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Danube River Basin Management Plan

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LIST OF ABBREVIATIONS

AA-EQS	Annual Average Environmental Quality Standard
AIA	Administration for Inspection Affairs
AQUASTAT	Aquastat water database – FAO, European Environment Agency
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
DB	Danube Basin
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
DRB	Danube River Basin in Montenegro
DrWPAs	Drinking Water Protected Area
DWB	Delineated Water Bodies
DWM	Directorate of Water Management (MARD)
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	Environmental Protection Agency in Montenegro
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
ICPDR	International Commission for the Protection of the Danube River
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
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
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
TE	Thermo-Electric
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 Danube River Basin (DRB) 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 groundwaters 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 Danube River Basin in Montenegro 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 Danube River Basin in Montenegro **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 Danube 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 Danube watershed in Montenegro is 7,260 km^2 or 52.5 % of state territory.

Surface Water Bodies (SWBs) - The Tara, Piva, Lim and Ćehotina Rivers are part of the Drina River Basin (flowing into the Sava River), while the Ibar River is flowing into the Zapadna Morava while rivers Tara, Piva, Lim and Ćehotina flow into the Drina River. The Danube watershed placed in Montenegro is the southernmost part of the Black Sea drainage. Mentioned watercourses are also the biggest rivers in the Danube River Basin in Montenegro. Three natural lakes that are relevant for the RBMP are also included in the list of water bodies: the Plavsko, Crno and Biogradsko lakes with surface area of 2.00, 0.53 and 0.27 km^2, respectively.

SWBs are grouped based on partial field valorisation and analyses on published and other (project results, other relevant sources). For the Danube River Basin, three 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 3 – Large lowland rivers with domination of medium sized bottom substrates and 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. One general lake type (Type Group 7 – Hilly and mountainous lakes) and artificial water bodies (AWBs) are also identified.

Based on the criteria described in the EU CIS Guidance Document No 2, **48 inland surface water bodies (rivers and lakes) were delineated for the Danube River Basin**, consisting of 38 natural watercourses, 3 natural lakes and seven surface waters identified as heavily modified water bodies (HMWBs).

Ground waters – 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. Some of the largest springs in the catchment area are Alipašini springs (Qmin =2000 l/s, Lim basin), Ravnjak, Bjelovac, Ljutica, Kućišta (all with Qmin >500 l/s, Tara basin) and Sinjac, Medjedjak, Nozdruk (all with Qmin >500 l/s, Piva basin). Unfortunately, their discharges are only periodically observed and discharge regimes are difficult to reconstruct.

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. With respect to intergranular aquifer, the Neogene sediments of lacustrine origins are generally characterized by low permeability and small groundwater reserves. The thickest Neogene (Middle Miocene, M_2) lacustrine deposits are in Pljevlja basin where intensive extraction of coal (20m thick layer, in average) is taking place. The major inflow into open mine pit is from underlying and surrounding Triassic karstic aquifer, and not from overlying and lateral Neogene deposits. The groundwater availability of alluviums very much depends on river size and flows. Some other alluviums are also supplying potable water but mostly to smaller settlements (villages). Notable thickness, but rarely over 10m characterized alluviums of Piva, Tara, Ćehotina, and Lim.

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 Danube 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 warer bodies. However, some zones which lack groundwater or contain minimal reserves (aquifuges) or not connected to adjacent aquifers, are not discussed and shown on the maps (blank polygons).

In the Danube River Basin, a total of **13 groundwater bodies** have been identified, comprised of 4 GWBs and 9 GGWBs. In total, 11 out of the 13 delineated water bodies are of transboundary character. There are no GWBs or GGWBs in the Danube River Basin that are larger than 1,000 km^2, while 5 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 Danube 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 48 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 17 SWBs (out of 48) it was assessed that point pollution is a significant pressure. Further analysis of all pressures resulted in a total of 11 out of the 48 waterbodies judged to be 'at risk', although with varying degrees of confidence. Nine surface water bodies are judged to be 'at risk' with a high degree of confidence. Two surface water bodies are judged to be 'at risk' based on both point

and diffuse source pressures but with a low confidence. The risk analysis also identified 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 48 assessed WBs, 14 WBs failed to achieve good status and mitigation measures have to be identified and applied.

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 is evaluated to be of medium confidence, which is 10.42% of total length of assessed WBs.

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 relatively 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 Danube 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 **no GWBs or GGWBs are at risk**. However, one GGWB, namely Beranska Bistrica - Ljubovidja should exploit their groundwater reserves with caution. 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 9 GWBs and GGWBs require less than 1% of their available water reserves.

The **chemistry of groundwater could be considered as generally satisfactory**. The analysis was based on the data provided by IHMS. Additional data for the assessment were also used: water quality data from the water supply systems are also carried out by the Institute for Public Health of Montenegro and data on specific priority pollutants analyzed by the Centre for Eco-Toxicological Research in Podgorica (CETI).

GWB risk assessment for diffuse pollution sources shows that the category of 'Low Risk' is the most widespread category in entire territory of the Danube River Basin (43.71% of the total basin). In addition, for 13.31% it was assessed under 'Very Low Risk', while for 35.95% it was assessed that there is no risk of pollution. With respect to **point source pollution risk assessment** on groundwaters, only one GGWB - Pljevlja Basin - is assessed as under the risk due to the impact of point pollution sources and three GGWBs are assessed as possibly at risk: Beranska Bistrica-Ljubovića, Gornji Ibar and Maoče. In general, majority of GWBs have good status, both quantitative and chemical.

Monitoring Programmes: The document provides a description of the **monitoring programme** for the Danube 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 Danube River Basin.

Surface Water Monitoring: The WFD compliant monitoring network for the surface waters in Danube River Basin covers 44 sites. A total of 27 sites are identified for surveillance monitoring, 25 for operational, while 12 sites are proposed for investigative monitoring. For some sites it is assessed that different types of monitoring should be applied.

Sites that are identified as relevant for both, surveillance and operational monitoring are considered as high priority sites – first order sites – 11 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) and Transnational Monitoring Network (TNMN – water quality monitoring network established to support the implementation of the Danube River Protection Convention). 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.

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 provided by the monitoring program and the achieved degree of reliability and accuracy should be included in water management plan for each water body.

Montenegro is in the process of adoption of the water status monitoring methodology that is compliant with requirements of the WFD.

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 Danube 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, and should be applied to GWBs at risk and potentially at risk.

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. 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 Danube River Basin is presented in the document, together with 26 monitoring sites.

The effect of climate change: The effect of climate change in the Danube River Basin reveals that changes in temperature and in precipitation will inevitably impact on and create changes in the water balance in the Danube River Basin. 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 analysis of maximum annual flows has not produced a uniform change, but rather has resulted in a different set of results for each of the hydrological stations. The overall number of hydrological droughts is not expected to increase during the period before 2100 in the Lim River Basin but is expected to increase in the upper stream of the Tara River Basin. 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.

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 Danube 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 and the results of the monitoring programmes showing the status of all water bodies and protected areas.

The register of protected areas required by the WFD under Article 6 is included, which 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 Danube 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 document 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 Danube River Basin.

There are losses incurred in the water supply system all across the Danube 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 68.1%. 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 Danube 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 77.7% 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
- Reducing the adverse effects of floods on human health, the environment, cultural heritage and the economy
- 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 48 surface water bodies, 17 can be considered for exemption but solely based on the need for extended deadlines in order to reach good status. Where SHPPs are indicated as causing pressure on the surface water bodies, mitigation measures are judged to be possible in the mid-term in order to ensure good status.

One surface water body, Piva (SWB No. 18), is judged to be unable to reach the good status by 2033 since the river is under extreme pressure from hydropeaking, which is not possible to be remedied technically, and in this case an exemption would be required.

One groundwater body is judged not to be able to meet its environmental objective until 2033 due to point source pollution arising from the coal mine at Pljevlja and the TE Plant, which would be disproportionately expensive to remedy in the shorter term.

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 27 supplementary measures, all of which are grouped according to priority, indicated as either as high, medium or low. Of the basic measures, 21 are classed 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: 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.

In order to clarify the specific actions required for the Danube 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 Danube River Basin would be expected to start in 2021.

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

1 INTRODUCTION AND 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 Danube 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 Danube 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 has stated that it intends to coordinate the preparation of flood risk management plans and river basin water management plans as 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.

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).

1.2 Structure of the Danube 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 Danube 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

[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 2019 - 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).

	Contents of the EU WFD Danube River Basin Management Plan
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)
	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 Danube 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

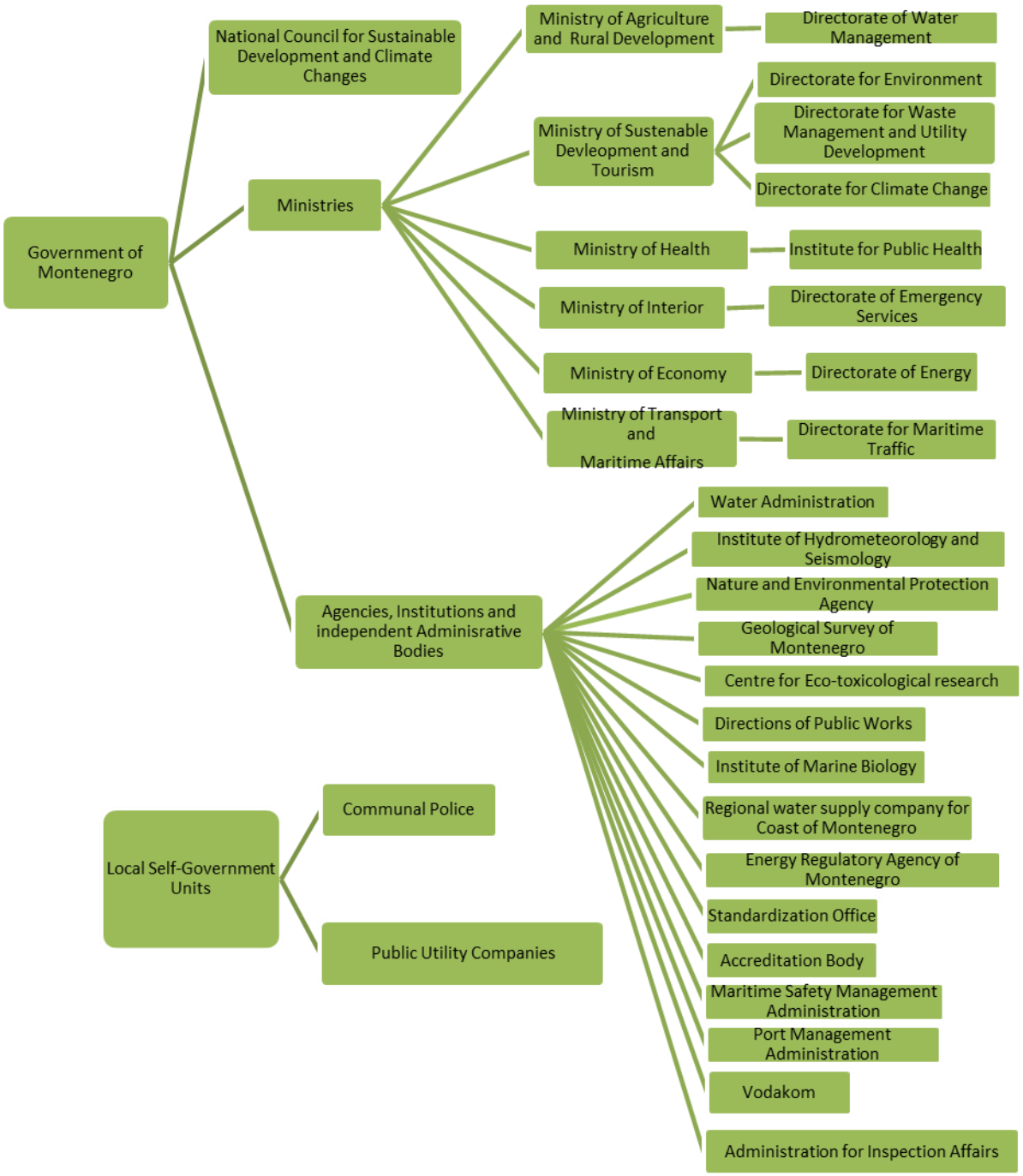
The **Government** is the supreme executive body of the country. It is responsible for adoption and endorsement of documents and acts submitted by respective ministries and take some high-level executive state decisions in water management. It has the power to adopt the strategic and planning documents 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, and of course all European water management directives..

