td></tr>
<tr><td>Watercourse</td><td colspan="3">Morača</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Non -existing wastewater treatment of several non-IED plants and animal farms</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM16</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Description of the Measure</td><td colspan="4">Decrease of WB loading with organic compounds and nutrients</td></tr>
<tr><td colspan="5">Neither of this non - IED plants/farms have any treatment facility for the waste waters (or if they have it is unfunctional). Special attention should be paid toward individual wastewater treatment.<br>The first step would involve the establishment of non-IED pollutant company/farm cadaster on municipality level and systematic analysis of their wastewater (chemical analysis of compounds in wastewater). The next step should be study with suggested solutions for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm.</td></tr>
<tr><td>Project Investor</td><td colspan="4">Podgorica municipality, non-IED pollutant plants/farms</td></tr>
<tr><td>Investment Costs</td><td colspan="4">Establishment of non-IED pollutant company/farm cadaster on municipality level – 80,000 EURO<br>Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 0.2 M EURO<br>Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm – 0.15 M EURO</td></tr>
<tr><td>Maintenance Costs</td><td colspan="4">1 – 1.3 M EURO/Year</td></tr>
<tr><td>Necessity of Permit Procedure</td><td colspan="2">☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td>Competent Water Authority</td><td colspan="4">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td>Other Relevant Authorities</td><td colspan="4">Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)</td></tr>
<tr><td>Status of Implementation</td><td colspan="4">No Status</td></tr>
<tr><td>Impact Assessment - Improvement of the Ecological or Chemical</td><td colspan="4">Significant</td></tr>
</table>

| | |
|---|---|
| Status of the Water Bodies (significant / high / medium / low) | |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters from non -IED plants/farms into the groundwater basin as well as in recipient WB |
| Priority (first / second / third) | First |

| Characteristics | | Improvement of communal waste management in Podgorica | | ID<br>AB MNE 17 |
|---|---|---|---|---|
| **Location** | Municipality | Podgorica | | |
| | Water body | SWB: Morača_5, Morača_6, Morača_7 and Ribnica<br>GWB: Zeta Valley | | |
| | Watercourse | Morača | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Bad or inadequate communal waste management | | |
| | Key Type of Measure | KTM21 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Improvement of communal waste management** |
|---|---|
| In accordance with the European directives, the capital of Podgorica has built the infrastructure needed for sustainable waste management. A sanitary landfill "Livade" with the Regional Recycling Centre was built; several recyclable yards were built in the city, the installation of temporary landfills for construction, plant and masonry waste. Also, the leachate water treatment plant for “Livade” landfill was built. This landfill is used with the disposal of waste from the territory of the municipalities of Podgorica, Tuzi, Danilovgrad and Cetinje, and therefore there is strong need for construction of new cells to meet the needs. | |

| | | |
|---|---|---|
| Project Investor | Podgorica municipality | |
| Investment Costs | Construction of new sanitary cells at the "Livade" landfill – 3 M EURO<br>Construction of a plant for the production of electric and thermal energy from landfill gas – 1 M EURO<br>Construction of composting / anaerobic digestion plants – 2 M EURO | |
| Maintenance Costs | 0.5 – 0.6 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>Podgorica Municipality | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Increased communal waste management efficiency will cause decreasing of leakage and pollution of related ground and surface WB | |
| Priority (first / second / third) | First | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Control the adverse impacts of recreation including fishing on Morača river</th><th>ID<br>AB MNE 18</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Podgorica</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Morača_5, Morača_6 and Morača_7<br>GWB: Zeta Valley</td></tr>
<tr><td>Watercourse</td><td colspan="3">Morača</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Basic measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Development of intensive eco -tourism and illegal fishing</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM19</td></tr>
<tr><td rowspan="4">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☐Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Emerald site</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
</table>

<table>
<tr><td>Description of the Measure</td><td colspan="2">Regulation of tourism and nature-based activities and strict enforcement of Low on freshwater fishery and aquaculture</td></tr>
<tr><td colspan="3">Illegal angling is the main cause of decreasing of fish population abundance in Morača River. All fishery related research in Montenegro has noticed a constant decrease of fish abundance, which could not be corelated to any other cause than poaching (water quality is more than excellent for the fish population without any heavy industrial pollution). Therefore, strict enforcement of Law on Freshwater Fishery and Aquaculture as well as production of strict 6-year plan for fish population management will improve the present situation.</td></tr>
<tr><td>Project Investor</td><td colspan="2">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td>Investment Costs</td><td colspan="2">Production of 6-year plan for fish population management – 15,000 EURO</td></tr>
<tr><td>Maintenance Costs</td><td colspan="2">No maintenance costs</td></tr>
<tr><td>Necessity of Permit Procedure</td><td>☐ Yes</td><td>☒ No</td></tr>
<tr><td>Competent Water Authority</td><td colspan="2">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td>Other Relevant Authorities</td><td colspan="2">Ministry of Sustainable Development and Tourism (MSDT): EPA<br>Water Administration of Montenegro (WA)</td></tr>
<tr><td>Status of Implementation</td><td colspan="2">No status</td></tr>
<tr><td>Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="2">Medium</td></tr>
<tr><td>Other Remarks</td><td colspan="2">Bringing the fisheries into a sustainable frame will not only improve the WB status but It will also make those activities sustainable on long term and provide opportunity for additional income</td></tr>
<tr><td>Priority (first / second / third)</td><td colspan="2">Second</td></tr>
</table>

| Characteristics | | Construction of wastewater treatment plants for Nikšić municipalities | | ID AB MNE 19 |
|---|---|---|---|---|
| **Location** | Municipality | NIkšić | | |
| | Water body | SWB: Zeta_2<br>GWB: Zeta Valley | | |
| | Watercourse | Zeta | | |
| | Surrounding Area | Urban | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Wastewater treatment for NIkšić municipality is inadequate and inappropriate and therefore those waters comes unprocessed in recipient WB | | |
| | Key Type of Measure | KTM1 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Decrease of WB loading with organic compounds and nutrients** |
|---|---|

Municipality of Nikšić has around 75,000 inhabitants, while in the urban part of the municipality there are 58,000 inhabitants. The aim of the project is design and construction of a wastewater treatment plant (WWTP) at the location "Studenci", as well as the reconstruction of one segment and the extension of the existing sewerage network in the urban area of the municipality of Nikšić in order to improve the existing system of waste water management and by that to reduce the negative impact of pollution of the river Zeta or Lake Skadar. The plant capacity is designed for 103,000 PE.

Implementation of segments of the project for reconstruction and extension of sewerage network is planned in two phases. Phase I included the extension of collector in the city center in a length of 11.8 km and construction of the connecting cables in a length of 11.5 km, while for the second phase is planned the construction of sewerage network in four settlements Rubeža, Ostrovac, Dragova Luka and Ćemenca for whose implementation is necessary to provide funding.

For the construction of wastewater treatment plant in the municipality of Nikšić at the location "Studenci" was adopted spatial - planning documentation, while the property at the location "Studenci", on which the construction of wastewater treatment plant is planned, is owned by the municipality of Nikšić.

Project segment which refers to the construction of I phase of the sewerage network or reconstruction of one segment and expansion of the existing sewerage network in the urban area was completed in 2013. This segment was implemented by EU Delegation to Montenegro, financed by funds from IPA 2008 approved by the European Commission.

Project construction of WWTP capacity of 103,000 ES is funded by the financial contract "Montenegro Water and Sanitation" concluded between Montenegro and the European Investment Bank 2012 and local budget funds.

Construction works on the plant were completed. The plant was put into operation in 2016, functional tests are in progress.

| Project Investor | Nikšić municipality | |
|---|---|---|
| Investment Costs | 6.7 M EURO | |
| Maintenance Costs | 1 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT) | |

| | |
|---|---|
| | Environmental Protection Agency<br>Water Administration of Montenegro (WA) |
| Status of Implementation | Tendering Design |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters into the groundwater basin as well as in recipient WB |
| Priority (first / second / third) | First |

| Characteristics | | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances in Zeta_2 WB | ID<br>AB MNE 20 |
|---|---|---|---|
| **Location** | Municipality | NIkšić | |
| | Water body | SWB: Zeta_2<br>GWB: Zeta Valley | |
| | Watercourse | Zeta | |
| | Surrounding Area | Urban/Rural | |
| | WFD Measure according to Art. 11 | Supplementary measure | |
| | Key Aspect/Pressure | Emission and discharge of Priority Hazardous Substances | |
| | Key Type of Measure | KTM15 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | | **Identification and reduction of emissions, discharges and losses of Priority Hazardous Substances Decrease in to Zeta_2 WB** |
|---|---|---|
| There is Steel plant in Nikišić and several other non IED plants as main pollutant within this WB, ether during usual operation or during regular repair maintenance periods. The first step should be an identification of PHS in their waste waters. The second stage would involve a study on possible solutions with an action plan. | | |
| Project Investor | Steel plant | |
| Investment Costs | Identification of PHS in Steel plant and other non-IED plants waste waters – 70,000 EURO<br>Studies on possible solutions with action plan – 15,000 EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | The solutions have to be developed in close collaboration with company engineers and designed to maximize reduction and if it is possible, to completely exclude PHS from the dump waters. | |
| Priority (first / second / third) | First | |

| Characteristics | | Improvement of communal waste management in NIkšić | | ID AB MNE 21 |
|---|---|---|---|---|
| **Location** | Municipality | NIkšić | | |
| | Water body | SWB: Zeta_2 and Gračanica_2<br>GWB: Zeta Valley and Nikšićko polje | | |
| | Watercourse | Zeta | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Bad or inadequate communal waste management | | |
| | Key Type of Measure | KTM21 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Improvement of communal waste management** |
|---|---|
| The collection, transport and disposal of municipal waste in the municipality of Nikšić are under the jurisdiction of the Public Utility Company. Waste collection is done with 70% of the territory (urban area and suburban areas where the concentration of the population is highest) and is currently stored at the temporary landfill Mislov do, whose area is 2 ha and is located 6.5 km south of the city. About 25,000 tons of waste per year is deposited on this site.<br>The regional landfill for the municipalities of Nikšić, Savnik and Pluzine is planned to be located in the municipality of Nikšić, at the locality of Budos. The expected lifetime of the entire landfill is 20 years. | |

| | | |
|---|---|---|
| Project Investor | Nikšić municipality | |
| Investment Costs | 16.57 M EURO (I phase 9.2 MEURO) | |
| Maintenance Costs | 0.5 – 0.6 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>NIkšić Municipality | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Increased communal waste management efficiency will cause decreasing of leakage and pollution of related ground and surface WB | |
| Priority (first / second / third) | First | |

| Characteristics | | Reducing pollution from agriculture in NIkšić Municipality | ID AB MNE 22 |
|---|---|---|---|
| **Location** | Municipality | Nilšić | |
| | Water body | SWB: Gračanica_1<br>GWB: Nikšićko polje | |
| | Watercourse | Gračanica | |
| | Surrounding Area | Rural | |
| | WFD Measure according to Art. 11 | Supplementary measure | |
| | Key Aspect/Pressure | Nutrient, agrochemicals and organic matter loading from the surrounding agriculture fields | |
| | Key Type of Measure | KTM2 and KTM3 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |
| **Description of the Measure** | **Reduction of nutrient, agrochemicals and organic matter loading from the agriculture fields** | | |
| In Župa region there is some amount of agricultural activities since this region has fertile soil. Gračanica river is draining this region and all remains of fertilizers and chemical compounds comes to this WB either by surface or by ground water (although the chemical compounds enter into ground water from the surface, the compounds can return into SWB through many springs within this area). Therefore, it is of essential importance to regulate and control the usage of these supplements especially the pesticides. The first step toward regulation on usage of chemical in agriculture is implementation of register of those who buy and use chemicals for treatment of soil and plants. | | | |
| Project Investor | Ministry of Agriculture and Rural Development (MARD), Nikšić municipality | | |
| Investment Costs | 0.15 M EURO | | |
| Maintenance Costs | | | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No | |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | | |
| Status of Implementation | No status | | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | | |
| Other Remarks | This measure is relatively easy to implement with introduction of ID Card for the Purchase of Agrochemicals as well as with farmer training for usage of Agrochemicals. | | |
| Priority (first / second / third) | Second | | |

| Characteristics | | Upgrades or improvements of dump waters from bauxite mines | | ID<br>AB MNE 23 |
|---|---|---|---|---|
| **Location** | Municipality | Nikšić | | |
| | Water body | SWB: Gračanica_1 and Gračanica_2<br>GWB: Nikšićko polje | | |
| | Watercourse | Gračanica | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Dump water absorbed red mud from mine and comes to this WB | | |
| | Key Type of Measure | KTM15 and 16 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Decrease of WB loading with inorganic/organic compounds** | |
|---|---|---|
| During heavy rains it is common that waters flash down into Gračanica river with sediment and red mud from bauxite mines. It is important to prevent this with proper management of such waters and with some treatment before their release in to final recipient (precipitation) | | |
| Project Investor | Bauxite Mines | |
| Investment Costs | Study on detail chemical analysis of damp waters – 30,000 EURO<br>Study on solution for the best and most appropriate dump water treatment – 30,000 EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Water Administration (WA) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Ministry of Agriculture and Rural Development (MARD) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of dump waters from the Bauxite Mines | |
| Priority (first / second / third) | First | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Remediation of contaminated sites along the Gračanica_2 WB</th><th>ID<br>AB MNE 24</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Nikšić</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Gračanica_2<br>GWB: Nikšićko polje</td></tr>
<tr><td>Watercourse</td><td colspan="3">Gračanica</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Several places along this WB used as illegal dump yards or remains of old factories.</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM4</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
</table>

<table>
<tr><th>Description of the Measure</th><th colspan="2">Improvement of possible risk of contaminant leakage</th></tr>
<tr><td colspan="3">There are several places along river bank which are used (or still in use) as illegal dump yards which need remediation, as well as some old factory and their dump-yards and waste water outflow places. The first step would be the establishment of cadaster of possibly contaminated sites. Next step is to undertake the chemical analysis of compounds in contaminated sites. After that the mitigation measured should be prescribed based on the contamination type.</td></tr>
<tr><td>Project Investor</td><td colspan="2">Nikšić municipality</td></tr>
<tr><td>Investment Costs</td><td colspan="2">Production of cadaster of possibly contaminated sites – 10,000 EURO<br>Chemical analysis of compounds in contemned sites – 30,000 EURO<br>Study on mitigation measures with action plan – 20,000 EURO</td></tr>
<tr><td>Maintenance Costs</td><td colspan="2">No maintenance costs</td></tr>
<tr><td>Necessity of Permit Procedure</td><td>☒ Yes</td><td>☐ No</td></tr>
<tr><td>Competent Water Authority</td><td colspan="2">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td>Other Relevant Authorities</td><td colspan="2">Ministry of Sustainable Development and Tourism (MSDT): EPA<br>Water Administration (WA)<br>Nikšić Municipality</td></tr>
<tr><td>Status of Implementation</td><td colspan="2">No Status</td></tr>
<tr><td>Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="2">Significant</td></tr>
<tr><td>Other Remarks</td><td colspan="2">Increased groundwater and surface water protection by remediation of contaminated sites.</td></tr>
<tr><td>Priority (first / second / third)</td><td colspan="2">First</td></tr>
</table>

| Characteristics | | Improvements in flow regime and/or establishment of ecological flows on Gračanica_2 WB | | ID<br>AB MNE 25 |
|---|---|---|---|---|
| **Location** | Municipality | NIkšić | | |
| | Water body | SWB: Gračanica_2<br>GWB: Nikšićko polje | | |
| | Watercourse | Gračanica | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Artificial lake "Liverovići" is used as a water reservoir for cooling of Steel Plant and there is no proper regulation of flow regime downstream of "Liverovići" dam. | | |
| | Key Type of Measure | KTM7 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **The management of water discharge from "Liveroivići" dam** | |
|---|---|---|
| The present ecological flow in Gračanica_2 WB is completely inadequate to maintenance any of previous river ecosystem. A recalculation is required to ensure minimal ecological condition in this WB. This accumulation was formed for the needs of Steel plant and in that time, there was no regulation for ecological flow. Nowadays the regulation mechanism of water discharge from this dam is not functional and the cost is mainly related to the repairing of this mechanism. Calculation of the minimum ecological flow is the first step toward improvement of this HMWB. | | |
| Project Investor | NIkšić municipality and Steel Plant | |
| Investment Costs | 40,000 EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Establishing of minimal ecological flow in Gračanica_2 WB is of essential importance to give any chance for river ecosystem to somehow sustain and function. | |
| Priority (first / second / third) | First | |

| Characteristics | | Improving hydromorphological conditions of Gračanica_2 WB (other than longitudinal continuity) | ID AB MNE 26 |
|---|---|---|---|
| **Location** | Municipality | NIkšić | |
| | Water body | SWB: Gračanica_2<br>GWB: Nikšićko polje | |
| | Watercourse | Gračanica | |
| | Surrounding Area | Urban/Rural | |
| | WFD Measure according to Art. 11 | Basic measure | |
| | Key Aspect/Pressure | Riverbed is destroyed by gravel extraction and illegal dump yard of construction waste material | |
| | Key Type of Measure | KTM6 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | **Bringing Gračanica_2 river in to natural status in terms of riverbed** | |
|---|---|---|
| Remediation of riverbanks and cleaning of illegal dumping sites from construction and other waste material | | |
| Project Investor | Nikšić municipality | |
| Investment Costs | 2 M EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>Nikšić Municipality | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | This WB status depend on this measure and if it will be applied properly Gračanica_2 WB will have chance to reach GOOD status | |
| Priority (first / second / third) | First | |

| Characteristics | | | Upgrades or improvements of industrial wastewater treatment plants (including farms) along Gračanica_2 WB | ID<br>AB MNE 27 |
|---|---|---|---|---|
| **Location** | Municipality | | Nikšić | |
| | Water body | | SWB: Gračanica_2; GWB: Nikšićko polje | |
| | Watercourse | | Gračanica | |
| | Surrounding Area | | Urban/Rural | |
| | WFD Measure according to Art. 11 | | Supplementary measure | |
| | Key Aspect/Pressure | | No wastewater treatment of non IED plants | |
| | Key Type of Measure | | KTM16 | |
| **Restrictions** | Protected Area | | ☐ Yes | ☒ No |
| | Flood Area | | ☐ Yes | ☒ No |
| **Description of the Measure** | **Decrease of WB loading with organic compounds and nutrients** | | | |
| Neither of this non - IED plants have any treatment facility for the waste waters. Special attention should be paid toward individual wastewater treatment. The first step should be establishment of non-IED pollutant company/farm cadaster on municipality level and systematic analysis of their wastewater (chemical analysis of compounds in wastewater). The next step should involve a study with suggested solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm. | | | | |
| Project Investor | NIkšić municipality, non-IED pollutant plants/farms | | | |
| Investment Costs | Establishment of non-IED pollutant company/farm cadaster on municipality level – 30,000 EURO<br>Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 0.1 M EURO<br>Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm – 30,000 EURO | | | |
| Maintenance Costs | | | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No | | |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | | | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | | | |
| Status of Implementation | No Status | | | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | | | |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters from non -IED plants/farms | | | |
| Priority (first / second / third) | First | | | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Zeta_3 WB</th><th>ID<br>AB MNE 28</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Nikšić</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Zeta_3<br>GWB: Prekornica - Bjelopavlići</td></tr>
<tr><td>Watercourse</td><td colspan="3">Zeta</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Within this WB waters are used for agriculture, and households there are no plan for such water usage (significant during summer months).</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM8</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
</table>