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, Vodacom and Procon.

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 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."

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
- 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 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.

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.

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 latter is not relevant to this RBMP).

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 aligned 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 standardisation.

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) and drinking water sources as far as their pollution from land-based sources is concerned. Under Article 3, the general water management principles – or, rather, objectives - are:

- 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 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 Danube river basin district as a part of the international basin district of the Danube in the territory of Montenegro, which includes the Ibar, Lima, Ćehotina, Tara and Piva River basins and associated groundwater

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. 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. 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 Danube and Adriatic Basins (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 cadastre (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 Coatal 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) 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- 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.

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

Issues	Tasks	Responsibilities	Legal reference	
			M 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 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 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 the Danube River Basin

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 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.

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 of flood risk relating to international river basins	Exchange of information with the countries with which water area is shared; Determining areas of significant flood endangered aquatic 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.	GM, MARD/WA, IHMS	WL Art 95b, 95c, 95d, 95e; 157	WFD Art. 3 and Art. 13

2.5.1 Danube River Basin District

Montenegro is a party to the Convention on Cooperation for the Protection and Sustainable Use of the Danube River Basin (Danube Protection Convention), Sofia, 29 June, 1994, in force in Montenegro since 28 October, 2008.

Under the Danube Protection Convention, the parties must seek to achieve the goals of sustainable and equitable water management, including the conservation, improvement and rational use of surface water and groundwater in the Danube catchment area, and cooperate in the prevention, control and reduction of transboundary impacts. They are to take (and harmonize) all appropriate legal, administrative and technical measures to at least maintain and improve environmental and water quality conditions and to prevent and reduce as far as possible any adverse impacts and changes. In addition, they must endeavor to control the hazards originating from accidental pollution, floods and ice hazards, and to reduce the pollution of the Black Sea from sources in the catchment area. Article 18 of the Convention provides for the establishment of the International Commission for the Protection of the Danube River (ICPDR) of which the structure is detailed in Annex IV, to advise the parties on the measures to be implemented. The parties are to report to ICPDR on the matters listed at Article 10.

In particular, the parties are required to record water conditions in the Danube basin applying agreed quantity and quality parameters and to adopt legislation on wastewater treatment requirements, the handling of hazardous substances and the reduction of inputs of nutrients or hazardous substances from non-point sources (Article 5). In addition, they must enumerate groundwater resources subject

to long-term protection, as well as protection zones for existing or future drinking water supplies, prevent the pollution of groundwater resources, especially those reserved for drinking water supply (in particular that caused by nitrates, pesticides and other hazardous substances), prevent and control accidental pollution risks, take into account possible influences of planned activities and existing measures on water quality, evaluate the importance of different biotope elements for the river ecology and propose measures for improving the aquatic and littoral ecological conditions (Article 6). Specific obligations relate to the setting of emission limits for industries and for municipal wastewater, the implementation of permit systems for wastewater discharges, the definition of water quality objectives and criteria (Article 7) and the inventory of point and non-point sources of pollution (Article 8).

Article 9 of the Convention requires the parties to cooperate in the field of monitoring and assessment through the harmonization of their methods, the development of agreed or joint monitoring systems, the elaboration and implementation of joint monitoring programmes concerning water quality and quantity, sediments and river ecosystems as a basis for the assessment of transboundary impacts, and the development of joint or harmonized methods for the monitoring and assessment of wastewater discharges.

The parties have the duty to exchange information on bi- and multilateral agreements, legislation and measures relating to water resources management, directives and other publications, as well as reasonably available data on the general conditions of the river environment, emissions and monitoring data, accidents and measures taken and planned to be taken to prevent, control and reduce transboundary impacts (Articles 4, 10 and 12). Information on the status or the quality of riverine environment is to be made available to the public (Article 14). The parties must consult each other, through ICPDR, on planned activities which are likely to cause transboundary impacts (Articles 10-11).

Article 16 calls for coordinated or joint communication, warning and alarm systems for emergency events (accidental pollution, other critical water conditions, floods and ice-hazards) and for consultations on ways and means of harmonizing such systems, as well as for cooperation in the adoption of joint emergency plans. Article 17 is about the provision of mutual assistance in emergency cases.

The construction or reconstruction 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 accordance with international law, the parties shall establish principles and procedures for the determination of liability for damage from transboundary impacts and compensation.

The Agreement provides for the establishment of a bilateral Water Management Commission consisting of six members, that is, three 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 parties may enter into special agreements to deal with specific issues.

There are no agreements between Montenegro and Bosnia, except for a memorandum of understanding[3] on cooperation in the implementation of the West Balkans Drina River Basin Management Project (dated 9 May, 2016). By the same token, no agreements exist between Montenegro and Serbia. Montenegro holds the status of observer in the International Commission for the Sava River Basin.

Montenegro shares one transboundary aquifer of the Dinaric Karst Aquifer System with Bosnia. A number of pressures on the aquifer system were identified during the implementation of the GEF

[3] Between the MARD and the Ministry of Foreign Trade and Economic Relations of Bosnia.

DIKTAS (Protection and Sustainable Use of the Dinaric Karst Aquifer System) project (2010-2014), and 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. The recommendation was meant for the entire aquifer system, covering Albania, Bosnia, Croatia and Montenegro, but has not been implemented yet. This effort could be resumed focusing on bilateral dialogue between Montenegro and Bosnia.

3 CHARACTERISTICS OF THE DANUBE RIVER BASIN

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

The total surface of Danube watershed in 7,260 km^2 or 52.5 % of state territory. From this surface river Ibar flows into the Western Morava while rivers Tara, Piva, Lim and Ćehotina flow into the Drina River. The Danube watershed in Montenegro is the southernmost part of the Black Sea drainage basin (Figure 3.1).

The Tara River springs below the peaks of Maglić Kariman (about 2,400 m above sea level). From the source to the mouth of river Drcka, the right bank of the Tara River is much more developed than the left. The larger left tributaries are Opasanica, Pčinja, Plašnica, Štitarica, Ravnjak and the spring of Ljutica. On the right side, the Tara receives Drcka, Skrbuša, Svinjača, Jezerština, Rudnjiča, Bjelojevićka and Selačko rivers. The surface of the Tara River Basin is 2,040 km^2. The length is 148 km.

The Ćehotina River originates from beneath the Stožer mountain. After the Lim river it is the largest tributary of the Drina river. Ćehotine's influences the are Koričić, Maočnica, Vezišnica and Voloder. The surface of the Ćehotina basin to H.S. Gradac is 809.8 km^2.

The Lim River originates from the Plavsko Lake, although its source is the Vruja and Grnčar Rivers, which are forming the Ljuča river and bring almost all water in Lake Plavsko. Prior to Andrijevica on the left side in Lim flows Murinska and Zlorečica rivers, while the right are the tributaries are Đurička, Rženička, Velička and Komarača rivers. From Andrijevica to Berane, the Lim receives left tributaries Kraštica, Trebić, Ševarinska and Bistrica rivers, while the right tributaries are Šekularska and Kaludra rivers. From Berane to Bijelo Polje, there are the Brzava and Ljubovića tributaries on left side while from the right side there are Dapsićka and Lješnica rivers. From Bijelo Polje to Dobrakov on the left side there is the Bjelopoljska Lješnica river and on the right side the Bjelopoljska Bistrica river. The total length of Lim within MNE is 98 km with drainage area of 2,280 km^2.

The Piva River is formed from the high Montenegrin mountain ranges. This river, along the stream, has several names. Its source, under the south-western slopes of Durmitor, to Šavnik, is called Bukovica. Merging with Bijela in Šavnik, the watercourse continues under the name Pridvorica, retaining the name to the mouth of the Upper Komarnica in Pridvorica. The further downstream watercourse continues under the name Komarnice until the Pivski Monastery, where it receives the tributary of the Sinjaci and change of the name to Piva. The watercourse flows to Šćepan Polje, where it meets the Tara River and from there begins the Drina River. The surface of the Piva river basin is estimated at about 1,784 km^2 to Šćepan Polje. The upper Komarnica springs from under Durmitor and then runs through a canyon with a depth of 600 m and about 4 km long. Along the Komarnica stream there are pronounced karst phenomena, with insufficiently studied underground leakage and numerous hot springs.

The Ibar River originates from the north-eastern slopes of Hajla mountain at an altitude of 1,760 m. The main tributaries are the Županica, Limnička, Ibarac, Grahovska, Bukovačka, Baltička, Crnja and Bačka rivers. The shape of the Ibar basin to the hydrological station Bać is in a form of array with very prominent hydrography and possibilities for rapid formation of flood waves. The surface of the Ibar basin within MNE up from hydrological station at Bać is 413 km^2 while the length of flow within MNE is 35 km.

Table 3.1 Major rivers within the Danube River Basin in MNE

River Name	Length (km)	Drainage Area (km^2)
Tara	148	2,040
Ćehotina	99*	810*
Lim	98*	2,280*
Piva	85	1,784
Ibar	35*	413*

*length and surface area within MNE

Lake Plavsko is the biggest glacial (mountain) lake in Montenegro. It is placed in Plav/Gusinje valley at an altitude of 906 m. The average depth of this lake is about 4m while the biggest dept is 10m in central part of the lake. The shoreline is about 8 km while the surface is 2 km^2. It fills with water from river Ljuča, which brings water from surrounding Prokletije massif and it empties with Lim River which starts from this Lake. It is ellipse like shaped with length of 2.1 km and width of 1 km.

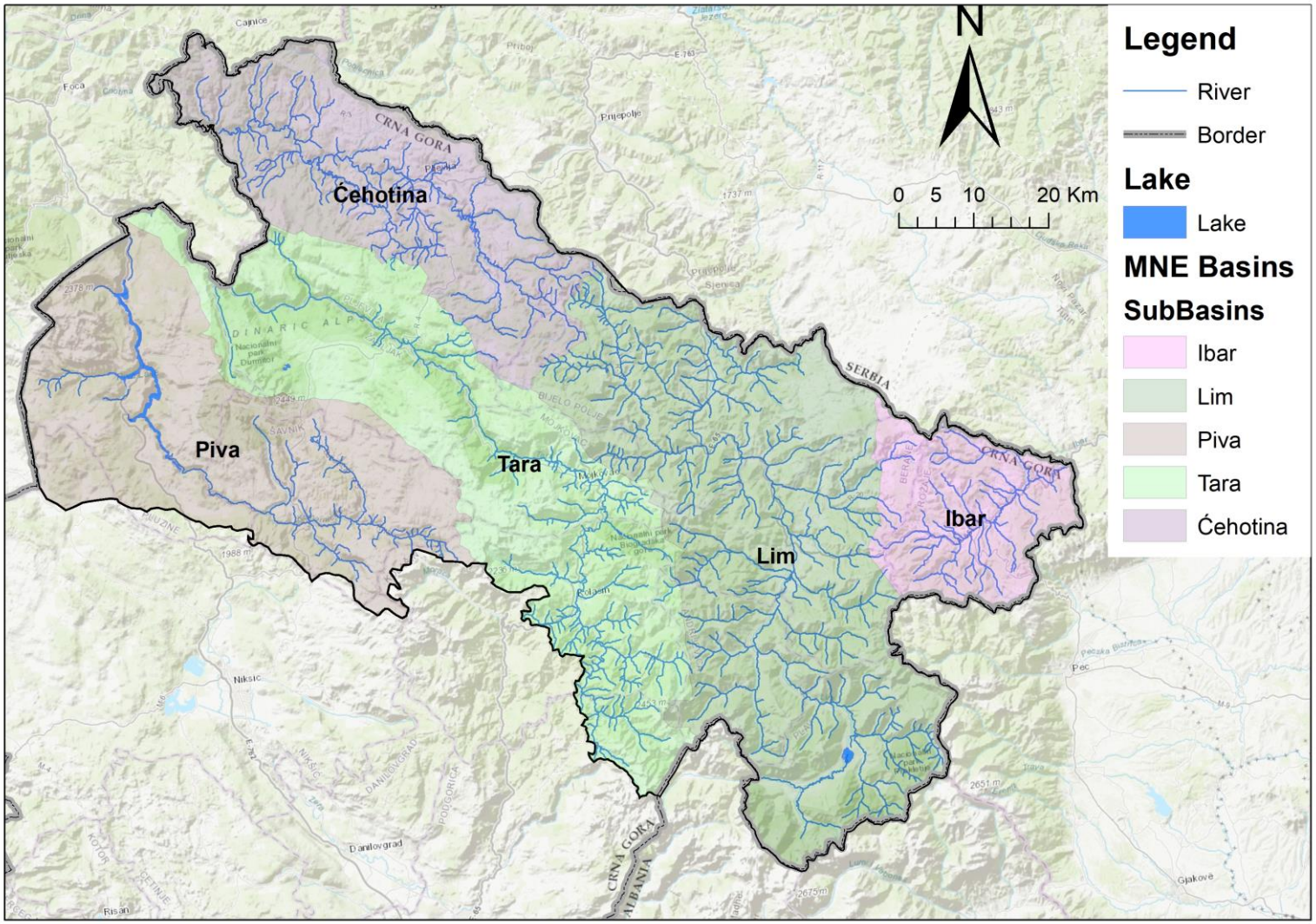
Lake Crno is one of the highest mountain lakes placed on Durmitor massif on altitude 1,416 m above sea level. It consists of two parts, Samall and Big Crno lake kidney shaped subunits. The smaller subunit is deeper with maximum depth of 49 m, while the largest part is shallower with maximum depth of 24 m. The total length of the whole lake (both subunits) is 1.15 km with a maximal width is 0.6 km. It fills with water from the well called Čeline, several smaller underwater wells as well as from the several smaller mountain brooks. The water from lakes goes underground and appears in two regions as wells in Tara and Komarnica valleys. It is placed in National Park "Durmitor".

Lake Biogradsko is situated at an altitude of 1100 m on the Bjelasica mountain. It is surrounded with Biogradska gora ancient-forest and it is one of the most beautiful mountain lakes in MNE. The lake is 1.1 km in length and 0.41 km in width with average depth of 4.5 m. The maximum dept is about 12 m in central part of the Lake. It is fed with water from the small Biogradska river and from the Bendovac brook while from the Lake it flows out small river Jezerštica which ends into the Tara River. It is placed in National Park "Biogradska Gora".

Table 3.2 Natural lakes in the Danube River Basin

Lake Name	Lake Surface Area (km$^{2)}$	Lake type
Lake Plavsko	2	glacial (mountain)
Lake Crno	0.53	glacial (mountain)
Lake Biogradsko	0.27	glacial (mountain)

Figure 3.1 Sub-Basin and river network in the Danube 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 – 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 is to identify the boundaries of the **surface water categories.** To ensure that water bodies do not cross the boundaries of surface water types, the suggested second step in delineating surface water bodies is to identify the boundaries of the **surface water types** in each river basin district[4].

This section describes the typology and delineation of the surface water bodies for the Danube River Basin (DRB) based on the ecoregions and types. The DBR is located within one ecoregion: Ecoregion # 5 Dinaric Western Balkans[5].

The typology was determined for each category of the surface water, i.e. rivers and lakes. For typology of rivers and lakes in the Danube River Basin, System A was applied with the descriptors according to the EU Water Framework Directive (Annex II), as shown in Table 3.3. This resulted in a total of 5 types of river water bodies and 3 types of lake water bodies in the Danube River Basin (Table 3.4).

Table 3.3 Rivers and Lakes – System A

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

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

[5] https://www.eea.europa.eu/data-and-maps/figures/ecoregions-for-rivers-and-lakes

Table 3.4 Types of River and Lake Water Bodies in Montenegro and in the Danube River Basin

#	River Type name	DRB
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	

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[6], 48 separate inland surface water bodies (rivers and lakes) were delineated in the Danube River Basin.

The inland surface water bodies in the DRB include 7 heavily modified water bodies (HMWBs) and 3 natural lakes (Table 3.5).

The designation surface water within municipalities has been used in order to provide a clear focus for the Programme of Measures, which are outlined in Section 10.

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

The typology of the rivers is presented in Figure 3.2. The surface water bodies are illustrated in Figure 3.3.

Table 3.5: Delineated Surface Water Bodies in the Danube River Basin

Sub-Basin	Surface Water Body	Type	Condition	Length or Area	Map No.[7]	Municipalities
Tara	Opasanica / Verušica	R1	Natural	27.04 km	1	Podgorica[8]
Tara	Tara_1	R1	Natural	6.03 km	2	Podgorica Kolašin[9]
Tara	Tara_2[10]	R1	HMWB	6.97 km	3	Kolašin
Tara	Drcka	R1	Natural	18.87 km	4	Kolašin
Tara	Tara_3	R4	Natural	29.96 km	5	Kolašin
Tara	Biogradsko Lake	L2	Natural	0.23 km^2	6	Kolašin Mojkovac
Tara	Tara_4	R5	Natural	19.35 km	7	Mojkovac
Tara	Tara_5	R7	Natural	79.77 km	8	Mojkovac Žabljak Pljevlja Plužine
Tara	Crno Lake	L1	Natural	0.52 km^2	9	Žabljak
Piva	Tušina/Bukovica	R1	Natural	30.93 km	10	Šavnik
Piva	Pridvorica	R4	Natural	14.89 km	11	Šavnik
Piva	Bijela	R1	Natural	9.00 km	12	Šavnik
Piva	Komarnica_1	R1	Natural	18.13 km	13	Šavnik
Piva	Komarnica_2	R5	Natural	17.07 km	14	Šavnik
Piva	Piva Reservoir	R7	HMWB	12.5 km^2	15	Šavnik Plužine
Piva	Vrbnica_1	R1	Natural	4.39 km	16	Plužine
Piva	Vrbnica_2	R2	Natural	3.22 km	17	Plužine
Piva	Piva[11]	R7	Natural	9.72 km	18	Plužine
Lim	Grlja_1	R1	Natural	5.61 km	19	Gusinje
Lim	Grlja_2	R4	Natural	2.08 km	20	Gusinje
Lim	Grnčar	R1	Natural	6.71 km	21	Gusinje
Lim	Ljuča	R4	Natural	12.76 km	22	Gusinje Plav
Lim	Plavsko Lake	L3	Natural	1.99 km^2	23	Plav
Lim	Lim_1	R4	Natural	26.02 km	24	Plav
Lim	Komarača[12]	R1	HMWB	20.49 km	25	Plav

[7] Map numbers refer to the position of the surface water bodies shown in Figure 3.3

[8] Podgorica Municipality is mostly in the Adriatic River Basin but extends into the Danube River Basin (12%)

[9] Kolašin Municipality is mostly in the Danube River Basin (53%)