| **Description of the Measure** | **Detail plan and analysis of balance of water usage in Zeta_3 WB** | |
|---|---|---|
| Due to agriculture and households there is unknown water mass usage and unknow balance of this usage. In order to secure water balance, it is of importance to know who, when, where and how much water is using from this WB | | |
| Project Investor | NIkšić municipality | |
| Investment Costs | Production of cadaster of water users within Zeta_3 WB – 10,000 EURO<br>Production of detail analysis of water usage in Zeta_3 WB – 10,000 EURO | |
| Maintenance Costs | No mitigation measures | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Medium | |
| Other Remarks | This measure will enable precise insight and will give necessary bases for establishing of water efficiency. | |
| Priority (first / second / third) | Second | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Control the adverse impacts of recreation including angling on Zeta river</th><th>ID<br>AB MNE 29</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Nikšić/Danilovgrad</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Zeta_3 and Zeta_4; GWB: Prekornica - Bjelopavlići</td></tr>
<tr><td>Watercourse</td><td colspan="3">Zeta</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Basic measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Development of eco -tourism and illegal angling</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM19</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☒Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Regulation of tourism and nature-based activities and strict enforcement of Low on freshwater fishery and aquaculture</td></tr>
<tr><td colspan="5">Tourism makes strong pressure on nature resources and it has impact on surface WB. Precise regulation together with study of risks and mitigation measures action plan (implementation of such plan) will help to achieve proclaimed sustainability goal and will reduce pressure on related WBs. All fishery related research in Montenegro have noticed a constant decrease of fish abundance which could not be corelated to any other cause than poaching (water quality is more than excellent for the fish population without any heavy industrial pollution). Illegal fishing is the main cause of decreasing of fish population abundance in Zeta river. Therefore, strict enforcement of Law on Freshwater Fishery and Aquaculture as well as production of strict 6-year plan for fish population management will improve present situation.</td></tr>
<tr><td colspan="2">Project Investor</td><td colspan="3">Danilovgrad/Nikšić municipality, Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Investment Costs</td><td colspan="3">Production of study on tourism risks and mitigation measures with action plan – 20,000 EURO<br>Implementation of mitigation measures with action plan – 20,000 EURO<br>Production of 6-year plan for fish population management – 15,000 EURO</td></tr>
<tr><td colspan="2">Maintenance Costs</td><td colspan="3">No maintenance costs</td></tr>
<tr><td colspan="2">Necessity of Permit Procedure</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td colspan="2">Competent Water Authority</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other Relevant Authorities</td><td colspan="3">Ministry of Sustainable Development and Tourism (MSDT); EPA Water Administration (WA)</td></tr>
<tr><td colspan="2">Status of Implementation</td><td colspan="3">No status</td></tr>
<tr><td colspan="2">Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="3">Medium</td></tr>
<tr><td colspan="2">Other Remarks</td><td colspan="3">Bringing of tourism development and fishery in sustainable frame will not only improve the WB status but It will also make those activities sustainable on long term and provide opportunity for additional income</td></tr>
<tr><td colspan="2">Priority (first / second / third)</td><td colspan="3">Second</td></tr>
</table>

| Characteristics | | Construction of wastewater treatment plant and extension of the sewer network in Danilovgrad municipality | | ID<br>AB MNE 30 |
|---|---|---|---|---|
| **Location** | Municipality | Danilovgrad | | |
| | Water body | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | | |
| | Watercourse | Zeta | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Wastewater treatment for Danilovgrad municipality is inadequate and inappropriate and therefore those waters comes unprocessed in recipient WB | | |
| | Key Type of Measure | KTM1 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☒ Yes | ☐ No | |

| **Description of the Measure** | **Decrease of WB loading with organic compounds and nutrients** | |
|---|---|---|
| The existing wastewater system is limited to three independent collection systems (sewerage) in the most built up parts of the city. Treatment of wastewater is not performed, and the wastewater is simply collected and conveyed by gravity prior to discharge to the Zeta River. Total length of sewerage system is 3,171 m, and 2,029.5 m of sewer network is made of asbestos–cement and 1,141.5m is made of PVC pipelines, and the connected population is 2,000. representing slightly less than 40% of that in the built-up area. Some parts of this area and all of the rural areas of Danilovgrad municipality are reliant instead on on-site sanitation in the form of pits and septic tanks that represent a potential risk for soil and under waters.<br>Wastewater system upgrades, involving (i) construction of about 30 km of wastewater collection networks in residential areas, (ii) installation of 5 wastewater pumping stations, and (iii) a new wastewater treatment plant (WWTP) with a capacity of 6,000 PE.<br>Between the state of Montenegro and the EBRD is signed a loan agreement for financing this project in the amount of EURO 5,350,000.<br>The contract for the design and construction of a waste water treatment plant has been signed. The company "Karkanias Environmental Technology S.A." from Greece is in charge of design and construction. The completion is scheduled for 2023. | | |
| Project Investor | Danilovgrad municipality | |
| Investment Costs | 2.4 M EURO for WWTP and 2.75 M EURO for extension of sewer system | |
| Maintenance Costs | 0.5 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>Danilovgrad Municipality | |
| Status of Implementation | Detailed Design | |

| | |
|---|---|
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters into the groundwater basin as well as in recipient WB |
| Priority (first / second / third) | First |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Reduction of pollution from agriculture in Bjelopavlići plane</th><th>ID<br>AB MNE 31</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Danilovgrad</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići</td></tr>
<tr><td>Watercourse</td><td colspan="3">Zeta</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Nutrient, agrochemicals and organic matter loading from the surrounding agriculture fields</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM2 and KTM3</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Reduction of nutrient, agrochemicals and organic matter loading from the agriculture fields</td></tr>
<tr><td colspan="5">In Bjelopavlići plane there is significant amount of agricultural activities since this region has fertile soil and it is rich in surface and ground water (although the chemical compounds enter into ground water from the surface, the compounds can return into SWB through many springs within this area). Zeta river is draining this region and all remains of fertilizers and chemical compounds comes to this WB either by surface or by ground water. Therefore, it is of essential importance to regulate and control the usage of these supplements especially the pesticides. The first step toward regulation on usage of chemical in agriculture is implementation of register of those who buy and use chemicals for treatment of soil and plants.</td></tr>
<tr><td colspan="2">Project Investor</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD), Ulcinj municipality</td></tr>
<tr><td colspan="2">Investment Costs</td><td colspan="3">0.1 M EURO</td></tr>
<tr><td colspan="2">Maintenance Costs</td><td colspan="3">It is hard to foresee the maintenance</td></tr>
<tr><td colspan="2">Necessity of Permit Procedure</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td colspan="2">Competent Water Authority</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other Relevant Authorities</td><td colspan="3">Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA)</td></tr>
<tr><td colspan="2">Status of Implementation</td><td colspan="3">No status</td></tr>
<tr><td colspan="2">Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="3">High</td></tr>
<tr><td colspan="2">Other Remarks</td><td colspan="3">This measure is relatively easy to implement with introduction of ID Card for the Purchase of Agrochemicals as well as with farmer training for usage of Agrochemicals.</td></tr>
<tr><td colspan="2">Priority (first / second / third)</td><td colspan="3">Second</td></tr>
</table>

| Characteristics | | Improving longitudinal continuity on Zeta river | | ID<br>AB MNE 32 |
|---|---|---|---|---|
| **Location** | Municipality | Danilovgrad | | |
| | Water body | SWB: Zeta_3 and Zeta_4<br>GWB: Prekornica - Bjelopavlići | | |
| | Watercourse | Zeta | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of Hydro Plant "Slap Zete" and barrier in "Slap Zete" dam | | |
| | Key Type of Measure | KTM5 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Reestablishment of longitudinal connectivity** | |
|---|---|---|
| On Zeta river there is one barrier in "Slap Zete" dam which prevent longitudinal connectivity especially during lower water flow (late spring, summer and first half of autumn months). Design and construction of appropriate fish passage will help in reestablishment of riverine connectivity. | | |
| Project Investor | Hydro Plant "Slap Zete" | |
| Investment Costs | 50,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Water Administration (WA) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Ministry of Agriculture and Rural Development (MARD) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | Establishment (improvement) and maintenance of longitudinal river connectivity is of essential importance for preservation river ecosystem functionality | |
| Priority (first / second / third) | Second | |

| Characteristics | | Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Morača_5 WB | | ID<br>AB MNE 33 |
|---|---|---|---|---|
| **Location** | Municipality | Danilovgrad | | |
| | Water body | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | | |
| | Watercourse | Zeta | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Within this WB waters are used for agriculture, industry, households there are no plan for such water usage (significant during summer months). | | |
| | Key Type of Measure | KTM8 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☒ Yes | ☐ No | |

| **Description of the Measure** | **Detail plan and analysis of balance of water usage in Podgorica municipality** | |
|---|---|---|
| Due to agriculture, industry, households and craft activities within Danilovgrad municipality there is unknown water mass usage and unknow balance of this usage. In order to secure water balance, it is of importance to know who, when, where and how much water is using from this WB | | |
| Project Investor | Danilovgrad municipality | |
| Investment Costs | Production of cadaster of water users within Zeta_4 WB – 20,000 EURO<br>Production of detail analysis of water usage within Zeta_4 WB – 20,000 EURO | |
| Maintenance Costs | No mitigation measures | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | medium | |
| Other Remarks | This measure will enable precise insight and will give necessary basis for establishing of water efficiency. | |
| Priority (first / second / third) | Second | |

| Characteristics | | Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances in Zeta_4 WB | | ID<br>AB MNE 34 |
|---|---|---|---|---|
| **Location** | Municipality | Danilovgrad | | |
| | Water body | SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići | | |
| | Watercourse | Zeta | | |
| | Surrounding Area | Urban/Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Emission and discharge of Priority Hazardous Substances | | |
| | Key Type of Measure | KTM15 and KTM 16 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☒ Yes | ☐ No | |

| **Description of the Measure** | **Identification and reduction of emissions, discharges and losses of Priority Hazardous Substances Decrease in to Zeta_4 WB** | |
|---|---|---|
| Neither of this non - IED plants/farms have any treatment facility for the waste waters (or if they have it is unfunctional). Special attention should be paid toward individual wastewater treatment. First step should be establishment of non-IED pollutant company/farm cadaster on municipality level and systematic analysis of their wastewater (chemical analysis of compounds in wastewater). Next step should involve a study with suggested solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm. | | |
| Project Investor | Danilovgrad municipality, non-IED pollutant plants/farms | |
| Investment Costs | Establishment of non-IED pollutant company/farm cadaster on municipality level – 40,000 EURO<br>Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 0.1 M EURO<br>Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm – 40,000 EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status | Significant | |

| | |
|---|---|
| of the Water Bodies (significant / high / medium / low) | |
| Other Remarks | The solutions have to be developed in close collaboration with company engineers and designed to maximize reduction and if it is possible, to completely exclude PHS from the dump waters. |
| Priority (first / second / third) | First |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Improvement of communal waste management in Danilovgrad</th><th>ID<br>AB MNE 35</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Danilovgrad</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Zeta_4<br>GWB: Prekornica - Bjelopavlići</td></tr>
<tr><td>Watercourse</td><td colspan="3">Zeta</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Bad or inadequate communal waste management</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM21</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td colspan="2">☐ Yes</td><td>☒ No</td></tr>
<tr><td>Flood Area</td><td colspan="2">☒ Yes</td><td>☐ No</td></tr>
</table>

| | | |
|---|---|---|
| **Description of the Measure** | **Improvement of communal waste management** | |
| Within the State Waste Plan, in Danilovgrad, a site for the recyclable yard and sorting facility is foreseen. Collected waste will be transfer to a regional sanitary landfill in Podgorica. | | |
| Project Investor | Danilovgrad municipality | |
| Investment Costs | 0.1 M EURO | |
| Maintenance Costs | 0.02 – 0.03 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration of Montenegro (WA)<br>Danilovgrad Municipality | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Increased communal waste management efficiency will cause decreasing of leakage and pollution of related ground and surface WB | |
| Priority (first / second / third) | First | |

| Characteristics | | Reduce nutrient pollution from agriculture (Improvement of aquaculture in order to reduce nutrient and organic matter loading) in region of Opasanica / Verušica WB | ID<br>AB MNE 36 |
|---|---|---|---|
| **Location** | Municipality | Danilovgrad | |
| | Water body | SWB: Zeta_3 and Zeta_4<br>GWB: Prekornica - Bjelopavlići | |
| | Watercourse | Zeta | |
| | Surrounding Area | Rural | |
| | WFD Measure according to Art. 11 | Basic measure | |
| | Key Aspect/Pressure | Nutrient and organic matter loading from the fish farms | |
| | Key Type of Measure | KTM2 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☒ Yes | ☐ No |

| **Description of the Measure** | **Reduction of Nutrient and organic matter loading from the fish farms** |
|---|---|
| Precise calibration of feeding in order to minimize organic matter loading. Balancing of diet. | |

| | | |
|---|---|---|
| Project Investor | Private companies, Fish-farm owners, Ministry of Agriculture and Rural Development (MARD) | |
| Investment Costs | 15,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | This measure is relatively easy to implement, and it will have significant positive impact on WB chemical/biological status especially during summer low flow regime. | |
| Priority (first / second / third) | First | |

<table>
<tr><th colspan="2">Characteristics</th><th>Improving hydromorphological conditions of Ribnica WB (other than longitudinal continuity)</th><th>ID<br>AB MNE 37</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="2">Podgorica</td></tr>
<tr><td>Water body</td><td colspan="2">Ribnica</td></tr>
<tr><td>Watercourse</td><td colspan="2">Ribnica</td></tr>
<tr><td>Surrounding Area</td><td colspan="2">Urban</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="2">Basic measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="2">One part of Ribnica riverbed is in a concrete channel (concrete made riverbed)</td></tr>
<tr><td>Key Type of Measure</td><td colspan="2">KTM6</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td>☒ No</td></tr>
<tr><td>Flood Area</td><td>☐ Yes</td><td>☒ No</td></tr>
</table>

| **Description of the Measure** | **Bringing Ribnica river in to natural status in terms of riverbed** | |
|---|---|---|
| This measure is easy to implement since only one small part of Ribnica riverbed is in concrete. Restoration is required to a natural state, i.e. removal of concrete structure followed by river rehabilitation. | | |
| Project Investor | Podgorica municipality | |
| Investment Costs | 0.3 M EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>Podgorica Municipality | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | This will significantly improve ecological status of Ribnica WB | |
| Priority (first / second / third) | First | |

| Characteristics | | Feasibility study for Improving hydromorphological conditions of Morača_6 WB (other than longitudinal continuity) | ID AB MNE 38 |
|---|---|---|---|
| **Location** | Municipality | Podgorica | |
| | Water body | SWB: Morača_6<br>GWB: Zeta Valley | |
| | Watercourse | Morača | |
| | Surrounding Area | Urban | |
| | WFD Measure according to Art. 11 | Supplementary measure | |
| | Key Aspect/Pressure | Due to intensive gravel extraction (legal and illegal) one significant part of Morača river flow is literally destroyed comparing to original shape. | |
| | Key Type of Measure | KTM6 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | **Bringing Morača_6 WB in to natural status in terms of riverbed** |
|---|---|
| This measure is not easy to implement since it depends on huge hydro-engineering restoration activity in relatively long part of river flow. A feasibility study is required to evaluate the potential cost effectiveness of the required improvements | |

| | | |
|---|---|---|
| Project Investor | Podgorica municipality, gravel extraction companies | |
| Investment Costs | 30,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Water Administration (WA) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Ministry of Agriculture and Rural Development (MARD) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | This will significantly improve ecological status of Morača_6 from HMWB in good ecological status. | |
| Priority (first / second / third) | First | |

| Characteristics | | A feasibility study on improving waste water treatment in municipality within the Capital - Golubovci | | ID AB MNE 39 |
|---|---|---|---|---|
| **Location** | Municipality | Podgorica | | |
| | Water body | SWB: Morača_6 and Morača_7<br>GWB: Zeta Valley | | |
| | Watercourse | Morača | | |
| | Surrounding Area | Urban | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Domestic waste water | | |
| | Key Type of Measure | KTM1 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☒ Yes | ☐ No | |

| **Description of the Measure** | **Improvement of waste water treatment in Golubovci** | |
|---|---|---|

The central objective of the Feasibility Study is the identification of suitable wastewater treatment techniques for the rural and small settlements of Ponari, Vukovci, Bistrica, Kurilo and Bijelo Polje (coud be extended to other settlements according to the agglomerations).. In order to protect Skadar Lake from organic pollution, ecological remediation (eg. reed beds) solutions of wastewater treatment have to be evaluated, taking into account climate and natural conditions as well as economic issues.