[10] Construction of highway causing modification to Tara River

[11] Under pressure of hydropeaking on daily basis

[12] River substantially altered by small hydropower development

Sub-Basin	Surface Water Body	Type	Condition	Length or Area	Map No.[7]	Municipalities
Lim	Kutska/Mojanska/ Zlorečica	R1	Natural	28.02 km	26	Andrijevica
LIm	Lim_2	R7	Natural	44.14 km	27	Andrijevica Berane Bijelo Polje
LIm	Bistrica[13]	R2	HMWB	17.29 km	28	Berane
Lim	Popča / Vrbička rijeka	R1	Natural	24.18 km	29	Petnjica Berane
Lim	Lješnica	R2	Natural	9.31 km	30	Berane
Lim	Ljubovića_1	R2	Natural	25.30 km	31	Bijelo Polje
Lim	Ljubovića_2	R5	Natural	7.11 km	32	Bijelo Polje
Lim	Bistirca (Lj)[14]	R1	HMWB	5.89 km	33	Bijelo Polje
Lim	Lim_3	R7	Natural	23.84 km	34	Bijelo Polje
Lim	Bistrica (L)_1	R1	Natural	5.21 km	35	Bijelo Polje
Lim	Bistrica (L)_2	R2	Natural	14.83 km	36	Bijelo Polje
Ibar	Ibar_1	R1	Natural	11.21 km	37	Rožaje
Ibar	Crnja	R1	Natural	7.33 km	38	Rožaje
Ibar	Ibar_2	R4	Natural	21.48 km	39	Rožaje
Ćehotina	Ćehotina_1 /Kozička rijeka	R1	Natural	21.49 km	40	Bijelo Polje Pljevlja
Ćehotina	Ćehotina_2	R4	Natural	7.58 km	41	Pljevlja
Ćehotina	Otilovići Reservoir	R5	HMWB	7.58 km	42	Pljevlja
Ćehotina	Ćehotina_3	R5	Natural	6.80 km	43	Pljevlja
Ćehotina	Ćehotina_4[15]	R5	HMWB	10.13 km	44	Pljevlja
Ćehotina	Vezišnica	R1	Natural	11.33 km	45	Pljevlja
Ćehotina	Ćehotina_5	R5	Natural	19.32 km	46	Pljevlja
Ćehotina	Voloder	R1	Natural	21.23 km	47	Pljevlja
Ćehotina	Ćehotina_6	R5	Natural	38.43 km	48	Pljevlja

[13] River substantially altered by small hydropower development

[14] River substantially altered by small hydropower development

[15] Alteration of the river flow

Figure 3.2 Typology of the Surface Water Bodies in the Danube River Basin

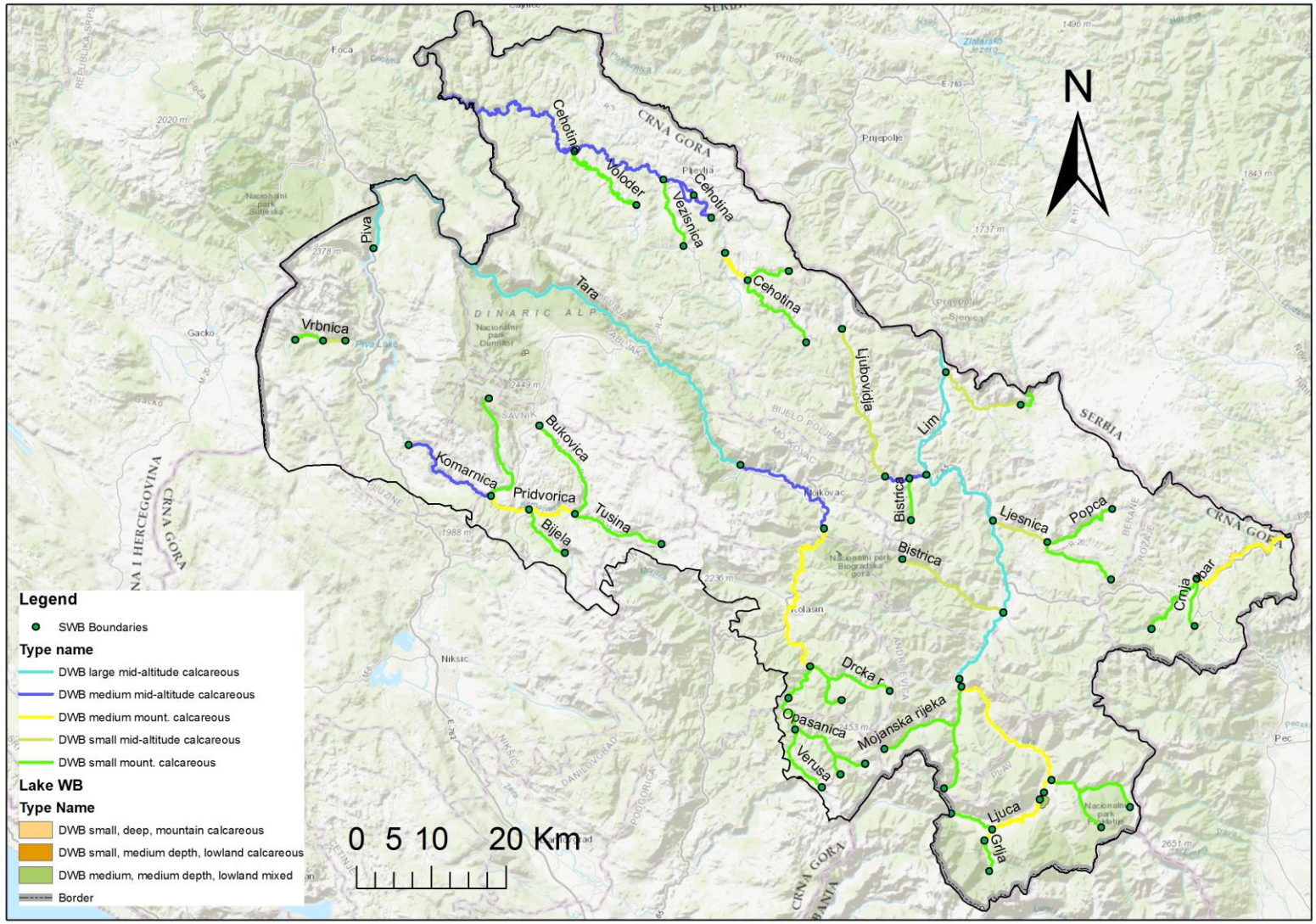
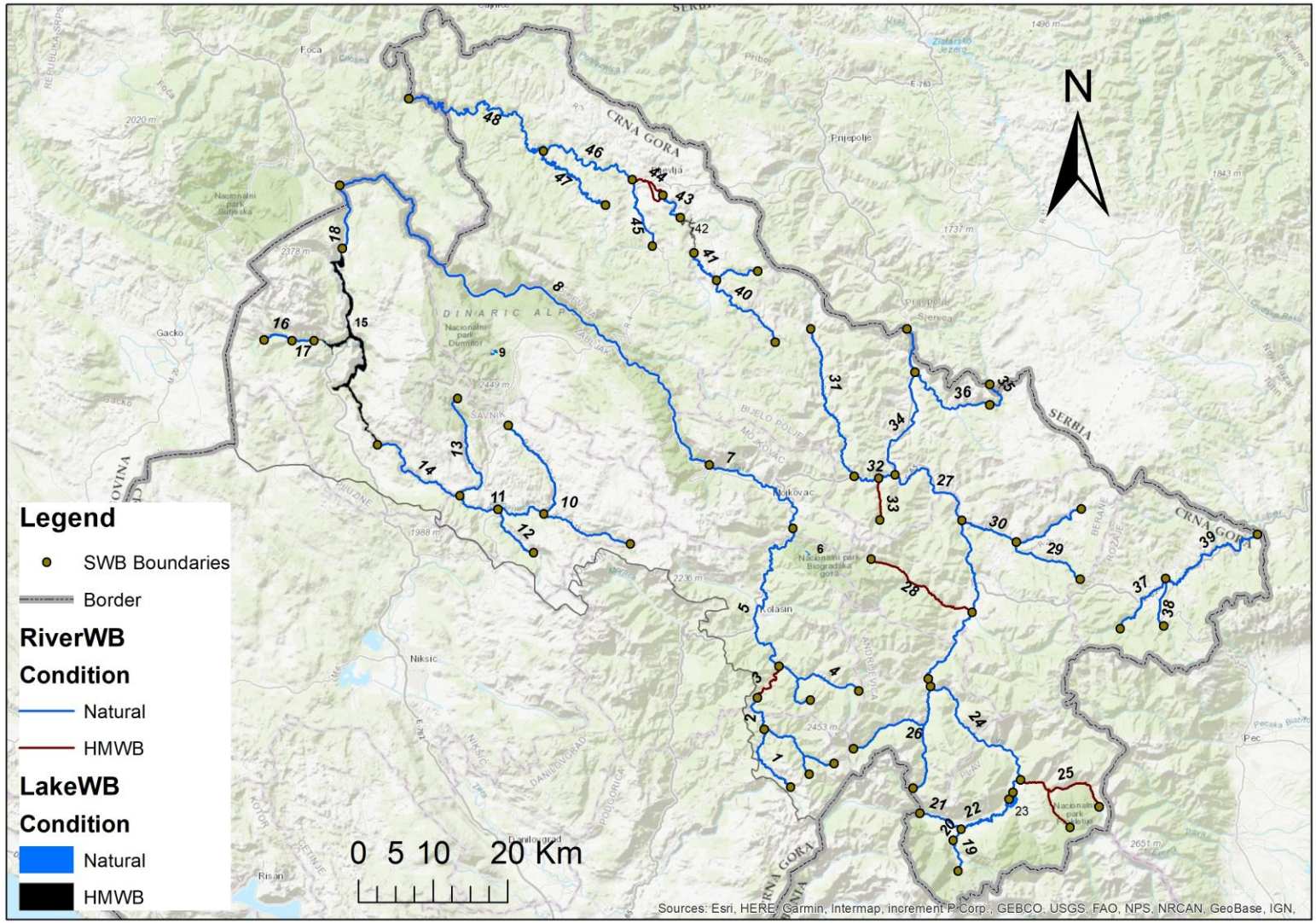


Figure 3.3 Surface Water Bodies in the Danube River Basin



3.3 Description of the groundwater

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.[16,17]

3.3.1 Geo-structural units and stratigraphy

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.

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

3.3.2 Aquifer systems

The Danube River Basin comprises 52.5% of the national territory. Lim, Ćehotina, Tara and Piva are discharging into Drina River, while Ibar River belongs to Zapadna Morava River basin. 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 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.

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

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

[17] 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

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.

Some of the largest springs in the Black Sea catchment are Alipašini springs (Q_{min} =2000 l/s, Lim basin), Ravnjak, Bjelovac, Ljutica, Kućišta (all with Q_{min} >500 l/s, Tara basin) and Sinjac, Medjedjak, Nozdruk (all with Q_{min} >500 l/s, Piva basin)[18]. Unfortunately, their discharges are only periodically observed, and discharge regimes are difficult to reconstruct.

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.

With respect to intergranular aquifer, the Neogene sediments of lacustrine origins are generally characterized by low permeability and small groundwater reserves. The thickest Neogene (Middle Miocene, M_2) lacustrine deposits are in Pljevlja basin where intensive extraction of coal (20m thick layer, in average) is taking place. The major inflow into open mine pit is from underlying and surrounding Triassic karstic aquifer, and not from overlying and lateral Neogene deposits

The permeability and groundwater availability of alluviums very much depends on river size and flows. Some other alluviums are also supplying potable water but mostly to smaller settlements (villages). Notable thickness, but rarely over 10m characterized alluviums of Piva, Tara, Ćehotina, and Lim.