The estimated maximum agglomeration load is approx. 15,000 population equivalents and, in this moment, there is no network for collecting of waste waters so they are discharged into individual septic permeable tanks without any treatment.

| | | |
|---|---|---|
| Project Investor | Podgorica municipality | |
| Investment Costs | 30,000 Euro | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Feasibility Study envisaged in the Spatial Urban Plan of the Capital City | |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters into the groundwater basin as well as in recipient WB | |
| Priority (first / second / third) | First | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Study on the prevention and control of the adverse impacts of invasive alien species and introduced diseases</th><th>ID<br>AB MNE 40</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Podgorica</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: Morača_6 and Morača_7<br>GWB: Zeta Valley</td></tr>
<tr><td>Watercourse</td><td colspan="3">Morača</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Urban/Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Illegal introduction of non-native species</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM18</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood Area</td><td>☒Yes</td><td colspan="2">☐ No</td></tr>
</table>

<table>
<tr><th>Description of the Measure</th><th colspan="2">Strict enforcement of Low on freshwater fishery and aquaculture</th></tr>
<tr><td colspan="3">Invasive species already are well adapted to this part of Morača river course but with unknow effect on this ecosystem. Therefore, research is required in order to find out if there are some negative effect and with suggestions for mitigation measures for those negative effects</td></tr>
<tr><td>Project Investor</td><td colspan="2">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td>Investment Costs</td><td colspan="2">20,000 EURO</td></tr>
<tr><td>Maintenance Costs</td><td colspan="2"></td></tr>
<tr><td>Necessity of Permit Procedure</td><td>☐ Yes</td><td>☒ No</td></tr>
<tr><td>Competent Water Authority</td><td colspan="2">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td>Other Relevant Authorities</td><td colspan="2">Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)</td></tr>
<tr><td>Status of Implementation</td><td colspan="2">No status</td></tr>
<tr><td>Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="2">Medium</td></tr>
<tr><td>Other Remarks</td><td colspan="2">Study will give an answer on negative effect of already acclimatized non-native species which occurs in this part of Morača river and will give suggestions how to mitigate some of the registered negative effects.</td></tr>
<tr><td>Priority (first / second / third)</td><td colspan="2">Second</td></tr>
</table>

| Characteristics | | Reduction of pollution from agriculture in Lješkopolje | | ID AB MNE 41 |
|---|---|---|---|---|
| **Location** | Municipality | Podgorica | | |
| | Water body | Sitnica | | |
| | Watercourse | Sitnica | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Nutrient, agrochemicals and organic matter loading from the surrounding agriculture fields | | |
| | Key Type of Measure | KTM2 and KTM3 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Reduction of nutrient, agrochemicals and organic matter loading from the agriculture fields** |
|---|---|

In Lješkopolje region there are many agricultural activities since this region has fertile soil. Sitnica river is draining this region and is the recipient of fertilizers and chemical compounds. The first step toward regulation on usage of chemical in agriculture is implementation of register of those who buy and use chemicals for treatment of soil and plants. Therefore, it is of essential importance to regulate and control the usage of this supplements especially the pesticides. A plan of action for the implementation of good agricultural practice is required.

| | | |
|---|---|---|
| Project Investor | Ministry of Agriculture and Rural Development (MARD), Podgorica municipality | |
| Investment Costs | 20,000 EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | This measure is relatively easy to implement with introduction of ID Card for the Purchase of Agrochemicals as well as with farmer training for usage of Agrochemicals. | |
| Priority (first / second / third) | Second | |

| Characteristics | | Improving longitudinal continuity on Sitnica WB | | ID<br>AB MNE 42 |
|---|---|---|---|---|
| **Location** | Municipality | Podgorica | | |
| | Water body | Sitnica | | |
| | Watercourse | Sitnica | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of small barrier for irrigation system | | |
| | Key Type of Measure | KTM5 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Removing of barriers in order to ensure longitudinal connectivity** | |
|---|---|---|
| On Sitnica river watercourse there are several barriers made of stone and concrete which prevent connectivity in biological terms during low water flow. In order to restore this river, it is needed to remove both the concrete and the barriers. | | |
| Project Investor | Podgorica municipality | |
| Investment Costs | 80,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | Establishment (improvement) and maintenance of longitudinal river connectivity is of essential importance for preservation river ecosystem functionality | |
| Priority (first / second / third) | Second | |

| Characteristics | | Reduce pollution from agriculture along CIjevna WB | | ID<br>AB MNE 43 |
|---|---|---|---|---|
| **Location** | Municipality | Tuzi | | |
| | Water body | SWB: CIjevna<br>GWB: KučI, Zeta Valley | | |
| | Watercourse | Cijevna | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | Nutrient, agrochemicals and organic matter loading from the surrounding agriculture fields | | |
| | Key Type of Measure | KTM2 and KTM3 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Reduction of nutrient, agrochemicals and organic matter loading from the agriculture fields** |
|---|---|

Along river Cijevna in one part of its flow, there is the vineyard of AD "Plantaže" which is biggest grape producer in this part of the Europe. Considering their vast and intensive grape production large quantities of fertilizer and agrochemical are used: This can result in compromised quality status of the Cijevna surface WB and/or in to the GWB. An investigative study (investigative groundwater monitoring and determination of the residual chemical loading to the groundwater) with continual groundwater monitoring are required to verify if pollution form agrochemicals is causing a decrease in the quality of the SWB or GWB, as well as of monitoring of extracted groundwater and effects of this extraction on groundwater table and river water level.

| | | |
|---|---|---|
| Project Investor | AD "Plantaže" | |
| Investment Costs | 0.1 M EURO | |
| Maintenance Costs | | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | This measure is reflecting in minimizing of usage of fertilizers and agrochemicals and impact assessment on natural water regime | |
| Priority (first / second / third) | Second | |

| Characteristics | | Improving longitudinal continuity on Cijevna surface WB | | ID AB MNE 44 |
|---|---|---|---|---|
| **Location** | Municipality | Tuzi | | |
| | Water body | SWB: CIjevna<br>GWB: Kuči, Zeta Valley | | |
| | Watercourse | Cijevna | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | Existence of big barrier – waterfall called “NIjagara” | | |
| | Key Type of Measure | KTM5 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☒ No | |
| | Flood Area | ☐ Yes | ☒ No | |

| **Description of the Measure** | **Construction of fish passage in order to ensure longitudinal connectivity** | |
|---|---|---|
| In order to ensure the river connectivity, it is necessary to design and construct appropriate fish passage on “Nijagara” locality. Although this barrier is natural it is also partly constructed by human and therefore become less penetrable during high waters. The fish pass will allow for improved ecosystem connectivity regarding fish spawning. | | |
| Project Investor | Tuzi municipality | |
| Investment Costs | 0.3 M EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT)<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of Implementation | No status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High | |
| Other Remarks | Establishment (improvement) and maintenance of longitudinal river connectivity is of essential importance for preservation river ecosystem functionality | |
| Priority (first / second / third) | Second | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Water efficiency, implementation of technical measures for irrigation and households water sharing in Cijevna river WB</th><th>ID<br>AB MNE 45</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Tuzi</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: CIjevna<br>GWB: Kuči, Zeta Valley</td></tr>
<tr><td>Watercourse</td><td colspan="3">Cijevna</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Existence of pumps which extract water from Cijevna for irrigation or households needs</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM8</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td>Flood Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
</table>

| **Description of the Measure** | **Detail plan and analysis of balance of water usage in region of Cijevna WB** | |
|---|---|---|
| Due to agriculture and some households needs there is unknown water mass usage and unknow balance of this usage. In order to secure water balance, it is of importance to know who, when, where and how much water is using from this WB | | |
| Project Investor | Tuzi municipality | |
| Investment Costs | Production of cadaster of water users within Zeta_4 WB – 10,000 EURO<br>Production of detail analysis of water usage within Zeta_4 WB – 10,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | |
| Status of Implementation | No Status | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | This measure will enable precise insight and will give necessary bases for establishing of water efficiency. | |
| Priority (first / second / third) | First | |

| Characteristics | | Improvement of wastewater treatment in Tuzi municipality | ID<br>AB MNE 46 |
|---|---|---|---|
| **Location** | Municipality | Tuzi | |
| | Water body | SWB: WB 2_North<br>GWB: Kuči, Zeta Valley | |
| | Watercourse | Skadar Lake | |
| | Surrounding Area | Urban/Rural | |
| | WFD Measure according to Art. 11 | Basic measure | |
| | Key Aspect/Pressure | There is no wastewater treatment for Tuzi municipality | |
| | Key Type of Measure | KTM1 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |

| **Description of the Measure** | **Decrease of WB loading with organic compounds and nutrients** | |
|---|---|---|
| The Municipality of Tuzi with approx.12,000 inhabitants currently has no sewer system. The construction of the sewer network for the urbanized part of the municipality with a main collector (capacity of 4000 to 5000 PE) is the first phase of the implementation of the central sewer system. Generally, the sewer network could be extended to the rural settlement (villages). Until then the wastewater is collected and pre-treated in sealed septic tanks which should be emptied annually. The construction of the WWTP is essential to reduce the pollutant load to Lake. The location of the WWTP is part of the feasibility study. The capacity of the future WWTP depends on the proposed connection of households in the rural districts of the municipality | | |
| Project Investor | Tuzi municipality | |
| Investment Costs | 10 M EURO | |
| Maintenance Costs | 1 M EURO/Year | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)<br>Tuzi Municipality | |
| Status of Implementation | Desktop study | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Significant | |
| Other Remarks | Increased groundwater and surface water protection by avoiding the infiltration of used waters into the groundwater basin as well as in recipient WB | |
| Priority (first / second / third) | First | |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Prevention and control the adverse impacts of invasive alien species and introduced diseases</th><th>ID<br>AB MNE 47</th></tr>
<tr><td rowspan="4">Location</td><td>Municipality</td><td colspan="3">Tuzi</td></tr>
<tr><td>Water body</td><td colspan="3">SWB: WB 2_North<br>GWB: Kuči, Zeta Valley</td></tr>
<tr><td>Watercourse</td><td colspan="3">Skadar Lake</td></tr>
<tr><td>Surrounding Area</td><td colspan="3">Rural</td></tr>
<tr><td rowspan="3"></td><td>WFD Measure according to Art. 11</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key Aspect/Pressure</td><td colspan="3">Illegal introduction of non-native species</td></tr>
<tr><td>Key Type of Measure</td><td colspan="3">KTM18</td></tr>
<tr><td rowspan="2">Restrictions</td><td>Protected Area</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td>Flood Area</td><td>☒Yes</td><td colspan="2">☐ No</td></tr>
<tr><td>Description of the Measure</td><td colspan="4">Strict enforcement of Low on freshwater fishery and aquaculture</td></tr>
<tr><td colspan="5">Invasive species already are well adapted in Skadar Lake but with unknow effect on this ecosystem. Therefore, research is required to determine if there are some negative effect and with suggestions for mitigation measures for any negative effects</td></tr>
<tr><td colspan="2">Project Investor</td><td colspan="3">NP “Skadar Lake” /Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Investment Costs</td><td colspan="3">30,000 EURO</td></tr>
<tr><td colspan="2">Maintenance Costs</td><td colspan="3">No maintenance costs</td></tr>
<tr><td colspan="2">Necessity of Permit Procedure</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td colspan="2">Competent Water Authority</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other Relevant Authorities</td><td colspan="3">Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA)</td></tr>
<tr><td colspan="2">Status of Implementation</td><td colspan="3">No status</td></tr>
<tr><td colspan="2">Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)</td><td colspan="3">Medium</td></tr>
<tr><td colspan="2">Other Remarks</td><td colspan="3">Study will give an answer on negative effect of already acclimatized non-native species which occurs in Skadar Lake and will give suggestions how to mitigate some of the registered negative effects.</td></tr>
<tr><td colspan="2">Priority (first / second / third)</td><td colspan="3">Second</td></tr>
</table>

| Characteristics | | Control the adverse impacts of recreation including fishing on Skadar Lake | ID<br>AB MNE 48 |
|---|---|---|---|
| **Location** | Municipality | Tuzi | |
| | Water body | SWB: WB 2_North<br>GWB: Kuči, Zeta Valley | |
| | Watercourse | Skadar Lake | |
| | Surrounding Area | Rural | |
| | WFD Measure according to Art. 11 | Supplementary measure | |
| | Key Aspect/Pressure | Development of intensive eco - tourism and illegal angling | |
| | Key Type of Measure | KTM19 | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No |
| | Flood Area | ☒Yes | ☐ No |
| | Emerald site | ☒ Yes | ☐ No |
| | Other | | |

| **Description of the Measure** | **Regulation of tourism and nature-based activities and strict enforcement of Low on freshwater fishery and aquaculture** | |
|---|---|---|
| Lately Skadar Lake basin has become a fast-developing center for summer tourism. As such tourism makes strong pressure on nature resources and it has impact on surface WB. Precise regulation together with study of risks and mitigation measures action plan (implementation of such plan) will help NP “Skadar Lake” to achieve proclaimed sustainability goal and will reduce pressure on related WB. Illegal angling is the main cause of decreasing of fish population abundance in Skadar Lake. Therefore, strict enforcement of Law on Freshwater Fishery and Aquaculture as well as production of strict 6-year plan for fish population management will improve present situation. | | |
| Project Investor | Ulcinj municipality, Ministry of Agriculture and Rural Development (MARD) | |
| Investment Costs | Production of study on tourism risks and mitigation measures with action plan – 30,000 EURO; Implementation of mitigation measures with action plan – 100,000 EUROl Production of 6-year plan for fish population management – 80,000 EURO | |
| Maintenance Costs | No maintenance costs | |
| Necessity of Permit Procedure | ☐ Yes | ☒ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA; Water Administration (WA) | |
| Status of Implementation | No status | |
| Impact Assessment (significant / high / medium / low) | Medium | |
| Other Remarks | Bringing of tourism development and fishery in sustainable frame will not only improve the WB status but It will also make those activities sustainable on long term and provide opportunity for additional income | |
| Priority (first / second / third) | Second | |

| Characteristics | | Gradual canalization of waste water of rural and touristic areas along Adriatic Coast | | ID<br>AB MNE 49 |
|---|---|---|---|---|
| **Location** | Municipality | All along the Adriatic Coast (seven) | | |
| | Water body | several | | |
| | Watercourse | Adriatic Coast, Bojana River, Sasko Lake | | |
| | Surrounding Area | Rural and periurban | | |
| | WFD Measure according to Art. 11 | Basic measure | | |
| | Key Aspect/Pressure | In numerous rural and touristic settlements (weekend houses) there is no canalization of waste waters and their treatment. Water from septic tanks (often with open bottom) is percolating and infiltrating in underlying permeable rocks, flowing towards shoreleine as regional erosional base and polluting GWBs and SWBs, and sea water and beaches. | | |
| | Key Type of Measure | | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☐Yes | ☒ No | |
| | Emerald site | ☒ Yes | ☐ No | |
| | Other | | | |

| | |
|---|---|
| **Description of the Measure** | Inquiry of exisiting status, needed WTPs and canalization infrastructure, and preparation of technical documentation and design for reducing organic pollutants and nutrients |

In the immediate area of the Adriatic coast, but also in the gravitational hillside outside urban centers (rural areas) a large number of private holiday homes and unconnected tourist facilities were built since the mid-20th century, and especially intensified in the first decade of the 21st century. Most of these houses use septic tanks and no connections to sewer network. Most of the tanks are dug in shallow residual material above the limestone, highly porous rock masses and sewage are draining and infiltrating into underlying aquifers with futrher movement to coastal areas. It is necessary to, in cooperation with the municipal centers 'utility services (PUCs), record the maintenance of existing facilities (analysis of PUCs' involvement in the emptying and maintenance of pits), develop observation piezometers (at least 30) along the coast, prepare a preliminary design and build at least one pilot plant with sewage wastewater treatment system and plant in the selected settlement. This creates the conditions for the implementation of the next WWTP to ensure the construction of a sewage network with numerous smaller treatment plants, which is essential for the protection of groundwater, river and sea waters and sustainable economic and tourism development.

| | | |
|---|---|---|
| Project Investor | Ministry of Agriculture and Rural Development (MARD)<br><br>Municipalities: Ulcinj, Bar, Budva, Tivat, Kotor i Herceg Novi | |
| Investment Costs | 250,000 EURO | |
| Maintenance Costs | 100.000 EURO/an | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | |

| | |
|---|---|
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br><br>Public Enterprise for Management of Coastline<br><br>Water Administration (WA) |
| Status of Implementation | No status |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | High |
| Other Remarks | Improvement of status, increased protection of surface and groundwater by prevention of infiltration of polluted water in recipent water body |
| Priority (first / second / third) | First |

| Characteristics | | Reduction of sea water intrusion in Ulcinj and Bar coastal zones | | ID AB MNE 50 |
|---|---|---|---|---|
| **Location** | Municipality | Ulcinj, Bar | | |
| | Water body | SWB: Bojana, Sasko lake: GWB: Ulcinj polje, Mozura-Pastrovici | | |
| | Watercourse | Bojana River, Sasko Lake | | |
| | Surrounding Area | Rural | | |
| | WFD Measure according to Art. 11 | Supplementary measure | | |
| | Key Aspect/Pressure | In the Bojana delta as well as to a lesser extent in the Bar polje (field) in the coastal area, there are indications of the movement of the brackish water front inland and the salinization of surface and groundwater WBs. Increasing the use of coastal freshwater by pumping wells along naturally small riverbed gradient can intensify this salinization process. | | |
| | Key Type of Measure | | | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No | |
| | Flood Area | ☒Yes | ☐ No | |
| | Emerald site | ☒ Yes | ☐ No | |
| | Other | | | |
| **Description of the Measure** | Inquiry of exisiting status, preparation of technical documentation and design for monitoring (piezometric network and water chemistry observations). | | | |
| Establishment of a piezometer network for monitoring the water table and groundwater quality in the Adriatic coast in the wider area of the mouth of Bojana and in Barsko Polje (at least 10 piezometers) and systematic control of the use of existing wells (quantity and quality of water), introducing obligations for approving projects for the construction of future water supply facilities. Adaptation and automation of the existing gauge station at the mouth of Bojana for continuous monitoring and data transmission. | | | | |
| Project Investor | Public Enterprise for Management of Coastline<br>Municipalities: Ulcinj, Bar | | | |
| Investment Costs | 150,000 EURO | | | |
| Maintenance Costs | 15.000 EURO/an | | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No | | |
| Competent Water Authority | Ministry of Agriculture and Rural Development (MARD) | | | |
| Other Relevant Authorities | Ministry of Sustainable Development and Tourism (MSDT); EPA<br>Water Administration (WA) | | | |
| Status of Implementation | No status | | | |

| | |
|---|---|
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low) | Medium |
| Other Remarks | Improvement of status, increased protection of surface and groundwater by prevention of infiltration of salt water in recipent water body |
| Priority (first / second / third) | Second |

## Table 10. 4 Measures relating to the Skadar Sub-Basin

| ID (preliminary) | Measure | Type of Measure | | | | |
|---|---|---|---|---|---|---|
| | | Basic | Supplementary | Technical | Institutional | Legal |
| SL MNE 01 | Construction of the Wastewater Treatment Plant, Centinje | x | | x | | |
| SL MNE 02 | Extension of the Sewer Network in Cetinje | x | | x | | |
| SL MNE 03 | Feasibility Study - Rehabilitation of the Wastewater Treatment Plant, Rijeka Crnojevica | x | | | | |
| SL MNE 04 | Water Quality Guideline for Agricultural Irrigation in the Tuzi Region | | x | | x | |
| SL MNE 05 | Initiative for the Preservation of the Donja Zeta River and the Development of the Study on the Designation of the Protected Natural Value | | x | | x | |
| SL MNE 06 | Construction of a Sewer Network as part of the Virpazar-Murici Road Reconstruction | x | | x | | |
| SL MNE 07 | Feasibility Study - Construction of a Sewer Network in Boljevici, Limljani and Gluhi Do | x | | x | | |
| SL MNE 08 | Rehabilitation of the Wastewater Treatment Plant, Virpazar | x | | x | | |
| SL MNE 09 | Feasibility Study - Construction of a Sewer Network in Orahovo and Dupilo | x | | x | | |
| SL MNE 10 | Procurement of Equipment for the Use, Storage and Disposal of Plant Protection Products in the Golubovci Region | | x | | x | |
| SL MNE 11 | Farmers' Training on Handling of Pesticides | | x | | x | |
| SL MNE 12 | Designation of Natura 2000 Sites in the Sub-Basin of Skadar Lake | | x | | | x |
| SL MNE 13 | Baseline Study for the Implementation of a Third Water Protection Zone "Bolje Sestre" | x | | x | | x |
| SL MNE 14 | Management Study "Water Abstraction, Bolje Sestre" for Regional Water Supply | | x | | x | |
| SL MNE 15 | Introduction of an ID Card for the Purchase of Agrochemicals | | x | | | x |
| SL MNE 16 | Implementation of a Wastewater Charge | | x | | | x |
| SL MNE 17 | Eel Management Planning in Lake Shkodra/Skadar and Buna/Bojana River | | x | | x | |

| Characteristics | | Construction of the Wastewater Treatment Plant, Centinje | ID<br>SL MNE 01 |
|---|---|---|---|
| **Location** | Municipality | Cetinje | |
| | District | Rijeka Crnojevica | |
| | Water body | Skadar Lake Vucko Blato | |
| | Watercourse | Crnojevica River | |
| | Watercourse Code Number | | |
| | GPS Coordinates of Measure | X=6578377.003<br>Y=4693265.379 | |
| | Surrounding Area | Rural | |
| **General** | Relevant transboundary impact | ☒ Yes | ☐ No |
| | WFD Measure according to Art. 11 | Basic measure | |
| | Key Aspect/Pressure | Urban wastewater (nutrients, phosphorous, etc.) | |
| | Key Type of Measure | KTM1 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |
| | Other | | |

| Description of the Measure | Construction of the **Wastewater** Treatment Plant, Centinje |
|---|---|