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,

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

- 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 the Danube 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. However, some zones which lacking groundwater or contain minimal reserves (aquifuges) or not connected to adjacent aquifers, are not attributed to GWBs and shown on the maps (blank polygons).

3.4.2 Delineation of groundwater bodies

In the Danube River Basin there are a total of 13 groundwater bodies, comprised of 4 GWBs and 9 GGWBs (Figure 3.4). The groups of ground water bodies are shown separately in Figure 3.5. In total, 11 out of the 13 delineated water bodies are of transboundary character. There are no GWBs or GGWBs in the DRB that are larger than 1000 km^2, while 5 GWBs are smaller than 300 km^2. Table 3.6 shows the correlation of population and minimal extracted groundwater in the municipalities of the Danube River Basin.

Table 3.7 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 – DB (Danube River Basin)
- Water body – GW (Groundwater Body) or GGW (Group of Groundwater Bodies)
- Aquifer – K (karst), I (intergranular), C (complex)

Table 3.6 Correlation of population and minimal extracted groundwater in the municipalities of the Danube River Basin[19]

Municipality	Population	Q_{min} (l/s)
Pljevlja	30 786	134
Bijelo Polje	46 051	500
Berane	33 970	330
Rožaje	22 964	125
Plav	13 108	121
Kolašin	8 380	78
Mojkovac	8 622	126
Žabljak	3 569	57
Šavnik	2 070	50
Plužine	3 246	650
Andrijevica	8 622	126

The location and description of each GWB or GGWBs shown in Figure 3.4, Figure 3.5 and Table 3.7 below. A detailed characterisation of each GW or GGW body is presented in Annex 1 of this RBMP.

[19] Data provide by Monstat 2011

Figure 3.4 Groundwater bodies in the Danube River Basin

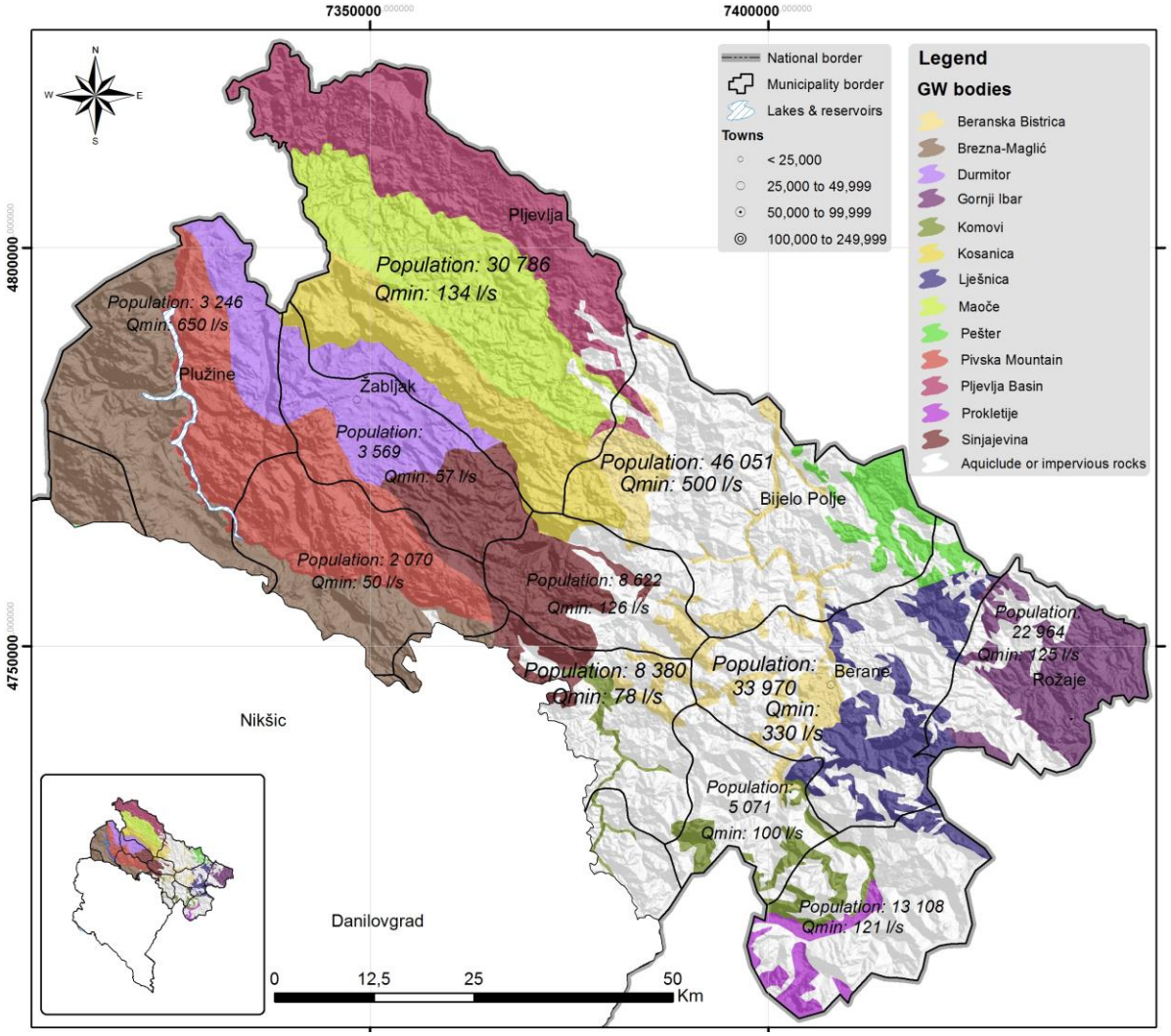


Figure 3.5 Groups of groundwater bodies in the Danube River Basin

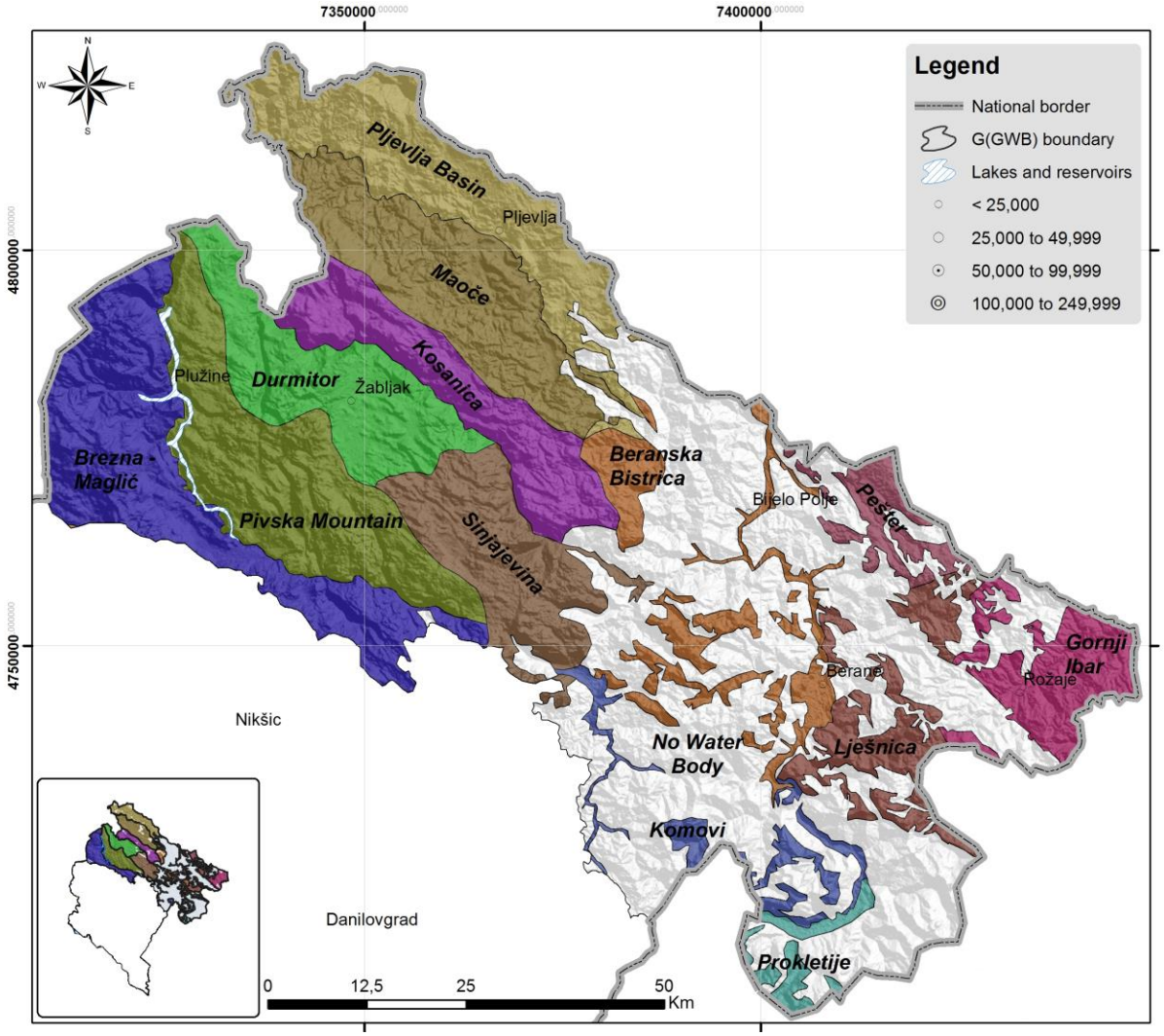


Table 3.7 Groundwater Bodies or Groups of Groundwater Bodies in the Danube River Basin

No.	Code	Character	Name	Sub - Basin	Link to Surface Water Bodies	Area (km^2)
1	ME_DB_GW_K_1	Transboundary	Brezna – Maglić	Piva	Tušinja/Bukovica Pridvorica Bijela Komarnica Piva reservoir Piva Vrbnica_1 Vrbnica_2	702.9
2	ME_DB_GW_K_2	Inner	Pivska Mountain	Piva	Tušinja/Bukovica Pridvorica Bijela Komarnica_1 Komarnica_2 Piva reservoir Piva	629.9
3	ME_DB_GW_K_3	Inner	Sinjajevina	Tara	Tara_4	406.0
4	ME_DB_GGW_K_4	Transboundary	Durmitor	Tara	Tara_5 Crno Lake	429.1
5	ME_DB_GW_K_5	Transboundary	Kosanica	Tara	Tara_3 Tara_4 Tara_5 Draga	377.5
6	ME_DB_GGW_C_1	Transboundary	Maoče	Ćehotina	Ćehotina 1/ Kozička Rijeka Ćehotina_2 Ćehotina_3 Ćehotina_4 Ćehotina _5 Ćehotina_6 Otilovici reservoir Voloder Vezišnica Sjevernica_1 Sjevernica_2	526.7
7	ME_DB_GGW_I_1	Transboundary	Pljevlja basin	Ćehotina	Ćehotina 1/ Kozička Rijeka Ćehotina_2 Ćehotina_3	554.0