Construction of a wastewater treatment plant according to the requirements of the Urban Waste Water Directive (secondary and tertiary treatment for discharge into defined sensitive areas); extension of the sewer network including a pipeline tunnel for collected wastewater from the Cetinje sewer network to the WWTP. The proposed measure will have a capacity of 20,000 PE.

| | | |
|---|---|---|
| Project Investor | Municipality of Cetinje | |
| Investment Costs | 10,000,000 € | |
| Maintenance Costs | 300,000 € – 450,000 €/year<br>The amount of annual maintenance costs is calculated based on similar services in other cities. | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Sustainable Development and Tourism (MSDT)<br>Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |

| | |
|---|---|
| Status of Implementation<br><br>(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | The location of the WWTP is defined in the Spatial Urban Plan (SUP) of Cetinje.<br><br>- Feasibility Study („Energoprojekt - Hidroinzenjering a.d." 2010)<br><br>- Detailed Design (2013)<br><br>- Tendering Design is prepared by the National Project Implementation Unit (PROCON)<br><br>(EU grants and/or other donor funds are required for investment) |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies of Skadar Lake<br><br>(significant / high / medium / low) | Significant |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Affected Tributary to Skadar Lake (significant / high / medium / low) | Significant |
| Other Remarks | Increased groundwater protection by avoiding the infiltration of used waters into the groundwater basin |
| Priority<br><br>(first / second / third) | First |

| Characteristics | | Extension of the Sewer Network in Cetinje | ID SL MNE 02 |
|---|---|---|---|
| **Location** | Municipality | Cetinje | |
| | District | Bajice, Humci and Donji Kraj | |
| | Water Body | Skadar Lake Vucko Blato | |
| | Watercourse | Rijeka Crnojevic | |
| | Watercourse Code Number | | |
| | GPS coordinates of Measure | | |
| | Surrounding Area | Urban | |
| **General** | Relevant transboundary impact | ☐ Yes | ☒ No |
| | WFD Measure According to Art. 11 | Basic measure | |
| | WFD Key Aspect/Pressure | Domestic wastewater | |
| | Key Type of Measure | KTM1 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |
| | Other | | |

| **Description of the Measure** | **Extension of the Sewer Network in Cetinje** |
|---|---|
| Only 40% (approx. 6000 PE) of the population in Cetinje is currently connected to the sewer system. The extended sewer network will cover almost 100% of the population of the Municipality. | |

| | | |
|---|---|---|
| Project Investor | Municipality of Cetinje | |
| Investment Cost | 2,200,000€ | |
| Maintenance Cost | | |
| Necessity of Permit Procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Sustainable Development and Tourism (MSDT)<br>Ministry of Agriculture and Rural Development (MARD) | |
| Other Relevant Authorities | Water Administration of Montenegro (WA) | |
| Status of Implementation<br>(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Detailed urban plans for the construction of the missing infrastructure<br>Detailed Design | |
| Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies of Skadar Lake (significant / high / medium / low) | High<br>(precondition for wastewater treatment in the proposed WWTP) | |
| Impact Assessment – improvement of the ecological or chemical status of the affected | High | |

| | |
|---|---|
| tributary to Skadar Lake (significant / high / medium / low) | |
| Other remarks | Increased groundwater protection by avoiding the infiltration of used waters into the groundwater basin |
| Priority<br><br>(first / second / third) | Second |

| Characteristics | | Feasibility Study - Rehabilitation of the Wastewater Treatment Plant, Rijeka Crnojevica | ID<br>SL MNE 03 |
|---|---|---|---|
| **Location** | Municipality | Cetinje | |
| | District | Rijeka Crnojevica | |
| | Water body | Skadar Lake Vucko Blato | |
| | Watercourse | Crnojevica River | |
| | Watercourse Code Number | | |
| | GPS Coordinates of Measure | | |
| | Surrounding Area | Rural | |
| **General** | Relevant transboundary impact | ☐ Yes | ☒ No |
| | WFD Measure according to Art. 11 | Basic measure | |
| | WFD Key Aspect/Pressure | Domestic wastewater | |
| | WFD Key Type of Measure | KTM 1 | |
| **Restrictions** | Protected Area | ☐ Yes | ☒ No |
| | Flood Area | ☐ Yes | ☒ No |
| | Other | | |

| **Description of the Measure** | **Feasibility Study – Rehabilitation of the WWTP Rijeka, Crnojevica** |
|---|---|

The derelict wastewater treatment plant at Rijeka Crnojević has been built for the needs of the former fish processing factory (AD "Ribarstvo" Rijeka Crnojević).

The village Rijeka Crnojevića with approx. 600 inhabitants has developed into a very popular tourist destination. Especially during the summer time the population triples. Furthermore, the increased activity of the restaurants during tourist season leads to increased wastewater amounts.

The water level of the river and the lake decreases during the summer season. The untreated waste water is discharged untreated near to the city, thus significantly harming the ecological system of the river and the waterbody of Vucko Blato downstream.

The public utility proposed the construction of a waste water treatment plant of a capacity to cover the permanent residents and projected number of tourists and which could be operated flexible. The capacity of the modernized WWTP will be around 2500 population equivalents (PE).

| | | |
|---|---|---|
| Project investor | Municipality of Cetinje | |
| Investment Cost | 50,000 € (for the Feasibility Study)<br><br>Necessary to estimate the construction costs for rehabilitation and extension | |
| Maintenance Costs | | |
| Necessity of permit procedure | ☒ Yes | ☐ No |
| Competent Water Authority | Ministry of Sustainable Development and Tourism (MSDT)<br><br>Ministry of Agriculture and Rural Development (MARD) | |
| Other relevant authorities | Water Administration of Montenegro (WA) | |

| | |
|---|---|
| Status of implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Desktop study without cost estimation |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | low |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake (significant / high / medium / low) | medium |
| Other remarks | |
| Priority (first / second / third) | first (feasibility study)<br>second (implementation) |

| Characteristics | | Water Quality Guideline for Agricultural Irrigation in the Tuzi Region | | ID SL MNE 04 |
|---|---|---|---|---|
| **Location** | Municipalities | Municipality of Tuzi | | |
| | Districts | ./. | | |
| | Water bodies | Skadar Lake North | | |
| | Water courses | ./. | | |
| | Code number of water course | ./. | | |
| | Surrounding area | Agricultural | | |
| **General** | Relevant transboundary impact | ☐ Yes | ☒ No | |
| | WFD Measure according to Art. 11 | Basic measure (institutional) | | |
| | Key aspect / pressure | Pesticides | | |
| | Key Type of Measure | KTM 12 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood area | ☒ Yes | ☐ No | |
| | Other | National Park | | |

| **Description of the Measure** | **Water Quality Guideline for Agricultural Irrigation in the Tuzi Region** |
|---|---|
| The current guideline does not consider quality values for water which is used for irrigation of agricultural land. A revision of the guideline is necessary to support water users and environmental authorities to establish a supervision system in the vulnerable coastal region of Skadar Lake. Because of the short groundwater passage and a possible surface run-off to Lake Skadar it is a preventative measure against discharge of contaminated (pesticides, agrochemicals etc.) water. | |
| Project investor | Municipality of Tuzi |
| Investment cost | 3,000 € |
| Maintenance | |
| Competent authority | Ministry of Agriculture and Rural Development (MARD) |
| Other relevant authorities | Water Administration of Montenegro (WA) |
| Status of implementation | Desktop Study |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake<br>(significant / high / medium / low) | Medium |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the tributary to Skadar Lake<br>(significant / high / medium / low) | |
| Priority (first / second / third) | Third |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Initiative for the Preservation of the Donja Zeta River and the Development of the Study on the Designation of the Protected Natural Value</th><th>ID<br>SL MNE 5</th></tr>
<tr><td rowspan="6">Location</td><td>Municipality</td><td colspan="3">Danilovgrad, Podgorica</td></tr>
<tr><td>District</td><td colspan="3"></td></tr>
<tr><td>Water body</td><td colspan="3">Skadar Lake North</td></tr>
<tr><td>Water course</td><td colspan="3">Rijeka Zeta and its tributaries (Sušica, Gračanica, Brestica, Rimanic stream, Bobulja, Vranjak, Masula)</td></tr>
<tr><td>Code number of water course</td><td colspan="3"></td></tr>
<tr><td>Surrounding area</td><td colspan="3">The surrounding area is characterized by natural, semi-natural and anthropogenic habitats. The greater part of the area is the valley of the Zeta River. It is a plain area from which karst hills (hills) rise in some places. Part of this area is urbanized. Two urban centres are the Danilovgrad town and the town of Spuž which are on the bank of the river Zeta. The remaining part contains uninhabited and partly inherited space. A part of the inhabited area is made up of rural settlements characterized by scattered construction.</td></tr>
<tr><td colspan="5">The procedure for the designation of Zeta river protected natural heritage was initiated pursuant to Article 28 of the Nature Protection Act ("Official Gazette of Montenegro", No. 054/16).<br><br>This measure is envisaged by the spatial planning and environmental protection reports. The aim of the measure is to protect the natural values of Zeta River and restoring its aquatic ecosystem at the state of 30 years ago. Therefore, this is a long-term management action that will be defined by the Zeta River Protection Study.</td></tr>
<tr><td rowspan="4">General</td><td>Relevant transboundary impact</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Measure according to WFD</td><td colspan="3">Supplementary measure</td></tr>
<tr><td>Key aspect / pressure</td><td colspan="3">Domestic wastewater from urban settlements Spuž and Danilovgrad<br><br>Industrial wastewater from several agriculture and stone processing facilities</td></tr>
<tr><td>Key type of Measure</td><td colspan="3"></td></tr>
<tr><td rowspan="3">Restrictions</td><td>Protected Area</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Flood area</td><td>☒ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td>Other</td><td colspan="3"></td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Initiative for the Preservation of the Donja Zeta River and the Development of the Study on the Designation of the Protected Natural Value</td></tr>
<tr><td colspan="5">The main objective of this institutional measure is the preparation of a Study of Protection for the designation of a Protected Natural Area of Zeta River, including further scientific research, and measures for the sustainable management its natural values. On the basis of the obtained results and expert assessment, its classification into the appropriate category would be carried out and proposed an adequate protection regime, in accordance with the provisions defined by the Law on Nature Protection.</td></tr>
</table>

| | |
|---|---|
| The initiative was taken by the Municipality of Danilovgrad and the capital of Podgorica and an agreement was signed on February 13, 2019.<br><br>Following the agreement, a contract on the preparation of a study of protection was signed between the Agency for Nature and Environment Protection and the Municipality of Danilovgrad.<br><br>The Agency formed a research team which is working of drafting the study to be completed by the beginning of September.<br><br>After the designation of a protected natural value, the administrative body will be established whose basic tasks will be defined by the protection study and will primarily be aimed at: establishing monitoring of protected natural assets, controlling curves and potential polluters, supplying the Zeta river and tourist valorization. | |
| Investment cost | 265,000 € |
| Maintenance | |
| Competent authority | Municipality of Danilovgrad |
| Other relevant authorities | Capital Podgorica, Environmental Protection Agency, Ministry of Sustainable Development and Tourism, Ministry of Agriculture and Rural Development, Water Administration of Montenegro (WA)<br><br>Other relevant authorities |
| Status of implementation | The procedure for protection of the river Zeta and its proclamation of a protected natural good is in progress. |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake<br><br>(significant / high / medium / low) | Medium |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the tributary to Skadar Lake<br><br>(significant / high / medium / low) | Low |
| Other remarks | |
| Priority (first / second / third) | Third |

| Characteristics | | Construction of a Sewer Network as part of the Virpazar-Murici Road Reconstruction | | ID SL MNE 6 |
|---|---|---|---|---|
| Location | Municipality | Bar | | |
| | District | Virpazar, Murici | | |
| | Water body | Skadar Lake Southwest | | |
| | Watercourse | | | |
| | Watercourse code number | | | |
| | GPS coordinates of the Measure | | | |
| | Surrounding area | Rural, coastal part of the lake | | |
| General | Relevant transboundary impact | ☐ Yes | ☒ No | |
| | WFD Measure category | Basic measure | | |
| | Key aspect / pressure | Domestic wastewater | | |
| | Key type of Measure | KTM 1 | | |
| Restrictions | Protected area | ☒ Yes | ☐ No | |
| | Flood area | ☐ Yes | ☒ No | |
| | Other | National Park Skadar Lake | | |

| **Description of the Measure** | **Construction of a Sewer Network as part of the Virpazar-Murici Road Reconstruction** |
|---|---|

In the coastal part of Skadar Lake there are several settlements that do not have permanent and high quality water supply and a connection with the sewer to Virpazar. Because of the low natural ecological functionality of the shore zone and the increasing tourism activities the Municipality plans the extension of water supply and wastewater infrastructure for this part.

The reconstruction of the Virpazar-Murici (19 km) and the sewer (as well as water supply facilities) construction should be combined using the economic synergies.

Because the Measure belongs to the sewer network to the WWTP Virpazar it is part of PoM.

| | | |
|---|---|---|
| Project investor | Municipality of Bar | |
| Investment cost | 500,000 € | |
| Maintenance | | |
| Necessity of permit procedure | ☒ Yes | ☐ No |
| Competent water authority | Ministry of Sustainable Development and Tourism (MSDT)<br>Ministry of Agriculture and Rural Development (MARD) | |
| Other relevant authorities | National Park Authority<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / | Desktop Study | |

| | |
|---|---|
| Construction Supervision / Operation and Maintenance) | |
| Impact assessment in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | Medium |
| Impact assessment in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake<br>(significant / high / medium / low) | |
| Other remarks | |
| Priority (first / second / third) | Third |

| Characteristics | | Feasibility Study - Construction of a Sewer Network in Boljevici, Limljani and Gluhi Do | ID SL MNE 7 |
|---|---|---|---|
| **Location** | Municipality | Bar | |
| | District | Boljevici, Limljani, Gluhi Do | |
| | Water body | Skadar Lake Southwest | |
| | Watercourse | | |
| | Code number of watercourse | | |
| | GPS coordinates of the Measure | | |
| | Surrounding area | National Park, rural | |
| **General** | Relevant transboundary impact | ☐ Yes ☒ No | |
| | Measure according to WFD | Basic measure | |
| | Key aspect / pressure | Domestic waste water | |
| | Key type of Measure | KTM 1 | |
| | Protected Area | ☒ Yes | |
| | Flood area | ☒ Yes (partly) | |
| **Restrictions** | | | |
| | Other | National Park | |

| **Description of the Measure** | **Feasibility Study - Construction of a Sewer Network in Boljevici, Limljani and Gluhi Do** |
|---|---|

Currently, the drainage of sewage from facilities in the area (< 500 p.e. ) is carried out in an improvised manner, mostly with individual sewers-absorbent wells. These constitute a direct threat to the surrounding area.

The construction of a sewerage network at the mentioned site would prevent the percolation of sewage from inadequate septic tanks via the groundwater passage into the lake.

The feasibility study should show if the extension of the sewer network and treatment in the WWTP Virpazar is a more cost-efficient solution than a decentralized wastewater treatment facility.

Because the measure belongs to the sewer network to the WWTP Virpazar it is part of the PoM.

Because of the hydrogeological conditions and low natural buffer capacities the area is assessed to be a sensitive area according to the Urban Wastewater Directive.

| | | |
|---|---|---|
| **Project investor** | Municipality of Bar status? Timeline? | |
| **Estimated? investment cost** | 50.000 € | |
| **Maintenance** | ./ | |
| **Necessity of permit procedure** | ☒ Yes | ☐ No |
| **Competent water authority** | Ministry of Sustainable Development and Tourism (MSDT) Ministry of Agriculture and Rural Development (MARD) | |
| **Other relevant authorities** | National Parks, Water Directorate, Environmental Protection Agency, Water Administration of Montenegro (WA) | |

| | |
|---|---|
| **Status of implementation** (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Desktop Study |
| **Impact assessment** in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | Medium |
| **Impact assessment** in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake (significant / high / medium / low) | ./. |
| Other remarks – why in front? | |
| **Priority** (first / second / third) | Third |

| Characteristics | | Rehabilitation of the Wastewater Treatment Plant, Virpazar | | ID<br>SL MNE 8 |
|---|---|---|---|---|
| Location | Municipality | Bar | | |
| | District | Virpazar | | |
| | Water body | Skadar Lake Southwest, Skadar Lake Pelagic Zone | | |
| | Watercourse | ./. | | |
| | Code number of watercourse | ./. | | |
| | GPS coordinates of the Measure | | | |
| | Surrounding area | National Park Skadar Lake | | |
| General | Relevant transboundary impact | ☐ Yes | ☒ No | |
| | Measure according to WFD<br>(Basic Measure / Supplementary Measure) | Basic Measure | | |
| | WFD Key Aspect/Pressure | Domestic wastewater | | |
| | WFD Key Type of Measure | KTM1 | | |
| Restrictions | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☒ Yes | ☐ No | |
| | Other | National Park | | |

| **Description of the Measure** | **Rehabilitation of the Wastewater Treatment Plant, Virpazar** | |
|---|---|---|
| Project investor | Municipality of Bar | |
| Investment cost | 50.000 € (Feasibility Study)<br>Construction cost cannot be estimated before it is clear which parts of existing facilities can be used | |
| Maintenance | Estimate after Detailed Design | |
| Necessity of permit procedure | ☒ Yes | ☐ No |
| Competent water authority | Ministry of Sustainable Development and Tourism (MSDT) Ministry of Agriculture and Rural Development (MARD) | |
| Other relevant authorities | National Park Authority, Environmental Protection Agency, Water Administration of Montenegro (WA) | |
| Status of implementation<br>(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Desktop study | |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake | High | |

| | |
|---|---|
| (significant / high / medium / low) | |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake<br><br>(significant / high / medium / low) | |
| Other remarks | |
| Priority<br><br>(first / second / third) | First (Feasibility Study)<br><br>Second (implementation) |

| Characteristics | | Feasibility Study - Construction of a Sewer Network in Orahovo and Dupilo | | ID<br>SL MNE 9 |
|---|---|---|---|---|
| **Location** | Municipality | Bar | | |
| | District | Orahovo, Dupilo | | |
| | Water body | Skadar Lake Southwest, Skadar Lake Vucko Blato | | |
| | Watercourse | | | |
| | Code number of watercourse | | | |
| | GPS coordinates of the Measure | | | |
| | Surrounding area | Rural, partly National Park | | |
| **General** | Relevant transboundary impact | ☐ Yes ☒ No | | |
| | Measure according to WFD | Basic measure | | |
| | WFD Key Aspect /Pressure | Domestic wastewater | | |
| | WFD Key Type of Measure | KTM1 | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood Area | ☒ Yes (partly) | ☐ No | |
| | Other | National Park (partly) | | |

| **Description of the Measure** | **Feasibility Study - Construction of a Sewer Network in Orahovo and Dupilo** |
|---|---|

**Construction of the sewer network in Orahovo and Dupilo (Feasibility Study)**

The settlements, which are < 250 PE have no sanitary infrastructure yet.