No.	Code	Character	Name	Sub - Basin	Link to Surface Water Bodies	Area (km^2)
					Ćehotina_4 Ćehotina _5 Ćehotina_6 Otilovici reservoir	
8	ME_DB_GGW_K_6	Transboundary	Prokletije	Lim	Ljuca Lim_1 Plavsko Komaraca	69.1
9	ME_DB_GGW_K_7	Transboundary	Komovi	Lim	Tara_1 Tara_2 Tara_3 Drcka Ljuča Plavsko Lim_1 Lim_2	127.7
10	ME_DB_GGW_C_2	Transboundary	Beranska Bistrica - Ljubovića	Lim	Lim_1 Lim_2 Kutska/ Mojanska/ Zlorečica Bistrica (L)_1 Bistrica (L)_2	327.7
11	ME_DB_GGW_K_8	Transboundary	Lješnica	Lim	Lim_2 Lješnica Popča / Vrbička rijeka	239.9
12	ME_DB_GGW_K_9	Transboundary	Pešter	Lim	Bistrica (L)_1 Bistrica (L)_2	117.0
13	ME_DB_GGW_K_10	Transboundary	Gornji Ibar	Ibar	Ibar_1 Ibar_2 Crnja	253.0

3.4.3 Characterization of groundwater bodies

Groundwater body No. 1: “Brezna - Maglić”

The groundwater body “Brezna - Maglić” (ME_DB_GW_K_1) is located in the north-western part of Montenegro. This GWB is elongated in SE-NE direction. It is extended from Krnja Jela in the south-east to Šćepan Polje in the north-west, and from Gatačko polje in the west to Pive River in the east. The total area is around 703 km^2, of which 624 km^2 is karst.

The area is represented by hilly-mountainous terrains and canyons of Komarnica and Piva rivers. The elevations range from 477 m.a.s.l. in the area of Šćepan Polje to 2,386 m.a.s.l. at the top of Maglić Mountain. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Piva River and Komarnica River. Besides these rivers there are also few significant streams such as Bijela River, Vrbnica and Mratinjski Potok.

Figure 3.6 Geographical position of the groundwater body “Brezna - Maglić”



This area belongs to tectonic zones “High Karst” and “Durmitor”. 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), Neogene deposits (clay, marl, sand and coal) and glacial sediments are also present to a smaller extent.

The karst aquifer is represented by highly karstified limestone and dolomite (Fig. 1 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water. The karst aquifer is mostly uncovered (just small part of this area is covered by the flysch, Neogene and glacial sediments). The mean annual precipitation amounts 1,712 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 1,027 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the catchment area of springs. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: swallow hole Bobotovo Groblje (Gacko)-Sinjac Spring (v=0.52 cm/s); swallow hole Dobra Voda (Čarađe)- Springs in Fatničko polje and Sinjac Spring (v=0.63-0.68 cm/s); swallow hole Ljeljinač (Gacko)-Sinjac Spring (v=1.19 cm/s); swallow hole of Tnovačko Lake-Čokova springs (v=7.86 cm/s); swallow hole in Krnovska Glavica-Gvozdenovića Spring (Bijela) (v=3.74 cm/s).

The karst springs are mostly distributed along the rivers. There are several strong karst springs such as: Čokova Springs (Qmin= 1 m^3/s), Spring near Kruševo, Mratinjski Spring, Jakšino Vrelo and Vrioca Spring (Qmin= 0.1 m^3/s), Pola Spring (Qmin= 0.01 m^3/s), Borovnik Spring, Podvodje Spring, Orašac Spring, Sutulija Spring (Qmin= 0.05 m^3/s; Qav=1 m^3/s; Qmax= 10 m^3/s), Sinjac Spring (Qmin= 0.5 m^3/s; Qav= 20 m3/s; Qmax= 200 m^3/s), Rastioci (Qmin= 0.1 m^3/s), Bukovik (Qmin= 0.1 m^3/s), Dube Spring, Duški springs (Qmin= 0.2 m^3/s), Oko Bijele (Qmin= 0.1 m^3/s) and Gvozdenovića Spring (Qav > 0.01 m^3/s).

Groundwater body No. 2: “Pivska Mountain”

The groundwater body “Pivska Mountain” (ME_DB_GW_K_2) is located in the north-western part of Montenegro. This GWB is elongated in SE-NE direction. It is distributed from Krnja Jela in the south-east to Šćepan Polje in the north-west, and from Piva in the west to Durmitor in the east. The total area is 630 km^2, of which 613 km^2 is karst.

The area is represented by hilly-mountainous terrains, deep canyons of Komarnica and Piva rivers and karst plateau above them. The elevations range from 477 m.a.s.l. in the area of Šćepan Polje to 2,523 m.a.s.l. at the top of Durmitor Mountain. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Piva River and Komarnica River. Streams are very rare at the karst plateau because the karst terrain is very permeable, but in the upstream part of the Piva basin there are few significant rivers – Piva tributaries which belong to this GWB, such as: Tušina, Bukovica and Pridvorica.

This area belongs to tectonic zones “High Karst” and “Durmitor”. According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, J, K) have the dominant distribution (Fig. 2 in Annex 1). Besides the carbonate rocks, the Cretaceous-Paleogene (K,Pg) flysch sediments (marlstone, claystone and marly limestone) and glacial sediments are also present.

Figure 3.7 Geographical position of the groundwater body "Pivska Mountain"



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 mostly uncovered (just small part of this area is covered by the flysch and glacial sediments). The mean annual precipitation amounts 1,584 mm/year. An assessed average recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,109 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the catchment area of springs. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: swallow hole of Malo Crno Lake-Dubrovska Springs (v=2.58 cm/s), swallow hole in Pošćenske Mountain-Dubrovska Springs, Todorova Cave-Medjedjak Spring and Ruđin do-Vrutak Spring. General groundwater flow direction is from E to W.

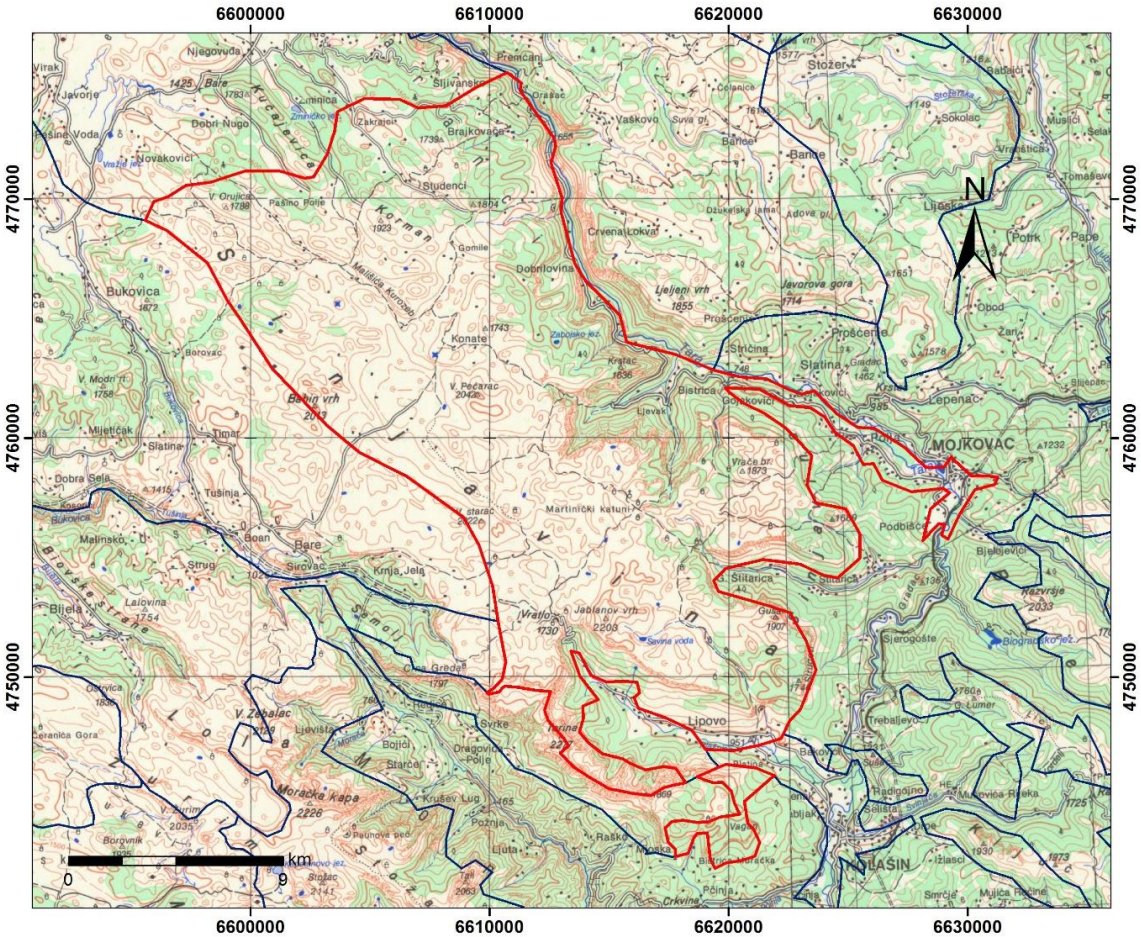
The karst springs are mostly distributed along the rivers. There are several strong karst springs such as: Bukovička springs (Q_{min}= 200 l/s), Šavnička Glava (Q_{min}= 100 l/s), Dubrovska Springs (Q_{min}= 500 l/s), Ilidža thermal spring (Q_{min}= 0.1 l/s); Bezujski Mlini, Vrutak Spring (Q_{min}= 100 l/s), Medjedjak Spring (Q_{min}= 500 l/s), Nozdruć Spring (Q_{min}= 500 l/s), Kaludjerovo Spring (Q_{min}= 400 l/s; Q_{max}= 1700 l/s).

Groundwater body No. 3: "Sinjajevina"

The groundwater body "Sinjajevina" (ME_DB_GW_K_3) is located in the northern part of Montenegro. This GWB is elongated in SE-NE direction. It is extended from Bistrica Moračka in the south-east to Brajkovača in the north-west, and from Babin Vrh in the west to Tara River in the east. The total area is 406 km^2, of which 394 km^2 is karst.

The area is represented by hilly-mountainous terrains, deep canyon of Tara River under UNESCO protection and high karst plateau above it. The elevations range from 640 m.a.s.l. in the area of Šćepan Polje to 2,022 m.a.s.l at the top of Sinjajevina Mountain. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Tara River, Plašnica and Bistrica River (Kolašin). Streams are very rare at the Sinjajevina karst plateau because the karst terrain is very permeable in that area.