The subject area is mostly covered by? the Spatial Plan of Special Purpose Areas for the Coastal Zone of Montenegro until 2030.

Because of significance of the Vucko Blato water body for drinking water abstraction, protection measures against pollution from wastewater are necessary. Before measures can be designed a Feasibility Study has to be elaborated, including a risk assessment concerning drinking water supply.

| | | |
|---|---|---|
| Project investor | Municipality of Bar | |
| Investment cost | 20,000 € | |
| Maintenance | N/A | |
| Necessity of permit procedure | ☒ Yes | ☐ No |
| Competent water authority | Ministry of Sustainable Development and Tourism (MSDT) Ministry of Agriculture and Rural Development (MARD) | |
| Other relevant authorities | National Parks, Water Directorate<br>Environmental Protection Agency<br>Water Administration of Montenegro (WA) | |
| Status of implementation<br>(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / | Desktop Study | |

| | |
|---|---|
| Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | Low |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake<br>(significant / high / medium / low) | |
| Other remarks | |
| Priority (first / second / third) | Second |

<table>
<tr><th colspan="2">Characteristics</th><th colspan="2">Procurement of Equipment for the Use, Storage and Disposal of Plant Protection Products in the Golubovci Region</th><th>ID<br>SL MNE 10</th></tr>
<tr><td rowspan="7">Location</td><td>Municipality</td><td colspan="3">Municipality within the Capital - Golubovci</td></tr>
<tr><td>District</td><td colspan="3">Central</td></tr>
<tr><td>Water body</td><td colspan="3">Skadar Lake North</td></tr>
<tr><td>Watercourse</td><td colspan="3">./.</td></tr>
<tr><td>Code number of watercourse</td><td colspan="3">./.</td></tr>
<tr><td>GPS coordinates of the Measure</td><td colspan="3"></td></tr>
<tr><td>Surrounding area</td><td colspan="3">Rural</td></tr>
<tr><td rowspan="4">General</td><td>Relevant transboundary impact</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td>Measure according to WFD</td><td colspan="3">Supplementary Measure</td></tr>
<tr><td>WFD Key Aspect/Pressure</td><td colspan="3">Pesticides, fungicides</td></tr>
<tr><td>WFD Key Type of Measure</td><td colspan="3">KTM 3</td></tr>
<tr><td rowspan="3">Restrictions</td><td>Protected Area</td><td>☒ Yes (partly)</td><td colspan="2">☐ No</td></tr>
<tr><td>Flood area</td><td>☒ Yes (partly)</td><td colspan="2">☐ No</td></tr>
<tr><td>Other</td><td colspan="3">National Park</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Procurement of Equipment for the Use, Storage and Disposal of Plant Protection Products in the Golubovci Region</td></tr>
<tr><td colspan="5">Procurement of cabinets for storage of unused and used plant protection products, as well as procurement of equipment for the protection against harmful effects when using pesticides.<br><br>This project involves the education of agricultural producers in terms of the implementation of plant protection treatments, and the behavior of packaging and its storage. In addition, there would be records of the use of plant protection products (diary).</td></tr>
<tr><td colspan="2">Project investor</td><td colspan="3">Municipality within the Capital - Golubovci</td></tr>
<tr><td colspan="2">Investment cost</td><td colspan="3">10,000 €</td></tr>
<tr><td colspan="2">Maintenance</td><td colspan="3">5,000 € / year</td></tr>
<tr><td colspan="2">Necessity of permit procedure</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td colspan="2">Competent authority</td><td colspan="3">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="2">Other relevant authorities</td><td colspan="3">Water Administration of Montenegro (WA)</td></tr>
<tr><td colspan="2">Status of implementation<br><br>(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)</td><td colspan="3">Desktop study</td></tr>
</table>

| | |
|---|---|
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake<br><br>(significant / high / medium / low) | Medium |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake<br><br>(significant / high / medium / low) | Medium |
| **Other remarks** | |
| **Priority** (first / second / third) | Third |

<table>
<tr><th colspan="3">Characteristics</th><th colspan="2">Farmers' Training on Handling of Pesticides</th><th>ID<br>SL MNE 11</th></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="4">General</td><td colspan="2">Relevant transboundary impact</td><td>☐ Yes</td><td colspan="2">☒ No</td></tr>
<tr><td colspan="2">Measure according to WFD</td><td colspan="3"></td></tr>
<tr><td colspan="2">Key aspect / pressure</td><td colspan="3">Pesticides, fertilizers</td></tr>
<tr><td colspan="2">Key type of Measure</td><td colspan="3">KTM 12</td></tr>
<tr><td rowspan="3">Restrictions</td><td colspan="2">Protected Area</td><td>☐ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Flood area</td><td>☐ Yes</td><td colspan="2">☐ No</td></tr>
<tr><td colspan="2">Other</td><td colspan="3"></td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="4">Farmers' Training on Handling of Pesticides</td></tr>
</table>

**Legal base:**

Rulebook on the program of the specialized course for plant protection products (Official Gazette of Montenegro, No. 35/15)

National Plan for the Sustainable Use of Plant Protection Products ("Official Gazette of Montenegro", No. 57/16)

5.3 Specialist Course

5.3.1 Activity: Authorization of institutions for conducting a specialized course

5.3.2 Activity: Preparation of material for a specialized course or education users and distributor of pesticides5.3.3 Activity: Control of authorized institutions for specialized course5.3.4 Activity: Creation of a database of pesticide users with completed specialized course

**Objective:**

Strengthening awareness in the use of pesticides and other agrochemicals

**Competent institution for Implementation:**

The Biotechnical Faculty and Phytosanitary Service, the Food Safety Administration

**Content of trainings:**

B 1: Plant protection

B.2. Good agricultural practice for plant protection products

B.3. Risks when using plant protection products

B.4. Measures for risk reduction

B.5. Storage and handling of plant protection products

B.6. Devices for the use of plant protection products

B.7. First Aid Measures

B.8. Waste management (plant protection products as waste)

B.9. Regulations and keeping prescribed records

| B.10. Practical teaching | | |
|---|---|---|
| Project investor | Ministry of Agriculture and Rural Development | |
| Investment cost | N/A | |
| Maintenance | N/A | |
| Necessity of permit procedure | ☐ Yes | ☒ No |
| Competent water authority | Ministry of Agriculture and Rural Development | |
| Other relevant authorities | Biotechnical Faculty, Phytosanitary Service, Water Administration of Montenegro (WA) | |
| Status of implementation<br>(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Desktop study | |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | High | |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake<br>(significant / high / medium / low) | High | |
| Other remarks | | |
| Priority (first / second / third) | Second | |

| Characteristics | | Designation of Natura 2000 Sites in the Sub-Basin of Skadar Lake | ID SL MNE 12 |
|---|---|---|---|
| **Location** | Municipalities | Bar, Podgorica, Tuzi, Cetinje, Ulcinji | |
| | Districts | | |
| | Waterbodies | All water bodies of Skadar Lake | |
| | Watercourses | | |
| | Code number of watercourse | | |
| | Surrounding area | National Park Skadar Lake | |

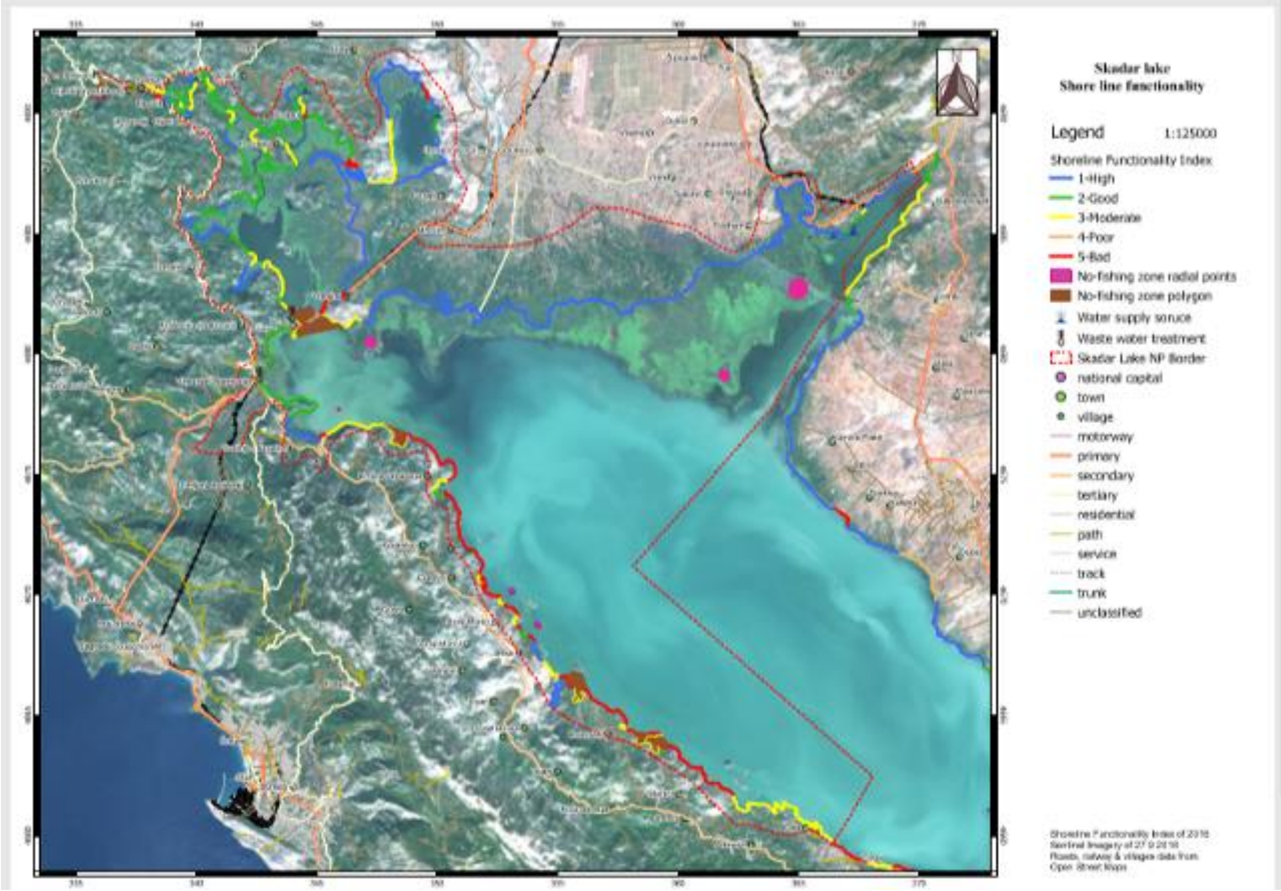


Figure 1: Area of possible Natura 2000 sites

| | | | |
|---|---|---|---|
| **General** | Relevant transboundary impact | ☐ Yes | ☒ No |
| | WFD Measure according to Art. 11 | Basic measure | |
| | WFD Key Aspect/Pressure | | |
| | WFD Key Type of Measure | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No |
| | Flood area | ☒ Yes | ☐ No |
| | Other | National Park Skadar Lake | |
| **Description of the Measure** | **Designation of Natura 2000 Sites in the Sub-Basin of Skadar Lake** | | |

| | |
|---|---|
| The process of the designation of Natura 2000 sites has been initiated by the Ministry of Sustainable Development and Tourism in coordination with the Nature and Environmental Protection Agency.<br><br>With the support of CSBL project, NEPA is working on developing the Reference List and Habitat Mapping for Lake Skadar. The process is expected to be completed by December 2019.<br><br>Because of the sensitive ecological system (terrestrial and aquatic) in the sub-basin the environmental objectives of the future Natura 2000 site management plan and the river basin management plan should be agreed to use the synergy effect and to avoid conflictive environmental objectives. | |
| Project investor | Ministry of Sustainable Development and Tourism/GIZ CSBL |
| Investment cost | 50,000 € (Phase 1) |
| Maintenance | NEPA |
| Competent Authority | Ministry of Sustainable Development and Tourism |
| Other relevant Authorities | NEPA, National Park Administration, Water Administration of Montenegro (WA) |
| Status of implementation | Habitat Mapping ongoing |
| Assessment of the impact according the improvement of the ecological or chemical status of the water bodies of Skadar Lake<br><br>(significant/ high /medium/ low ) | |
| Assessment of the impact according the improvement of the ecological or chemical status of the tributary to Skadar Lake<br><br>(significant/ high /medium/ low ) | |
| Other remarks | Use of synergies between WFD measures and NATURA 2000 measures |
| Priority | Second |

| Characteristics | | | Baseline Study for the Implementation of a Third Water Protection Zone “Bolje Sestre” | ID<br>SL MNE13 |
|---|---|---|---|---|
| **Location** | | Municipalities | Podgorica | |
| | | Districts | Water source ‘’Bolje Sestre’’ | |
| | | Water bodies | Skadar Lake, Malo Blato Gulf | |
| | | Water courses | | |
| | | Code number of water course | | |
| | | Surrounding area | Rural | |
| **General** | Relevant transboundary impact | | ☐ Yes | x No |
| | Measure according to Article 11 WFD | | Basic measure | |
| | Key aspect / pressure | | Domestic waste water | |
| | Key Type of Measure | | KTM 13 | |
| **Restrictions** | Protected Area | | ☐Yes | ☐ No |
| | Flood area | | ☐Yes | ☐ No |
| | Other | | | |

| **Description of the Measure** | **Baseline Study for the Implementation of a Third Water Protection Zone “Bolje Sestre”** |
|---|---|

The establishment of the third water protection zone is a legal obligation to the user of the water springs for public water supply.

The baseline study is necessary to define the catchment area of the natural reservoir and identify the possible impacts to the water quality which is probably result of underground water flow from alluviums of Moraca and Cijevna.

This measure is important to achieve a good water status of the water bodies of Lake Skadar.

Furthermore, according to Article 7 WFD the necessary protection of the water bodies which are used for water abstraction intended for human consumption (> 10 $m^3$/day and > 50 persons) has to be ensured.

The aim of the protection is to avoid deterioration in order to reduce the level of purification treatment required in the production of drinking water.

| | |
|---|---|
| Project investor | PE “Regional waterworks for Montenegrin coast” |
| Investment cost | 130,000 € |
| Maintenance | |
| Competent authority | Ministry for Agriculture and Rural Development (MARD) |
| Other relevant authorities | Water Administration of Montenegro (WA) |
| Status of implementation | Tendering design<br><br>Signing of the contract under IPA INTERREG Italy-Albania-Montenegro program is expected by the end of March, and the tender procedure will start by the end of December 2019. |

| | |
|---|---|
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake<br><br>(significant / high / medium / low) | High |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the tributary to Skadar Lake<br><br>(significant / high / medium / low) | Medium |
| Other remarks | |
| Priority (first / second / third) | Second |

| Characteristics | | Management Study “Water Abstraction, Bolje Sestre” for Regional Water Supply | | ID<br>SL MNE 14 |
|---|---|---|---|---|
| **Location** | Municipalities | Podgorica | | |
| | Districts | Water source ‘’Bolje Sestre’’ | | |
| | Water bodies | Skadar Lake, Malo Blato Gulf | | |
| | Water courses | | | |
| | Code number of water course | | | |
| | Surrounding area | Rural | | |
| **General** | Relevant transboundary impact | ☐ Yes | ☐ No | |
| | WFD Measure according to Article 11 | Supplementary measure | | |
| | Key aspect / pressure | Overuse of natural resource | | |
| | Key Type of Measure | KTM 13 | | |
| **Restrictions** | Protected Area | ☐ Yes | ☐ No | |
| | Flood area | ☐ Yes | ☐ No | |
| | Other | | | |

| **Description of the Measure** | **Management Study “Water Abstraction, Bolje Sestre” for Regional Water Supply** |
|---|---|

Bolje Sestre is a natural water reservoir used by the Regional water utility of Montenegrin Coast as a water supply source.
According to the WFD Principle of the Non-Deterioration an assessment to balance the quality of water use is required to ensure that water quality is not harmed.

The study has to consider natural changes in the water balance and the possible impact from the activities in adjacent GWB Zeta Valley and climate change.

| | |
|---|---|
| Project investor | PE “Regional waterworks for Montenegrin coast” |
| Investment cost | 100,000 € |
| Maintenance | To be assessed € / year |
| Competent water authority | Ministry of Agriculture and Rural Development (MARD) |
| Other relevant authorities | Ministry of Health<br>Water Administration of Montenegro (WA) |
| Status of implementation | Signing of the contract under IPA INTERREG Italy-Albania-Montenegro program is expected by the end of March, and the tender procedure will start by the end of December 2019. |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake<br>(significant / high / medium / low) | medium |

| | |
|---|---|
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the tributary to Skadar Lake<br><br>(significant / high / medium / low) | ./. |
| Other remarks | |
| Priority (first / second / third) | third |

<table>
<tr><th colspan="3">Characteristics</th><th>Introduction of an ID Card for the Purchase of Agrochemicals</th><th>ID<br>SL MNE 15</th></tr>
<tr><td colspan="5">Legal Base:<br>- Law on Plant Protection Products ("Official Gazette of Montenegro", No. 51/08, 40/11 and 18/14 (Article 8) in connection with Ordinance on the manner of issuing and appearance of the identity card for the professional use of plant protection products ("Official Gazette of Montenegro", No. 67/15 and 84/17)<br>- National Plan for the Sustainable Use of Plant Protection Products ("Official Gazette of Montenegro", No. 57/16)<br>5.2.4 Activity: Professional training of persons responsible for the marketing of pesticides;<br>5.3 Specialist course<br>5.3.1 Activity: Authorization of institutions for conducting a specialized course<br>5.3.2 Activity: Preparation of materials for specialized course or education of users and distributor of pesticides<br>5.3.3 Activity: Control of authorized institutions for specialist course<br>5.3.4 Activity: Creation of a database of pesticide users with a specialized course</td></tr>
<tr><td rowspan="4">General</td><td colspan="2">Relevant transboundary impact</td><td>☐ Yes</td><td>☒ No</td></tr>
<tr><td colspan="2">Measure according to WFD</td><td colspan="2">supplementary measure</td></tr>
<tr><td colspan="2">Key aspect / pressure</td><td colspan="2">Pesticides, fungicides</td></tr>
<tr><td colspan="2">Key type of Measure</td><td colspan="2">KTM 12</td></tr>
<tr><td rowspan="3">Restrictions</td><td colspan="2">Protected Area</td><td>☐ Yes</td><td>☐ No</td></tr>
<tr><td colspan="2">Flood area</td><td>☐ Yes</td><td>☐ No</td></tr>
<tr><td colspan="2">Other</td><td colspan="2">./.</td></tr>
<tr><td colspan="2">Description of the Measure</td><td colspan="3">Introduction of an ID Card for the Purchase of Agrochemicals</td></tr>
<tr><td colspan="5">The ID-card would be an obligation for everybody who handles agrochemicals. It will be a base for a system of purchase control. Only customers with the ID card could buy agrochemicals.<br>A certified training for the use of agrochemicals will be a precondition to get the ID-card. The cards would have a bar code, which would serve to transfer data to the system.<br>Following activities/resources are necessary:<br>• identification of users for training (state, pharmacy)<br>• consultants, NGOs, media<br>• organizing the trainings (training materials, premises, training equipment)<br>• issuing certificates<br>• printing the ID Cards</td></tr>
<tr><td colspan="3">Project investor</td><td colspan="2">Ministry of Agriculture and Rural Development (MARD)</td></tr>
<tr><td colspan="3">Investment cost</td><td colspan="2">./. (costs would be paid by the ID users)</td></tr>
</table>

| | |
|---|---|
| Maintenance | ./. (costs would be paid by the ID users) |
| Competent authority | Ministry of Agriculture and Rural Development (MARD) |
| Other relevant authorities | Food Safety, Veterinary and Phytosanitary Administration, Phytosanitary Inspection, Biotechnical Faculty, Water Administration of Montenegro (WA) |
| Status of implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Operation and Maintenance |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | medium |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake (significant / high / medium / low) | medium |
| Other remarks | ./. |
| Priority (first / second / third) | second |

| Characteristics | Implementation of a Wastewater Charge | ID<br>SL MNE 16 |
|---|---|---|

**Foreword Water Framework Directive**

**.....**

(38) The use of economic instruments by Member States may be appropriate as part of a programme of measures. The principle of recovery of the costs of water services, including environmental and resource costs associated with damage or negative impact on the aquatic environment should be taken into account in accordance with, in particular, the polluter-pays principle. An economic analysis of water services based on long-term forecasts of supply and demand for water in the river basin district will be necessary for this purpose.