Figure 3.8 Geographical position of the groundwater body "Sinjajevina"



This area belongs to tectonic zones "High Karst" and "Durmitor" (Fig. 3 in Annex 1). 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 Mesozoic flysch (breccia, sandstone and marl; J,K), glacial, alluvial and deluvial sediments are also present.

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 mostly uncovered (just small part of this area is covered by the flysch and glacial sediments). The mean annual precipitation amounts 1,889 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 1,133 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the catchment area of springs. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: Lokva swallow hole (Gornje Vučje)-Vrelo Bistrice Spring (*v*=1.22 cm/s); Ružice swallow hole (Sinjajevina)-Suvoramnjak (Bistrica) (*v*=1.65 cm/s). General groundwater flow direction is from W to E.

The karst springs are mostly distributed along the rivers. There are several strong karst springs such as: Milačko Vrelo (Q_{av} > 0.01 m^3/s), Vrelo Bistrice (Pčinje) (Q_{min}= 0.1 m^3/s), Vojkovića Spring (Plašnica) (Q_{min}= 1 m^3/s), Migalovića Spring (Q_{av} > 0.01 m^3/s), Ropušica Spring (Plašnica) (Q_{av} > 0.01 m^3/s), Ravnjak Spring (Q_{min}= 0.5 m^3/s), Ćorbudžak Spring (Q_{av} > 0.01 m^3/s), Savina Voda Spring (Q_{av} > 0.01 m^3/s).

Groundwater body No. 4: "Durmitor"

The group of groundwater bodies "Durmitor" (ME_DB_GGW_K_4) is located in the north-western part of Montenegro. This GGWB elongates in SE-NE direction. It is extended from Sinjajevina in the south-east to Šćepan Polje in the north-west, and from Durmitor in the west to Tara River in the east. The total area is 426.1 km^2, of which large majority 414 km^2 is karst.

The area is represented by hilly-mountainous terrains, canyon of Tara River and Sušica and karst plateau above them. The elevations range from 477 m.a.s.l in the area of Šćepan Polje to 2,523 m.a.s.l. at the top of Durmitor Mountain. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Tara River and Sušica River. In the area of Žabljak karst plateau there are many glacial lakes such as: Crno Lake, Vražje Lake, Modro Lake, Riblje Lake and many smaller lakes distributed along the Durmitor area.

Figure 3.9 Geographical position of the group of groundwater bodies "Durmitor"



This area belongs to tectonic zones "High Karst" and "Durmitor". 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), andesite (α), Neogene (clay, marl, sand, coal) and glacial sediments are also present.

The karst aquifer is represented by highly karstified limestone and dolomite (Fig. 4 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams in the karst plateau. The aquifer is mostly uncovered (just small part of this area is covered by the flysch and glacial sediments). The mean annual precipitation amounts 1,555 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 933 mm/year. According to a rough assessment the depth to groundwater level is over 300 m in the catchment area of springs, locally even over 600 m. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: Žabljački swallow hole-Bijela Vrela Spring (v= 5.78 cm/s), Borove Glave swallow hole (Bare Marića)-Bijela Vrela Spring (v= 0.55 cm/s), swallow hole in Bare Žugića-Ljutica Spring (v=1.8 cm/s). General groundwater flow direction is from W to E.

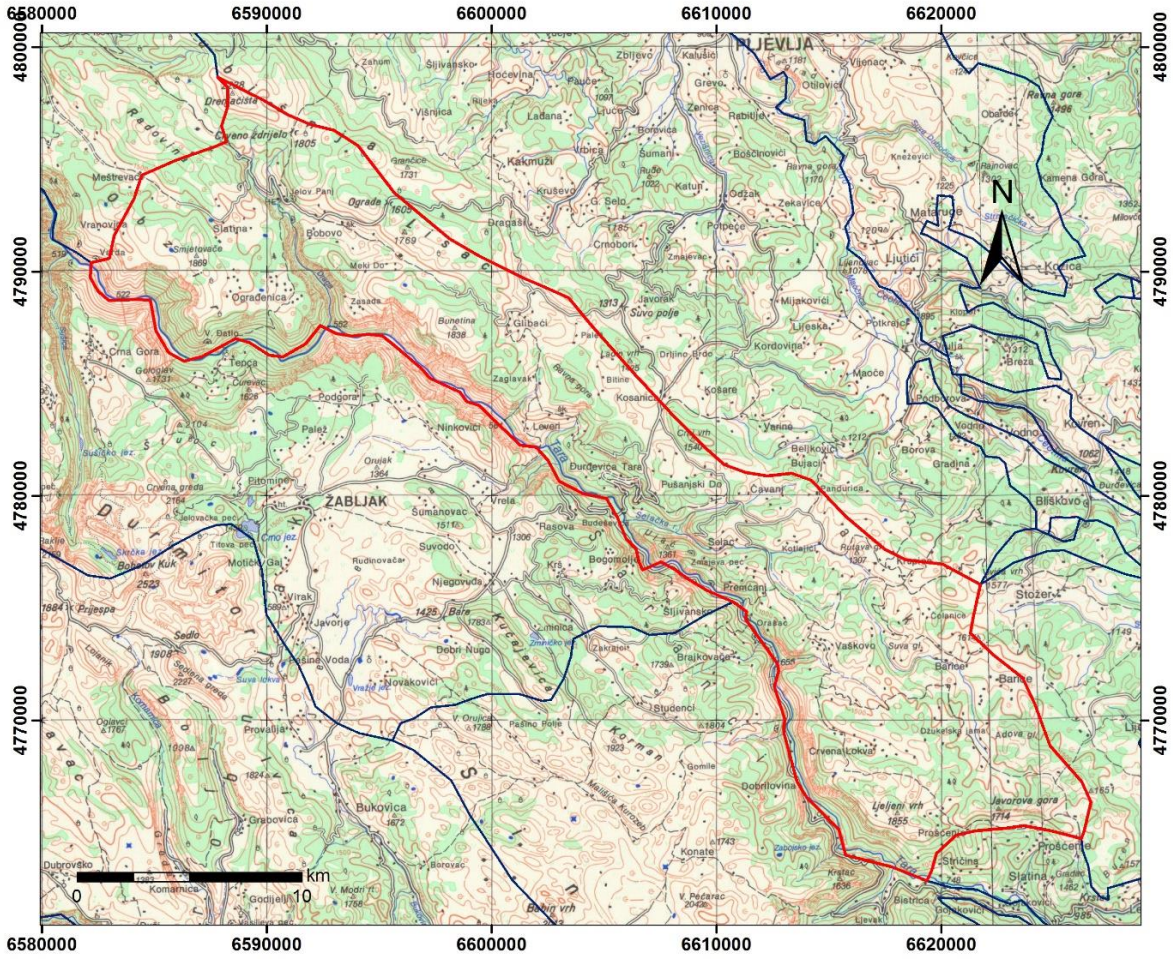
The karst springs are mostly distributed along the rivers. There are several strong karst springs such as: Vukovića Vrelo, Nozdruć Spring (Tara), Kaluđerovača Spring (Q_{min}= 0.5 m^3/s), Sige (Q_{min}= 0.1 m^3/s), Lazin Kamen, Bijela Vrela, Ljutica Spring (Q_{min}= 1 m^3/s), Lijećevine Spring, Spring in Polje Crkvičko, Oko Spring.

Groundwater body No. 5: "Kosanica"

The groundwater body "Kosanica" (ME_DB_GW_K_5) is located in the northern part of Montenegro. This GWB is elongated along the SE-NE direction. It is extended from Lepenac in the south-east to Tisov Krš in the north-west, and from Kosanica in the north-west to Tara River in the south-west. The total area is 377.5 km^2, of which 312.5 km^2 is karst.

The area is represented by hilly-mountainous terrains, deep canyon of Tara River and karst plateau above it. The elevation ranges from 519 m.a.s.l in the area of Šćepan Polje to 2,238 m.a.s.l. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Tara River and Draga River. Streams are very rare at the Kosanica karst plateau because the karst terrain is very permeable in that area.

Figure 3.10 Geographical position of the groundwater body "Kosanica"



This area belongs to tectonic zone “Durmitor”. 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 Mesozoic flysch (breccia, sandstone and marl; J,K), andesite (α), glacial and alluvial sediments are also present.

The karst aquifer is represented by highly karstified limestone and dolomite (Fig. 5 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water. 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 1,400 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 840 mm/year. According to a rough assessment the depth to groundwater level is mostly over 300 m in the catchment area of springs. Rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: Bitinski swallow hole in Kosanica- Springs of Leverska River (v=0.35 cm/s), Djurdjevski swallow hole in Kosanica-Djurdjevića Tara Springs (v=0.8 cm/s). General groundwater flow direction is from NE to SW.

The karst springs are mostly distributed along the Tara and Draga rivers. There are several strong karst springs such as: Mušova Vrela, Vrela Spring, Nikolića Luke, Kućište (Q_{min}= 1 m^3/s), Sokoline Sige (Q_{min}= 0.1 m^3/s), Borovac Spring, Bjelovac Spring (Q_{min}= 0.5 m^3/s); Springs of Leverska River, Djurdjevića Tara Springs.