Objectives of the waste water charge

- Construction and modernization of waste water treatment plants
- Improvement and further development of waste water treatment technologies
- Accurate operation of waste water treatment plants
- Reduction of waste water volume (e.g. industrial production, rehabilitation of sewer system)

The Waste Water Charge" is economic steering instrument beside the water law.

The group subject to such charges includes those who directly discharge waste water into rivers and lakes (municipalities, industry, fish farms etc.)

Producers of direct discharges must pay at least part of the costs for using water as an environmental medium

Charges are based on the amounts of substances and their harmfulness

Differences between waste water charge and waste water fee

- Fee is paid by water consumers
- Fee is paid to the waste water enterprises for collecting and treatment of waste water
- Fee must be cost-covering
- Charge is paid by the waste water discharger
- Charge is part of the fee
- Amount of charge depends of the standard of waste water treatment

The waste water charge may only be used for investments of the dischargers to improve water quality and could also adopted as a legal measure into the PoM.

| | | | |
|---|---|---|---|
| **General** | Relevant transboundary impact | ☐ Yes | ☒ No |
| | Measure according to WFD | supplementary measure | |
| | Key aspect / pressure | domestic and industrial waste water | |
| | Key type of Measure | KTM 9, KTM 10 | |

| **Description of the Measure** | **Implementation of a Wastewater Charge** |
|---|---|
| Project investor | Ministry of Agriculture and Rural Development (MARD) |
| Investment cost | ./. (costs would be paid by waste water discharges) |

| | |
|---|---|
| Maintenance | ./. (costs would be paid by waste water discharges) |
| Competent authority | Ministry of Agriculture and Rural Development (MARD) |
| Other relevant authorities | Ministry of Finance , Water Administration of Montenegro (WA) |
| Priority (first / second / third) | second |

| Characteristics | | Eel Management Planning in Lake Shkodra/Skadar and Buna/Bojana River | | ID SL MNE 17 |
|---|---|---|---|---|
| **Legal Basis:**<br>• European Eel Regulation EC 1100/2007, Article 2<br>• Council of the European Union Joint declaration on strengthening the recovery of European Eel, Interinstitutional file 2017/0287 (NLE)<br>• EU Water Framework Directive<br>Composition, abundance and age structure of fish fauna is one quality element to assess the ecological status of the water bodies | | | | |
| **General** | Relevant transboundary impact | ☒ Yes | ☐ No | |
| | Measure according to WFD | Supplementary Measure | | |
| | Key aspect / pressure | Spawning stock of eel outside safe biological limits, recruitment deficiency | | |
| | Key type of Measure | | | |
| **Restrictions** | Protected Area | ☒ Yes | ☐ No | |
| | Flood area | ☒ Yes | ☐ No | |
| | Other | National Park | | |
| **Description of the Measure** | **Eel Management Planning in Lake Shkodra/Skadar and Buna/Bojana River** | | | |

Eel management planning, specify and implement measures to reduce anthropogenic mortality and increase silver eel escapement

The European eel (*Anguilla anguilla*) is part of the native fish fauna in Lake Shkodra/Skadar catchment and has been of great economic importance. The species has experienced a drastic decline in stock abundance all over its natural distribution range, including Lake Shkodra/Skadar. In order to aid stock recovery, the European Eel Regulation EC 1100/2007 was put into effect by the European Council. Under this regulation, member states exhibiting natural habitats for the European eel on their territory are obliged to prepare Eel Management Plans containing appropriate measures to safeguard the escapement of a silver eel target biomass and to reduce anthropogenic mortalities.

In 2019, based on the request of the riparian partner countries Albania and Montenegro, the GIZ CSBL project started an initiative to support the preparation of Eel Management Planning including capacity building and implementation of data collection and monitoring.

The Eel Management Plan will then be finalized and commissioned to the European Commission under the responsibility of MARD for the Montenegrin part.

Time frame: CSBL support until 2020, Eel Management Plan to be finalized and commissioned until 2021

Effort: workload of 1 year for 2 scientists

| | |
|---|---|
| Project investor | Ministry of Agriculture and Rural Development (MARD) in co-operation with directorate for fishery of the Ministry for Agriculture in Albania |
| Investment cost | 100,000- € |
| Maintenance | ./. |
| Competent authority | Ministry of Agriculture and Rural Development (MARD) |
| Other relevant authorities | University of Montenegro<br>Water Administration of Montenegro (WA) |
| Status of implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance) | Operation (inventory, investigations in context with CSBL)<br>Tendering Design (Eel Management Plan) |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the water bodies of Skadar Lake (significant / high / medium / low) | High |
| Assessment of the impact in terms of an improvement of the ecological or chemical status of the affected tributary to Skadar Lake (significant / high / medium / low) | High |
| Other remarks | |
| Priority (first / second / third) | First |

# 11 NATIONAL STRATEGIC OBJECTIVES AND LINKAGE TO THE ADRIATIC RBMP

In order to achieve gradual and complete transposition and implementation of the entire EU acquis for Chapter 27 - Environment and Climate Change, Montenegro adopted in 2016 the National Strategy with Action Plan for transposition, implementation and enforcement of the EU acquis on Environment and Climate Change 2016-2020, which is in line with the UN sustainable development goals[247]. Furthermore, with respect to water, in accordance with Article 21 of the Water Act, the objective of the Water Management Strategy[248] is designed to achieve a unified and fully harmonized water regime in the territory of the Adriatic River Basin, which can be defined by the following:

- Creating a legal framework for the efficient functioning of the water sector
- Ensuring economic stability, which enables a sustainable development of the water sector
- Ensuring sufficient quantities of water of adequate quality for water supply of the population and all needs of the economy
- Protection of the population and material goods from floods and other forms of harmful effects of water
- Landscaping of the basins in order to protect the water management and other systems, as well as the environment protection
- Protection of waters and achieving good water status in order to protect and improve the environment and improve the state of biodiversity
- Establishment of measurement, management and IT support for the implementation of all water management goals
- Defining the connectivity and interdependence of all plans in the area of water with the requirements of spatial planning and preservation and protection of the environment, and vice versa, providing more reliable planning for locating other facilities and systems, respecting the criteria, limitations and opportunities arising from the water infrastructure
- Organizing the water sector in a way to be able to successfully implement the concept of integrated water resources management, in the context of managing all resources that depend on water and the water sector
- Involvement of the public in the process of adopting strategic guidelines for the development of integral water management schemes
- Provide a clear platform for all forms of international water cooperation with neighbouring countries, as well as with all other countries in the process of joining the EU.

As detailed in the Water Management Strategy, the management of water, which is in line with the objectives of the WFD, is based on the key principles of water management, water quantity, water quality, water information, water risks, water economics, sustainable development and public participation. The key principles are shown in Table 11.1 in relation to the main results to be achieved, the means of verification, the responsible authorities involved and recommendations for the RBMP.

[247] https://sustainabledevelopment.un.org/sdgs

[248] Stra Tegija Upra Vljanja Vodama Crne Gore, December, 2015

## Table 11.1 Key Principles of the strategic objectives for the Adriatic River Basin

| Strategic Objectives | Main results | Verification | Responsible Authorities | Recommendations for the RBMP | Related SDGs[249] |
|---|---|---|---|---|---|
| **Water Management** | | | | | |
| • Integrity - processes in nature, which is an important component of water, as well as the interconnection and interdependence of aquatic ecosystems and ecosystems in the coastal area should not be impaired<br>• Continuous management at all levels of planning and phases of planned use and protection<br>• Monitor and evaluate water governance implementation where appropriate, share the results with the public | • Clear policies and the implementation of RBMPs which aim to have measurable objectives within the predefined timeframe and on an appropriate scale, a clear task assignment for the responsible authorities, based on a sound monitoring and evaluation<br>• Transparency across water policies, water institutions and water governance frameworks for greater accountability and trust in decision-making | • Legislation, Ministerial Orders, decisions and sub-legal acts<br>• The legislation and regulations are harmonized with the EU.<br>• Internally or externally produced monitoring reports | MARD<br>WA<br>MSDT | • Ensure specific functions and capacities of all water related public institutions as per the water strategy<br>• Ensure all relevant daughter directives of the WFD are transposed into national legislation<br>• Undertake all WFD requirements and recommendations related to environmental objectives, compliant monitoring programmes<br>• Initiate transboundary technical working groups for monitoring of surface and groundwaters<br>• Develop structured educational and training programmes for staff in all public institutions involved in water management activities as per national regulations | 6.1<br>6.2<br>6.4<br>6.5<br>6.6<br>6.B<br>16.7 |

[249] Sustainable Development Goals

| Strategic Objectives | Main results | Verification | Responsible Authorities | Recommendations for the RBMP | Related SDGs[249] |
|---|---|---|---|---|---|
| **Water Quality** | | | | | |
| • Long-term protection of quality and all-consuming use of available water sources<br>• Irreplaceable water as a resource and conditions of existence - water as a natural public good can be used only in a way that does not endanger its substance and does not exclude its natural roll<br>• Long-term protection of quality and all-consuming use of available water sources<br>• The right to protection against harmful effects of water (protection of the population and its property), while respecting natural processes, protection of natural values and economic justification of protection | • Decreasing pollution, eliminating discharges and reducing the amount of materials and dangerous chemicals that are thrown away<br>• Implementation of proposed measures in the RBMP, which includes UWWT plant construction and sewage networks, repositioning of landfill and waste repository centers, improvements in fish farming procedures etc.<br>• Proposed measures in compliance with the EU legislation for climate change<br>• A practical document (legal regulation) which defines the water quality standards for chemical, biological and also defines the protocol for hydromorphological monitoring. | • Implementing the programme of measures in % and in reference to the proposed time schedule.<br>• Internally or externally produced monitoring reports<br>• Respective legal regulations, which include WFD compliant methodologies for chemical analysis, biological monitoring (5 groups) and hydromorphological assessment. | MARD<br>WA<br>MH<br>IPH<br>IHMS<br>EPA<br>IMB | • Establishment of all water protection zones (1,2, and 3) of the water springs for public water supply.<br>• Designation of vulnerable zones<br>• The designation of a ‘reference laboratory’ with respect to sampling and chemical analysis to meet the EQS Directive requirements to gain international accreditation<br>• Undertake further technical training for sampling, analysis and reporting of biological quality elements according to WFD guidelines<br>• Define legal regulations for chemical analysis, biological monitoring and supporting hydromorphological assessment<br>• Improve regulatory enforcement capacity<br>• Undertake ‘realistic’ monitoring programme for surface and groundwaters, taking into account the current technical abilities to conduct WFD compliant monitoring with | 6.3<br>6.6<br>15.1 |

| Strategic Objectives | Main results | Verification | Responsible Authorities | Recommendations for the RBMP | Related SDGs[249] |
|---|---|---|---|---|---|
| | | | | respect to technical ability, instrumentation and training requirements | |
| **Water Quantity** | | | | | |
| • Sustainable development, which, in order to meet the needs of the present, does not jeopardize the ability of future generations to meet their needs<br>• Fair and sustainable use of all water resources is provided, serving to all interests, including the protection of ecosystems | • Efficient and equal water allotment and distribution and a considerable increase in water use efficiency in all sectors and providing sustainable withdrawal<br>• Clear understanding and planning for irrigation and environmental (ecological) water requirements. | • Internally or externally produced reports | MSDT<br>IHMS | • Undertake environmental flow analysis on all surface water bodies during the next RBMP cycle<br>• Further develop hydrological model for use in development of future water balance scenarios for short and longer-term planning in all sub-basins of the River Basin | 6.1<br>6.6<br>6.B<br>15.1 |
| **Water Information** | | | | | |
| • Integration of the water system, based on integral water management, within a single water area, in accordance with the development of Montenegro, with the establishment of a unique water information system and respect for international agreements, especially with regard to sustainable water | • A better knowledge of all water resources as a public knowledge base for integrated water management for policy decision-making<br>• International data sharing with the Sava Commission and the ICPDR | • A fully developed and implemented water information system compatible with international and national information databases | WA<br>EPA<br>IHMS<br>IMB | • Develop procedures for data recording into the water information system for Montenegro and also for data analysis and reporting as required by the EEA<br>• Apply regulations to waterworks and concessionaires to measure and provide data on groundwater quantity and quality | 6.A<br>12.8 |

| Strategic Objectives | Main results | Verification | Responsible Authorities | Recommendations for the RBMP | Related SDGs[249] |
|---|---|---|---|---|---|
| management of the countries from the international river basin | • National data sharing with the Environmental information system and the IHMS information system | | | | |
| **Risk Management** | | | | | |
| • Risks emerging from water (floods and droughts) are contained through management and investments | • Reinforced resistance and capacities for adaptations to climate developments, natural risks and disasters | • Flood Risk Management Plans<br>• Drought Management Plans | MARD<br>WA<br>IHMS<br>MI<br>MH<br>Municipalities | • The implementation of EU Floods Directive<br>• Capacity building and the provision of funding for designing and implementing plans | 13.1<br>13.2<br>13.3<br>15.3 |
| **Public Participation** | | | | | |
| • Enable appropriate participation of the population and other stakeholders in the adoption of water management plans | • Effective mechanisms for public consultations an in decision-making processes | • Internally or externally produced reports | MARD | • Undertake the proposed actions included in the RBMP in order to provide information to all stakeholders<br>• Ensure public participation and feedback in all issues related to water resource management | 6.B |

In order to clarify the specific actions required for the Adriatic River Basin, it is imperative that a clear plan of action for all relevant stakeholders is outlined in order to monitor the progress during the first RBMP cycle, which for the Adriatic River Basin would be expected to start in 2021.

Table 11.2 outlines the 6 year action plan for the first RBMP cycle to be managed by the MARD, who are the official Competent Authority.

### Table 11.2 First 6-Year action plan

| Main Task | Responsibility | Timeframe | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
| **Water Management** | | | | | | | |
| Ensure specific functions and capacities of all water related public institutions as per the water strategy | MARD<br>WA | √ | √ | √ | | | |
| Ensure all relevant daughter directives of the WFD are transposed into national legislation | MARD<br>MSDT | √ | | | | | |
| Undertake all WFD requirements and recommendations related to environmental objectives, compliant monitoring programmes | IHMS<br>WA<br>IPH<br>IMB | √ | √ | √ | √ | √ | √ |
| Initiate transboundary technical working groups for monitoring of surface and groundwaters | MARD<br>WA | √ | | | | | |
| Develop structured on-going educational and training programmes for staff in all public institutions involved in water management activities as per national regulations | MARD<br>WA | √ | √ | √ | | | |
| **Water Quality** | | | | | | | |
| Establishment of all water protection zones (1,2, and 3) of the water springs for public water supply. | MARD<br>WA | √ | | | | | |
| Designation of vulnerable zones | MARD<br>WA | √ | √ | | | | |
| The designation of a ‘reference laboratory’ with respect to sampling and chemical analysis to meet the EQS Directive requirements to gain international accreditation | IHMS<br>CETI | √ | √ | √ | | | |
| Undertake further technical training for sampling, analysis and reporting of biological according to WFD guidelines | IHMS<br>IMB | √ | √ | | | | |

| Main Task | Responsibility | Timeframe | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
| Define legal regulations for chemical analysis, biological monitoring and supporting hydromorphological assessment | MARD | √ | | | | | |
| Improve regulatory enforcement capacity | Inspection administration | √ | √ | √ | | | |
| Undertake ‘realistic’ monitoring programme for surface and groundwaters, taking into account the current technical abilities to conduct WFD compliant monitoring with respect to technical ability, instrumentation and training requirements | IHMS<br>Companies and other legal entities which discharge waste water<br>MH/IPH<br>IMB | √ | √ | √ | √ | √ | √ |
| Apply regulations to waterworks and concessionaires to measure and provide data on groundwater quantity and quality | MARD<br>WA<br>Water Supply Companies<br>Municipalities | √ | √ | √ | √ | √ | √ |
| **Water Quantity** | | | | | | | |
| Undertake environmental flow analysis on all surface water bodies iduring the next RBMP cycle | IHMS<br>WA | √ | √ | √ | | | |
| Further develop hydrological model for use in development of future water balance scenarios for short and longer-term planning in all sub-basins of the River Basin | IHMS<br>WA | √ | √ | | | | |
| **Water Information** | | | | | | | |
| Develop procedures for data recording into the water information system for Montenegro and also for data analysis and reporting as required by the EEA | WA | √ | √ | √ | √ | √ | √ |
| **Risk Management** | | | | | | | |
| The implementation of EU Floods Directive | MARD<br>WA | √ | √ | √ | √ | | |
| Capacity building and the provision of funding for designing and implementing plans | MARD<br>WA<br>MSDT<br>MI | √ | √ | √ | | | |

| Main Task | Responsibility | Timeframe | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
| **Public Participation** | | | | | | | |
| Undertake the proposed actions included in the RBMP in order to provide information to all stakeholders | MARD<br>WA | √ | √ | √ | √ | √ | √ |
| Ensure public participation and feedback in all issues related to water resource management | MARD<br>WA | √ | √ | √ | √ | √ | √ |

# 12 ANNEXES

Annex 1:  Groundwater bodies – Characterization, status and references used (separate volume)

Annex 2:  Assessment of ecological status – proposal of the system for the Adriatic River Basin

Annex 3: Consultations on the RBMP (separate volume)

## Annex 2: Assessment of ecological status – proposal of the system for the Adriatic River Basin

Surface water status is the general expression of the status of a body of surface water, determined by the poorer of its ecological and chemical status. Good surface water status means that its ecological and chemical status are at least ”good”.

Ecological status is an expression of the quality of the structure and functioning of aquatic ecosystems. Good ecological status is the status of body of surface water classified in accordance with Annex V of the Water Framework Directive (WFD). Good ecological potential is the status of heavily modified or artificial body of water. Assessment of the ecological status is focused on the main course of the river water body. Flood plain area evaluation is included in the frame of hydromorphological assessment in this planning cycle.

Ecological status classification has basic principles:

Type specific classification,

- Selected quality elements should reflect the stress/pressure,
- Classification by used quality elements should fulfil normative definitions,
- The procedure of assessment is based on the comparison to the reference conditions.

The proposal includes:

- Grouping of water body types for purpose of design of type specific assessment of ecological status;
- Identification of indicative Biological Quality Elements (BQE) for water types;
- System of ecological status assessment for fresh water bodies, transitional and coastal water bodies;
- System of estimation of confidence level of the assessment of ecological status; and
- Recommendations for further work on development of proposed system.

### Grouping of water types for the purpose of ecological status assessment

Abiotic typology provides classification of water bodies according selected natural characteristics of aquatic systems (running and standing water bodies) and offers the frame for design of type specific system of the assessment of ecological status.

From the other side, assessment of ecological status is primarily based on monitoring of BQE, but also taking into the consideration supporting parameters (selected physico-chemical parameters, hydromorphological descriptors and, in some cases, basin specific pollutants).

To assess ecological status based on indicative BQE for particular water types, specific, selected biological traits are used. Biological traits (indexes, richness and biodiversity descriptors, numbers reflecting richness of specific groups of organisms selected as sentential organisms) react to stress and we use measures of these reactions to assess the ecological status. According to the EU WFD recommendations, we measure deviation from reference conditions as reflection of intensity of stress.

Reference conditions are those that are measured on sites that are not under disturbance, or sites where anthropogenic influence is minimal (near natural sites). Reference sites do not exist for many water types. In such cases, reference conditions are identified based on the data from “Best available sites", based on historical data and based on expert judgement. In very rare cases, paleontological data are available and could be used for identification of reference conditions.

As emphasized, abiotic typology provides the rough frame for type specific assessment system, but it could not provide classification that fully correspond to all BQE. Therefore, next step in typology is biological validation, to provide better base for type specific assessment of ecological status. Biological communities depend on many parameters, but some parameters primarily shape the community. As consequence, in many cases, abiotic types could be effectively grouped in biological type groups, since biological descriptors (traits) react the same, or very similarly in those groups. This approach also provide opportunity for optimization of the system and made it less complex.

From the other side, abiotic typology and descriptors that are usually used for definition of abiotic water body types could not recognize all specific water body types. In such cases, biological valorisation of typology minimize errors in design of type specific assessment systems and identify specific water body types. For example, abiotic typology could not identify specific watercourses that run over the mountain plateaus, if it do not use the declination of the terrain as parameter for description. Mentioned water bodies are often substantially different (in respect to typical biotic communities) in compare to stretches that run over the terrain with higher declination.

The abiotic water types corresponding type groups based on biological criteria are presented in the Table 1.

### Table 1. Abiotic river types and proposal of corresponding type groups based on biological criteria

| # | Type Name | Type Group | Adriatic River Basin |
|---|---|---|---|
| R1 | Dinaric Western Balkans_small_mountain_calcareous | 1. | Yes |
| R2 | Dinaric Western Balkans_small_mid-altitude_calcareous | 1. | Yes |
| R3 | Dinaric Western Balkans_small_lowland_calcareous | 2. | Yes |
| | | | |
| R4 | Dinaric Western Balkans_medium_mountain_calcareous | 1. | |
| R5 | Dinaric Western Balkans_medium_mid-altitude_calcareous | 1. | Yes |
| R6 | Dinaric Western Balkans_medium _lowland_calcareous | 2. | Yes |
| | | | |
| R7 | Dinaric Western Balkans_large _mid-altitude_calcareous | 3. | |
| R8 | Dinaric Western Balkans_large_lowland_calcareous | 3. | Yes |
| R9 | Dinaric Western Balkans_large_lowland_mixed | 3. | Yes |

The type groups are identified based on the following criteria:

- Dominant bottom type;
- Elevation;

- Size of the water body;
- Assessed water velocity; and consequently
- Expected types of biological communities.

Dominant mineral substrate bottom type is identified based on following simple scheme:

### Original scheme - Mineral substrate

| Description | Particle Size [mm] |
|---|---|
| Fine substrate (silt-clay and very find sand; grains no perceptible by eye) <0.125 mm | <0.125 |
| Sand (grains perceptible by eye) 0.125-2 mm | 0.125-2 |
| Gravel/pebble 2-100 mm | 2-100 |
| Cobble 100-250 mm | 100-250 |
| Boulder >250 mm | >250 |
| Stone (hygropetric sites) | |

### Simplified scheme, applied in this study:

<table>
<tr><th>Description</th><th>Particle Size [mm]</th><th>Preliminary Typology</th><th colspan="3">New Type Designation (according to dominant fractions)</th></tr>
<tr><td>Fine substrate</td><td><0.125</td><td>1</td><td rowspan="3">1 – fine substrate</td><td></td><td></td></tr>
<tr><td>Sand</td><td>0.125-2</td><td>2</td><td rowspan="3">2 – medium sized substrate</td><td></td></tr>
<tr><td>Gravel</td><td>2-64</td><td>3</td><td rowspan="3">3 – hard bottom substrate</td></tr>
<tr><td>Stone</td><td>64-256</td><td>4</td><td></td></tr>
<tr><td>Rock, basic rock</td><td>>256</td><td>5</td><td></td><td></td></tr>
</table>

Based on the above scheme (Table 1), as well as taking into the consideration possible water types that are not covered by presented water typology, as well as partial field valorisation of presented types, we identified seven groups of biological water types:

### Type Group 1

Small and medium sized mountain and mid-altitude watercourses with domination of hard bottom substrate;

Associated abiotic water types in Adriatic River Basin: R1, R2, R5

### Type Group 2

Small and medium sized lowland watercourses with domination of hard and medium sized bottom substrate;

Associated abiotic water types in Adriatic River Basin: R3 and R6

### Type Group 3

Large lowland rivers with domination of medium sized bottom substrates

Associated abiotic water types in the Adriatic River Basin: R8 and R9

### Additional Type Groups of Running Waters:

### Type Group 4

Large lowland rivers with domination of fine bottom substrates;

Associated abiotic water types: Type/Sub-type Dinaric Western Balkans_large_lowland_calcareous with domination of fine bottom substrate

Associated Water Bodies: The most downstream stretch of the Morača River, near to the confluence to the Skadar Lake – upstream border has to be delineated (most probably in the zone of several kilometres downstream to the confluence of the Cijevna River);

**Description**: the type is characterized with slow water current, fine bottom sediment (sand and partially fine sand and mud; biotic communities are different in compare to the upper stretch – several species of mussels are present and in some habitats with large number of specimens; aquatic vegetation is more significantly present; real planktonic algae are present in larger share.

### Type Group 5

Source regions of small and medium sized permanent watercourses with domination of hard and medium sized bottom substrate and specific biotic communities in the catchments area of the Adriatic Basin;

Associated abiotic water types: Permanent water bodies that are not covered by the abiotic typology, due to size. The Type group 5 covers all small permanent running water bodies in hilly mountainous areas.

**Type group 5a:** Small ephemeral running water bodies primarily located in the Mediterranean Biogrographic Region.

Associated abiotic water types: Hydrographical region of Boka Kotorska Bay, small tributaries of the Adriatic Sea and the Zeta River catchment;

**Type group 5b:** Source regions of small and medium sized permanent watercourses with domination of hard and medium sized bottom substrate and specific biotic communities in the catchments area of the Adriatic Basin in Montenegro, i.e. Catchment of the Trebišnjica River

Note: Type groups 5a and 5b are specific and those WBs desire attention in further work; the assessment of ecological status of those water bodies has to be elaborated after investigative monitoring; option is to use hyporheic fauna, and/or to select specific indicator groups of macroinvertebrates.

The assessment system and monitoring approach for other groups has to be considered in the case of specific monitoring activities, such as monitoring of protected areas (all types identified by the WFD), or other specific activities (e.g. Environmental Impact Assessment Studies).

### Type Group 6

Lowland Lakes.

Associated WBs in the Adriatic Basin: Malo Blato Lake, Skadar Lake WB1_Vucko blato, Saško Lake, Skadar Lake WB 2_North, Skadar lake W3_South west, Skadar Lake W4_Pelagic zone

### Type Group 7

Hilly and mountainous Lakes **– not relevant for the Adriatic River Basin**

### Type Group 8

Heavily Modified Water Bodies/Artificial Water Bodies.

Associated AWBs in the Adriatic Basin: Bilećko  Lake, Krupac Lake, Slansko Lake

### Grouping of Freshwater water bodies ecological status assessment scheme

The proposal of the system for ecological status assessment in Montenegro is based on:

- Review of assessment systems applied in European countries, primarily those that have similar natural characteristics, such as relief, climate, geological characteristics, historical dispersion of the biota, etc;
- Data on reference conditions in neighbouring areas (e.g. the Lim River Basin in Serbia, hilly and mountainous watercourses in Croatia and Bosnia and Herzegovina, lakes in Mediterranean area in Croatia, mountainous lakes in Bosnia and Herzegovina,, etc); and
- Data on aquatic biota and related parameters in Montenegro (published and unpublished from recent studies, including the training activities related to this project).

The proposal is also based on the expert input, which is the approach used in many European countries in the initial phases of the implementation of the EU WFD.

**IMPORTANT NOTE:** System of ecological status assessment involves the class boundaries for selected parameters for fish fauna. Fish data could be used only for indicative status assessment, due to limited data available to provide more confident system. The values for fish should not be used as relevant in the cases when values are different in compare to other BQE for the whole class. The data on fish gathered during first RBM cycle will be used for further development of the fish-based system in further phases.

**Type Group 1**

Small and medium sized mountain and mid-altitude watercourses with domination of hard bottom substrate.

**Indicative BQE:** Aquatic Macroinvertebrates, Phytobenthos and Fish Fauna.

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | I-II | II-III | III-IV | |
| **PHYSICO-CHEMICAL PARAMETERS[1]** | | | | | |
| pH value | | | 6.5 - 8.5 | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 7.0 | 5.0 | |
| $BOD_5$ | mg $l^{-1}$ | | 4.0 | 6.0 | |
| Total Organic Carbon (TOC) | mg $l^{-1}$ | | 5.0 | 7.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.3 | 0.8 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 3.00 | 6.00 | |
| Orthophosphates ($PO_4$-P) | mg $l^{-1}$ | | 0.05 | 0.1 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.1 | 0.2 | |
| Chloride | mg $l^{-1}$ | | 100 | | |
| **BIOLOGICAL PARAMETERS** | | | | | |
| **Aquatic Macroinvertebrates** | | | | | |
| Saprobic index (Zelinka & Marvan) | | 1.70 | 2.00 | 2.20 | 2.60 |
| BMWP Score | | 110.00 | 90.00 | 60.00 | 40.00 |
| ASPT Score | | 7.00 | 6.00 | 4.00 | 3.00 |
| Diversity index (Shannon-Weaver) | | 2.50 | 1.70 | 1.40 | 0.50 |
| Total No. of taxa | | 40.00 | 21.00 | 15.00 | 5.00 |
| Share of Oligochaeta-Tubificidae | % in No. of individuals | | 5.00 | | |
| EPT taxa | | 18.00 | 14.00 | 10.00 | 6.00 |
| No. of sensitive taxa | | 5.00 | 4.00 | 3.00 | 2.00 |
| **Phytobenthos** | | | | | |
| IPS index | | 17 | 15 | 12 | 9 |
| CEE index | | 12 | 9 | 7 | 5 |
| IDG index | | 17 | 14 | 11 | 8 |
| **Fish Fauna** | | | | | |
| Number of taxa | | 5 | 3 | 2 | |
| Salmonid taxa present | | 2 | Yes | No | |
| Cottidae or *Barbus* sp. present | | | Yes | No | |

[1] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

## Type Group 2

Small and medium sized lowland watercourses with domination of hard and medium sized bottom substrate

**Indicative BQE:** Aquatic Macroinvertebrates, Phytobenthos and Fish Fauna.

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | I-II | II-III | III-IV | IV-V |
| **PHYSICO-CHEMICAL PARAMETERS[1]** | | | | | |
| pH value | | | 6.5 - 8.5 | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 7.0 | 5.0 | |
| $BOD_5$ | mg $l^{-1}$ | | 5.0 | 6.0 | |
| Total Organic Carbon (TOC) | mg $l^{-1}$ | | 6.0 | 7.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.1 | 0.8 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 3.0 | 6.0 | |
| Orthophosphates ($PO_4$-P) | mg $l^{-1}$ | | 0.1 | 0.2 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.2 | 0.4 | |
| Chloride | mg $l^{-1}$ | | 100 | | |
| **BIOLOGICAL PARAMETERS** | | | | | |
| **Aquatic Macroinvertebrates** | | | | | |
| Saprobic index (Zelinka & Marvan) | | 1.80 | 2.00 | 2.40 | 2.80 |
| BMWP Score | | 100.00 | 80.00 | 50.00 | 30.00 |
| ASPT Score | | 7.00 | 5.00 | 4.00 | 3.00 |
| Diversity index (Shannon-Weaver) | | 2.20 | 1.50 | 1.20 | 0.50 |
| Total No. of taxa | | 35.00 | 25.00 | 12.00 | 5.00 |
| Share of Oligochaeta-Tubificidae | % in No. of individuals | | 5.00 | | |
| EPT taxa | | 16.00 | 12.00 | 8.00 | 4.00 |
| No. of sensitive taxa | | 13.00 | 10.00 | 5.00 | 2.00 |
| **Phytobenthos** | | | | | |
| IPS indeks | | 16 | 14 | 12 | 9 |
| CEE indeks | | 12 | 9 | 7 | 5 |
| **Fish Fauna** | | | | | |
| FIS Index (corresponding type 9) | | 0.71 | 0.57 | 0.43 | 0.29 |

[1] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

**Type Group 3**

Large lowland rivers with domination of medium sized bottom substrates.

**Indicative BQE:** Aquatic Macroinvertebrates, Phytobenthos and Fish Fauna.

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | I-II | II-III | III-IV | IV-V |
| **PHYSICO-CHEMICAL PARAMETERS[250]** | | | | | |
| pH value | | | 6.5 - 8.5 | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 7.0 | 5.0 | |
| $BOD_5$ | mg $l^{-1}$ | | 4.5 | 6.0 | |
| Total Organic Carbon (TOC) | mg $l^{-1}$ | | 5.0 | 7.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.1 | 0.8 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 3.00 | 6.00 | |
| Orthophosphates ($PO_4$-P) | mg $l^{-1}$ | | 0.1 | 0.2 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.2 | 0.4 | |
| Chloride | mg $l^{-1}$ | | 100 | | |
| **BIOLOGICAL PARAMETERS** | | | | | |
| **Aquatic Macroinvertebrates** | | | | | |
| Saprobic index (Zelinka & Marvan[251]) | | 1.90 | 2.10 | 2.80 | 3.20 |
| BMWP Score[252] | | 60.00 | 45.00 | 30.00 | 10.00 |
| ASPT Score[253] | | 6.00 | 5.00 | 4.00 | 3.00 |
| Diversity index (Shannon-Weaver[254]) | | 2.20 | 1.50 | 1.20 | 0.50 |
| Total No. of taxa | | 17.00 | 10.00 | 9.00 | 5.00 |
| Share of Oligochaeta-Tubificidae | % in No. of individuals | 10.00 | 20.00 | 40.00 | 70.00 |
| EPT taxa[255] | | 7.00 | 5.00 | 2.00 | 1.00 |
| No. of sensitive taxa | | | 4.00 | | |
| **Phytobenthos** | | | | | |

[250] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

[251] Zelinka, M., Marvan, P., 1961. Zur Präzisierung der biologischen Klassifikation der Reinheit fließender Gewässer. Arch. Für Hydrobiol. 389–407

[252] BMWP – Biological Monitoring Working Party is a tool for assessment of water quality using groups of macroinvertebrates (mostly families) as biological indicators

[253] ASPT – Average Score per Taxa - The average sensitivity of the families of organisms present is known as the Average Score Per Taxon and can be determined by dividing the BMWP score by the number of taxa present

[254] Shannon, C.E., Weaver, W., 1964. The Mathematical Theory of Communication, 10th ed, The mathematical theory of communication. The University of Illinois Press, Urbana

[255] EPT – Ephemeroptera, Plecoptera Trichoptera index

| | | | | | |
|---|---|---|---|---|---|
| IPS index[256] | | 16 | 14 | 12 | 9 |
| CEE index[257] | | 12 | 9 | 7 | 5 |
| **Fish Fauna** | | | | | |
| FIS Index (corresponding type 13) | | 0.71 | 0.57 | 0.43 | 0.29 |

[256] IPS – "Pollution Sensitivity Index" (Coste in CEMAGREF, 1982 Etude des méthodes biologiques quantitative d'appréciation de la qualité des eaux. Rapport Division Qualité des Eaux Lyon – Agence financière de Bassin Rhône–Méditerranée–Corse, Pierre-Bénite, 218 pp).

[257] CEE – "Commission for Economical Community metric" (Descy and Coste, 1991 A test method for assessing water quality based on diatoms. Verhandlung Internationale Vereingung de Limnologie 24, 2112-2116).

**Type Group 4**

Large lowland rivers with domination of medium sized bottom substrates.

**Indicative BQE:** Aquatic Macroinvertebrates, Macrophytes, Phytobenthos, Phytoplankton and Fish Fauna.

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | I-II | II-III | III-IV | IV-V |
| **PHYSICO-CHEMICAL PARAMETERS**[258] | | | | | |
| pH value | | | 6.5 - 8.5 | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 7.0 | 5.0 | |
| $BOD_5$ | mg $l^{-1}$ | | 5.0 | 8.0 | |
| Total Organic Carbon (TOC) | mg $l^{-1}$ | | 5.0 | 9.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.3 | 0.8 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 3.00 | 6.00 | |
| Orthophosphates ($PO_4$-P) | mg $l^{-1}$ | | 0.1 | 0.2 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.2 | 0.4 | |
| Chloride | mg $l^{-1}$ | | 100 | | |
| **BIOLOGICAL PARAMETERS** | | | | | |
| **Aquatic Macroinvertebrates** | | | | | |
| Saprobic index (Zelinka & Marvan) | | 2.00 | 2.20 | 2.90 | 3.20 |
| BMWP Score | | 50.00 | 40.00 | 30.00 | 10.00 |
| ASPT Score | | 5.00 | 4.00 | 3.00 | 2.00 |
| Diversity index (Shannon-Weaver) | | 2.20 | 1.50 | 1.20 | 0.50 |
| Total No. of taxa | | 17.00 | 10.00 | 9.00 | 5.00 |
| Share of Oligochaeta-Tubificidae | % in No. of individuals | 10.00 | 25.00 | 40.00 | 70.00 |
| No. of Bivalvia taxa | | | 3.00 | | |
| No. of taxa of Gastropoda | | | 3.00 | | |
| No. of sensitive taxa | | | 3.00 | | |
| **Macrophytes** | | | | | |
| Diversity index (Shannon-Weaver) | | 2.4 | 1.6 | 0.8 | 0.5 |
| Total No. of taxa | | 15 | 10.0 | 7.0 | 2.0 |
| **Phytobenthos** | | | | | |
| IPS indeks | | 14 | 10 | 8 | 6 |
| CEE indeks | | 12 | 9 | 7 | 5 |
| **Phytoplankton** | | | | | |

[258] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | I-II | II-III | III-IV | IV-V |
| CYA[259] | | 2.50 | 5.00 | 10.00 | 20.00 |
| EUG | | 2.50 | 5.00 | 10.00 | 15.00 |
| Abundance | | 2000 | 5000 | 15000 | 25000 |
| Biomass as Chl a[260] | µg/l | 25.0 | 50.0 | 100.0 | 250.0 |
| **Fish Fauna** | | | | | |
| FIS Index (corresponding type 13) | | 0.71 | 0.57 | 0.43 | 0.29 |

**Type Group 5**

Source regions of small and medium sized permanent watercourses with domination of hard and medium sized bottom substrate and specific biotic communities in the catchments area of the Adriatic Basin in Montenegro;

**Indicative BQE**: Aquatic Macroinvertebrates and Phytobenthos

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | **I-II** | **II-III** | **III-IV** | **I-II** |
| **PHYSICO-CHEMICAL PARAMETERS[261]** | | | | | |
| pH value | | | 6.5 - 8.5 | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 7.0 | 5.0 | |
| Total Organic Carbon (TOC) | mg $l^{-1}$ | | 5.0 | 7.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.3 | 0.8 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 3.00 | 6.00 | |
| Orthophosphates ($PO_4$-P) | mg $l^{-1}$ | | 0.05 | 0.1 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.1 | 0.2 | |
| Chloride | mg $l^{-1}$ | | 100 | | |
| **BIOLOGICAL PARAMETERS** | | | | | |
| **Aquatic Macroinvertebrates** | | | | | |
| Saprobic index (Zelinka & Marvan) | | 1.70 | 1.90 | 2.30 | 2.60 |
| BMWP Score | | 100.00 | 80.00 | 50.00 | 30.00 |
| ASPT Score | | 7.00 | 6.00 | 4.00 | 3.00 |
| Diversity index (Shannon-Weaver) | | 2.50 | 1.70 | 1.40 | 0.50 |
| Total No. of taxa | | 7 | 5 | 3 | 2 |

[259] Cyanobacteria

[260] Chlorophyll a

[261] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

| | | | | | |
|---|---|---|---|---|---|
| Share of Oligochaeta-Tubificidae | % in No. of individuals | | 5.00 | | |
| EPT taxa | | | 3 | | |
| No. of sensitive taxa | | | 3 | | |
| **Phytobenthos** | | | | | |
| IPS index/indeks | | 14 | 10 | 8 | 6 |

**Type Group 6**

**Lowland Lakes**

**Indicative BQE**: Aquatic Macroinvertebrates, Macrophytes, Phytobenthos and Phytoplankton

| Parameter | Units | Class Boundaries | | | |
|---|---|---|---|---|---|
| | | I-II | II-III | III-IV | IV-V |
| **PHYSICO-CHEMICAL PARAMETERS**[262] | | | | | |
| pH value | | | 6.5 - 8.5 | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 7.0 | 5.0 | |
| $BOD_5$ | mg $l^{-1}$ | | 5.0 | 8.0 | |
| Total organic Carbon (TOC) | mg $l^{-1}$ | | 6.0 | 9.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.3 | 0.8 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 3.00 | 6.00 | |
| Orthophosphate ($PO_4$-P) | mg $l^{-1}$ | | 0.1 | 0.2 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.2 | 0.4 | |
| Chloride | mg $l^{-1}$ | | 100 | | |
| **BIOLOGICAL PARAMETERS** | | | | | |
| **Aquatic Macroinvertebrates** | | | | | |
| Saprobic index (Zelinka & Marvan) | | 2.10 | 2.65 | 2.90 | 3.20 |
| BMWP Score | | 50.00 | 40.00 | 30.00 | 10.00 |
| Diversity index (Shannon-Weaver) | | 2.20 | 1.50 | 1.20 | 0.50 |
| Total No. of taxa | | 17.00 | 10.00 | 9.00 | 5.00 |
| Share of Oligochaeta-Tubificidae | % in No. of individuals | 10.00 | 25.00 | 40.00 | 70.00 |
| No. of taxa of Bivalvia | | | 3.00 | | |
| No. of taxa of Gastropoda | | | 4.00 | | |
| **Macrophytes** | | | | | |
| Diversity index (Shannon-Weaver) | | 2.4 | 1.6 | 0.8 | 0.5 |
| Total No. of taxa | | 15 | 10.0 | 7.0 | 2.0 |
| TSI – Trophic index | | 40 | 50 | 70 | 100 |

[262] The value of physical-chemical parameters is determined as the average value at three points along the vertical at the center of the deepest part of the water body: 0.5 m from the surface, at the depth of the thermocouple and to 10% of the depth from the bottom.

| | | | | | |
|---|---|---|---|---|---|
| Transparency[263] | M | 4 | 2 | 0.5 | 0.25 |
| **Phytobenthos** | | | | | |
| IPS index | | 14 | 10 | 8 | 6 |
| **Phytoplankton** | | | | | |
| CYA | % of biomass | 2.50 | 5.00 | 10.00 | 20.00 |
| Abundance | cells/ml | 2000 | 5000 | 15000 | 25000 |
| biomass as Chl a | µg/l | 25.0 | 50.0 | 100.0 | 250.0 |

**Type Group 8**

**Heavily Modified Water Bodies/Artificial Water Bodies**

**Lowland Reservoirs**

**Indicative BQE**: Aquatic Macroinvertebrates, Macrophytes, Phytobenthos and Phytoplankton

| Parameter | Units | Class Boundaries | | |
|---|---|---|---|---|
| | | II-III | III-IV | IV-V |
| **PHYSICO-CHEMICAL PARAMETERS[264]** | | | | |
| pH value | | | 6.5 - 8.5 | |
| Dissolved Oxygen | mg $l^{-1}$ | | 5.0 | |
| $BOD_5$ | mg $l^{-1}$ | | 6.0 | |
| Total Organic Carbon (TOC) | mg $l^{-1}$ | | 7.0 | |
| Ammonium ion ($NH_4$ - N) | mg $l^{-1}$ | | 0.80 | |
| Nitrate ($NO_3$-N) | mg $l^{-1}$ | | 6.0 | |
| Orthophosphate ($PO_4$-P) | mg $l^{-1}$ | | 0.20 | |
| Total dissolved Phosphate (P) | mg $l^{-1}$ | | 0.40 | |
| Chloride | mg $l^{-1}$ | | 100 | |
| **BIOLOGICAL PARAMETERS** | | | | |
| **Aquatic Macroinvertebrates** | | | | |
| Saprobic index (Zelinka & Marvan) | | 2.5 | 3 | 3.2 |
| BMWP | | 45 | 30 | 10 |
| Diversity index (Shannon-Weaver) | | 1.5 | 1.2 | 0.5 |
| Total No. of taxa | | 10 | 9 | 5 |
| Share of Oligochaeta-Tubificidae | % in No. of individuals | 25 | 40 | 70 |
| EPT taxa | | 5 | 2 | 1 |
| **Macrophyes** | | | | |

263 Or to the bottom

264 The value of physical-chemical parameters is determined as the average value at three points along the vertical at the center of the deepest part of the water body: 0.5 m from the surface, at the depth of the thermocouple and to 10% of the depth from the bottom.

| | | | | |
|---|---|---|---|---|
| Diversity index (Shannon-Weaver) | | 1.6 | 0.8 | 0.5 |
| Total No. of taxa | | 10 | 7 | 2 |
| **Phytobenthos** | | | | |
| IPS index/indeks | | 14 | 12 | 9 |
| **Phytoplankton** | | | | |
| CYA | % of biomass | 5 | 10 | 20 |
| Abundance | cells/ml | 5000 | 15000 | 25000 |
| Biomass as Chl a | µg/l | 50 | 100 | 250 |

*The value of the physico-chemical parameters is determined as the average value at three points along the vertical at the center of the deepest part of the water body: 0.5 m from the surface, at the depth of the thermocouple and to 10% of the depth from the bottom.

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### Transitional and coastal water bodies ecological assessment scheme

The following BQE are indicative for transitional and coastal water bodies: phytoplankton, phytobenthos and water macrophytes, aquatic macroinvertebrates and fish.

Based on the review of available systems applied for Mediterranean countries, the following candidate metrics have been considered: Phytoplankton, Macrophytes and Macroinvertebrates

**Identified Transitional Water Bodies in the Adriatic River Basin**

| № | Type name | Water Bodies |
|---|---|---|
| **1** | Polyhaline bay_silty-clay | Kotor and Risan Bay |
| **2** | Euhaline bay_silty-clay | Tivat Bay |
| **3** | Euhaline bay_clayey-silt | Hercegnovi bay |
| **4** | Euhaline estuary_sand | Bojana estuary |

**Phytoplankton**

Chlorophyll a concentration:

| Status | Type 4 | Types 1, 2 and 3 |
|---|---|---|
| High | <2.75 | <1.50 |
| Good | 2.76 - 4.00 | 1.51 - 2.20 |
| Moderate | 4.01 - 6.00 | 2.21 - 3.20 |
| Poor | 6.01 - 12.2 | 3.21 - 6.70 |
| Bad | > 12.2 | > 6.70 |

*podaci iz čitavog uzorkovanog vodenog stupca (0,5 m; 5 m i 10 m)

**Macrophyte**

The following indexes are considered to be used:

- EEI-c index (Orfanidis et al., 2011);
- CARLIT (Ballesteros et al., 2007, Nikolić et al., 2013); and
- Posidonia index/score.

**Macroinvertebrates**

The following indexes are considered to be used:

- BENTIX (Samboura 2004, Samboura & Reizopolou 2008); and
- AMBI (Borja et al., 2008, 2012).

**BENTIX Index**

The biotic index BENTIX (Simboura 2004) for benthic macroinvertebrates was developed for of the implementation of the EU WFD (Directive 2000/60/EC) for Greece. It imply the use of a five step numerical scheme for the classification of benthic communities and it is based on the concept of indicator groups – the relative contribution of tolerant and sensitive taxa. The tolerant and sensitive taxa are classified accordingly to the ratio of their occurrence in the benthic fauna by definition.

BENTIX index formula:

$$[(6 X \%GS + 2 X \%GT)]/100$$

where: GS is all sensitive and indifferent taxa and GT all tolerant and opportunistic taxa together

The re-grouping of the ecological groups is based on the concept of Hily (1984), Glémarec (1986) and Grall and Glémarec (1997) that have recognized five taxa groups according to their sensitivity to an increasing stress gradient: the sensitive group (GI), the indifferent group (GII), the tolerant group (GIII), the second-order opportunists (GIV), and the first-order opportunists (GV). Among them the first two are regarded as non-tolerant and as such are grouped under a single 'sensitive' group represented as GS in the formula. The other three groups are considered as generally 'tolerant' and are represented in the formula as GT. Thus, the groups GS and GT in the Bentix formula are corresponding to:

$$GS = GI+GII$$

$$GT=GIII+GIV+GV$$

The selection of the weight coefficients in the Bentix formula is not random and it is based on the realization that the probability of a benthic species picked up randomly, to be tolerant to stress is 3:1. So the probability ratio among 'tolerant' and 'non tolerant' groups is 3:1. This ratio is multiplied by 2 to create a scale ranging from 2 to 6. The 'sensitive' group GS (summing up groups GI, GII) is weighted by 6 to correspond highest status with highest value of the index and all tolerant taxa group GT (summing up groups GIII, GIV and GV) are equally weighted by 2. The absence of any 'sensitive' species (GS=0) results to an index value of 2 (poor status) and the absence of any one species (azoic state) corresponds to a zero value of the index (bad status). The boundary limits among classes were set after multiple tests with real data rendering a five-step scale with equal distances among the good and moderate class.

Bentix demonstrates high sensitivity in detecting ecological alterations in the benthic communities of the Mediterranean and at the same time is simple in its calculation involving only two ecological groups, also reducing the risk of assigning a species to a wrong group in case of controversy in the scoring. The resulting ecological quality classification scheme of the BENTIX index and the respective ecological quality ration values (EQR) is:

The BENTIX classification scheme:

| Ecological Status | Class boundaries | Boundary limits | Corresponding EQR |
|---|---|---|---|
| High | 4.5 < Bentix < 6 | 6 | 1 |
| Good | 3.5 < Bentix < 4.5 | 4.5 | 0.75 |
| Moderate | 2.5 < Bentix < 3.5 | 3.5 | 0.58 |
| Poor | 2.0 < Bentix <2.5 | 2.5 | 0.42 |
| Bad | 0 | 0 | 0 |

It is important to stress here that for purely muddy habitats (with fine silt and clay particles over 80%) where the benthic fauna is naturally dominated by some tolerant species (naturally stressed habitats), an adjustment of the H/G and G/M boundaries modifies them to H/G=4 and G/M=3.

**AMBI Index**

AMBI is an index that use benthic macroinvertebrates assemblages. It is widely used in Mediterranean countries for assessment of ecological status. A software is freely available for calculation of the index, with extensive database (about 6,300 species). Threshold values in the application can be accommodated for use in different water body types.

AMBI indeks (AZTI Marine Biotic Index) is based on the calculation of relative share of five ecological groups of marine macroinvertebrates with different sensitivity to stress/pollution, using the formula:

AMBI= [(0 x %GI) + (1,5 x %GII) + (3 x %GIII) + (4,5 x %GIV) + (6 x %GV)]/100

where:

- G I – Sensitive taxa,
- G II – Indifferent taxa,
- G III – Tolerant taxa,
- G IV – First order opportunistic taxa, and
- G V – Second order opportunistic taxa.

M-AMBI is prepared for the assessment according to the EU WFD and is calculated using AMBI software.

| AMBI Boundary limits | Description | M-AMBI Threshold values – corresponding EQR | Status |
|---|---|---|---|
| 0 – 1.2 | Natural | 0.83 – 1.00 | High |
| 1.3 – 3.3 | Slightly polluted | 0.62 – 0.82 | Good |
| 3,. – 5.0 | Moderately polluted | 0,.1 – 0.61 | Moderate |
| 5.1 – 6.0 | Highly polluted | 0,.1 – 0.40 | Poor |

| | | | |
|---|---|---|---|
| > 6 | No life available | 0 – 0.20 | Bad |

**Coastal Water Bodies related to the Adriatic River Basin**

Types and corresponding Water Bodies:

| № | Type name | Water Bodies |
|---|---|---|
| **1** | Polyhaline shallow sea/plitka zona, polihalini uslovi | CW1, CW2, CW3 and CW5 |
| **2** | Euhaline deep sea/duboko more, euhalini uslovi | CW4 |

**Phytoplankton**

Chlorophyll a concentration:

| Status | Type 1 | Type 2 |
|---|---|---|
| High | <0.94 | <0.62 |
| Good | 0.95 - 1.34 | 0.63 – 0.91 |
| Moderate | 1.35 - 1.95 | 0.92 - 1.35 |
| Poor | 1.96 - 4.00 | 1.36 - 2.78 |
| Bad | > 4.00 | > 2.78 |

In shallow coastal WBs, we can consider application of BENTIX and AMBI/M-AMBI (macroinvertebrates), as well as EEI-c index (Orfanidis et al., 2011); CARLIT (Ballesteros et al., 2007, Nikolić et al., 2013); and Posidonia index.

In this first step, we propose use of BENTIX and AMBI/M-AMBI (macroinvertebrates), CARLIT (modification by Nikolić et al., 2013) and Posidonia index. The potential use of EEI-c index (Orfanidis et al., 2011) should be considered in further steps.

**Posidonia index**

Shoot density, percentage cover of live *P. oceanica* and dead matte and the surface of different substrate types (sand/mud and rocks), as well as Conservation Index, should be calculated for each replicate, as described in Guala et al., (2017). Shoot density (no. of shoots per $m^2$) should be calculated based on the number of shoots/records in each 0.16 $m^2$ quadrant and averaged for each station and for each depth. Based on shoot density and depth, meadows should be categorized in five classes (high, good, moderate, poor and bad,) according to the classification system proposed by UNEP-RAC/SPA (2011, tables below).

From each LIT, the length of each key attribute (Lx), namely the coverage of P. oceanica, dead matte and the main substrate types, should be calculated by subtraction, as the distance occurring between two recorded intercepts along the transect (Bianchi et al., 2004). The percentage cover (R%) along a transect of 10 m length is calculated using the formula

R%=Σ(Lx/10*100).

For each transect, the Conservation Index (CI) was calculated, by the formula

CI=P/(P + D)

where P is the percentage cover of alive P. oceanica and D is the percentage cover of dead matte (Moreno et al., 2001; Montefalcone et al., 2006). CI is an environmental index useful to assess the state of health of the meadows; it ranges between 0 (minimum state of conservation) and 1 (maximum state of conservation).

Modified version of CARLIT index (Nikolić et al., 2013).

Index is calculated using the information about the length of the coast occupied by a community type, the ecological quality value (EQ) was calculated using the formula:

$EQ=\sum(li \times SLi) \sum li$

EQ = ecological quality value of a coastline sector
li = length of the coastline with the community category i
SLi = sensitivity level of the community category i

According to macroalgal community types and their sensitivity levels (SL) in the eastern part of the Adriatic Sea:

| **Community Type** | **Community Description** | **Sensitivity Level (SL)** |
|---|---|---|
| Cystoseira spicata 3 | Continuous belt of Cystoseira amentacea var. spicata | 20 |
| Cystoseira crinitophylla | Populations of Cystoseira crinitophylla | 20 |
| Cystoseira crinita | Populations of Cystoseira crinita | 20 |
| Cystoseira corniculata | Populations of Cystoseira corniculata | 20 |
| Cystoseira foeniculacea | Populations of Cystoseira foeniculacea | 20 |
| Trottoir | Organogenic build-ups of Lithophyllum byssoides and other coralline algae | 20 |
| Cystoseira barbata | Populations of Cystoseira barbata without other Cystoseira species | 16 |
| Cystoseira spicata 2 | Abundant patches of Cystoseira amentacea var. spicata | 15 |
| Cystoseira compressa | Populations of Cystoseira compressa without other Cystoseira species | 12 |
| Cystoseira spicata 1 | Rare scattered plants of Cystoseira amentacea var. spicata | 10 |
| Photophilic algae | Community dominated by Padina/Dictyota/Dictyopteris/Taonia/Halopteris | 10 |
| Corallina | Community dominated by Corallina elongata and/or Haliptilon virgatum | 8 |
| Mytilus | Community dominated by Mytilus galloprovinciallis | 6 |
| Green algae | Community dominated by Ulva/Enteromorpha/Cladophora | 3 |
| Cyanobacteria | Cyanobacterial belt | 1 |