Groundwater body No. 6: “Maoče”

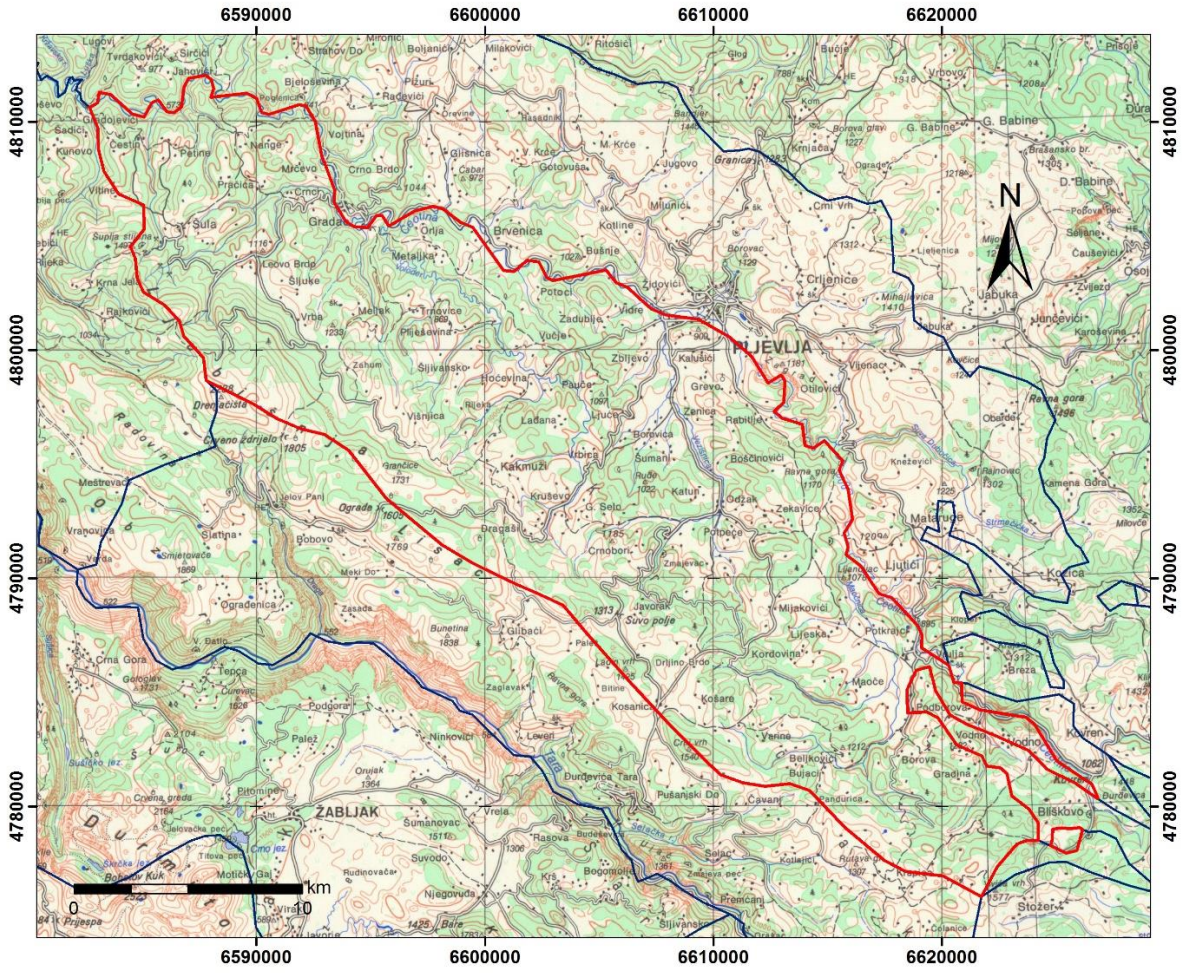
The group of groundwater bodies “Maoče” (ME_DB_GGW_C_1) is located in the northern part of Montenegro. This GGWB elongates in NW-SE direction. It is extended from Vitine in the north-west to Bliško in the south-east, and from Kosanica in the south-west to Pljevlja in the north-east. The total area is 526.7 km^2, of which 323.7 km^2 is karst.

The area is represented by hilly-mountainous terrains and valley along the Ćehotina River. An elevation ranges from 544 m.a.s.l. to 2,031 m.a.s.l. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Ćehotina River (with reservoir “Otilovići”), Maočnica, Voloder, Vežišnica and Sjevernica River.

This area belongs to tectonic zone “Durmitor”. According to the Geological Map of Montenegro 1:200,000, the Mesozoic limestone and dolomite (T, J) have the dominant distribution. Besides the carbonate rocks, the Diabase-chert formation (J_{2+3}), Neogene sediments (clay, marl, sand, coal) and andesite (α) are also present.

The karst aquifer is represented by highly karstified limestone and dolomite (Fig. 6 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams in the karst plateau. The aquifer is mostly uncovered (just small part of this area is covered by the Neogene sediments of Maoče coal basin, Diabase-chert formation and andesite). The mean annual precipitation amounts 1,021 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 613 mm/year. According to a rough assessment the depth to groundwater level is over 100 m in the catchment area of springs. There are no results of tracer tests from this area. General groundwater flow direction is from SW to NE.

Figure 3.11 Geographical position of the group of groundwater bodies "Maoče"



The karst springs are mostly distributed along the rivers. There are several strong karst springs such as: Mandovac Spring (Q_{min}= 0.01 m^3/s, Q_{av}=0.1 m^3/s; Q_{max}= 0.27 m^3/s), Zmajevac Spring (Potpeć) (Q_{min}= 0.045 m^3/s); Bezarska Vrela (Q_{min}= 0.024 m^3/s); as well as a few springs which discharge regime is unknown: Džanova Česma, Vodice Spring, Vrelo Spring, Gomilanovića Spring, Manito Vrelo, Rutovac, Točak, Spring of Rzavska River, Ratkova Pećina Spring.

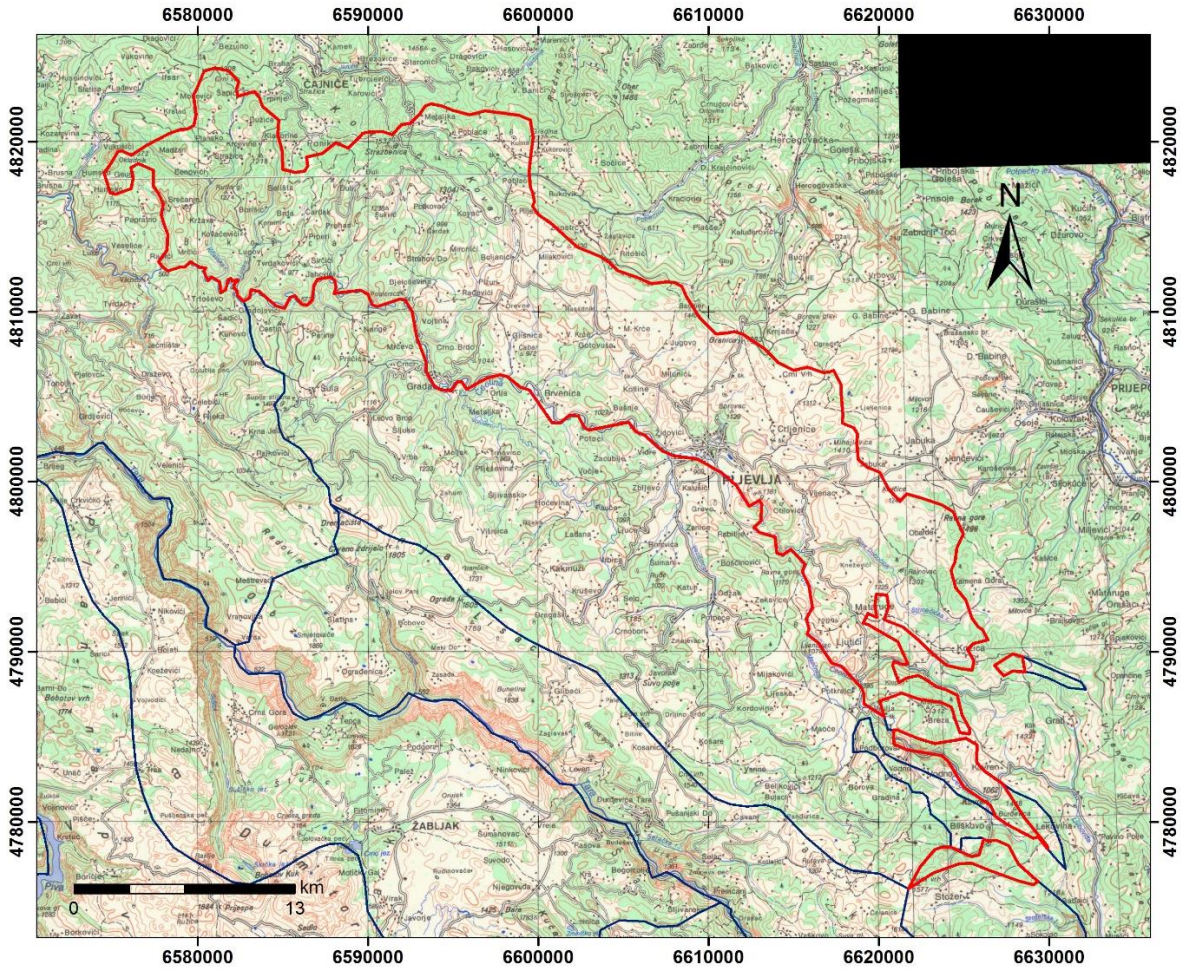
Groundwater body No. 7: "Pljevlja Basin"

The group of groundwater bodies "Pljevlja basin" (ME_DB_GGW_I_1) is located in the northern part of Montenegro. This GGWB elongates in NW-SE direction. It is outcroped from Vitine in the north-west to Bliško in the south-east, and from Pljevlja in the south-west to Jabuka in the north-east. The total area of this group of groundwater bodies in the territory of Montenegro is 554 km^2, of which 435 km^2 is karst.

The area is represented by hilly-mountainous terrains and valley along Ćehotina River. The elevations range from 544 m.a.s.l. to 1,353 m.a.s.l. There are numerous surface and subsurface karst landforms

in this area. Dolines are often densely arranged in the form of polygonal karst. The main rivers are Ćehotina River (with reservoir "Otilovići"), Suva Dubočica, Lužavska River and Kržavska River.

Figure 3.12 Geographical position of the group of groundwater bodies "Pljevlja basin"



This area belongs to tectonic zone "Durmitor". According to the Geological Map of Montenegro 1:200,000, the Mesozoic limestone and dolomite (T, J) have the dominant distribution. Besides the carbonate rocks, the Diabase-chert formation (J_{2+3}), Neogene sediments (clay, marl, sand, coal) and andesite (α) are also present (Fig. 7 in Annex 1).

The karst aquifer is represented by highly karstified limestone and dolomite, of prevailing Triassic age. The aquifer is of transboundary character extends also to neighbour Serbia. A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams in the karst plateau. The aquifer is mostly uncovered, but around 20% of it is covered by the Neogene sediments, Diabase-chert formation and andesite). The mean annual precipitation amounts 866 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 532 mm/year. According to a rough assessment the depth to groundwater level is over 100 m in most of catchment area of springs. There are only results of tracer tests from Serbia close to Montenegro border (Tmuša swallow hole). General groundwater flow direction is from NE to SW.

The karst springs are mostly distributed along the rivers. There are several karst springs such as: Bezdan Spring (Breznica River, Pljevlja) (Q_{min}= 0.05 m^3/s), Joguštica Spring (Q_{min}= 0.005 m^3/s). The spring Tvrdaš no longer exists because the water table had depleted below spring orifice due to intensive dewatering of open coal pit of Pljevlja.

Groundwater body No. 8: "Prokletije"

The group of transboundary groundwater bodies "Prokletije" (ME_DB_GGW_K_6) is located in the eastern part of Montenegro. This GGWB is extended from Prokletije in the south to Ljuča River in the north, and from Albania in the west to Rudo Polje in the east. The total area of this group of groundwater bodies in the territory of Montenegro is estimated on 69.1 km^2.

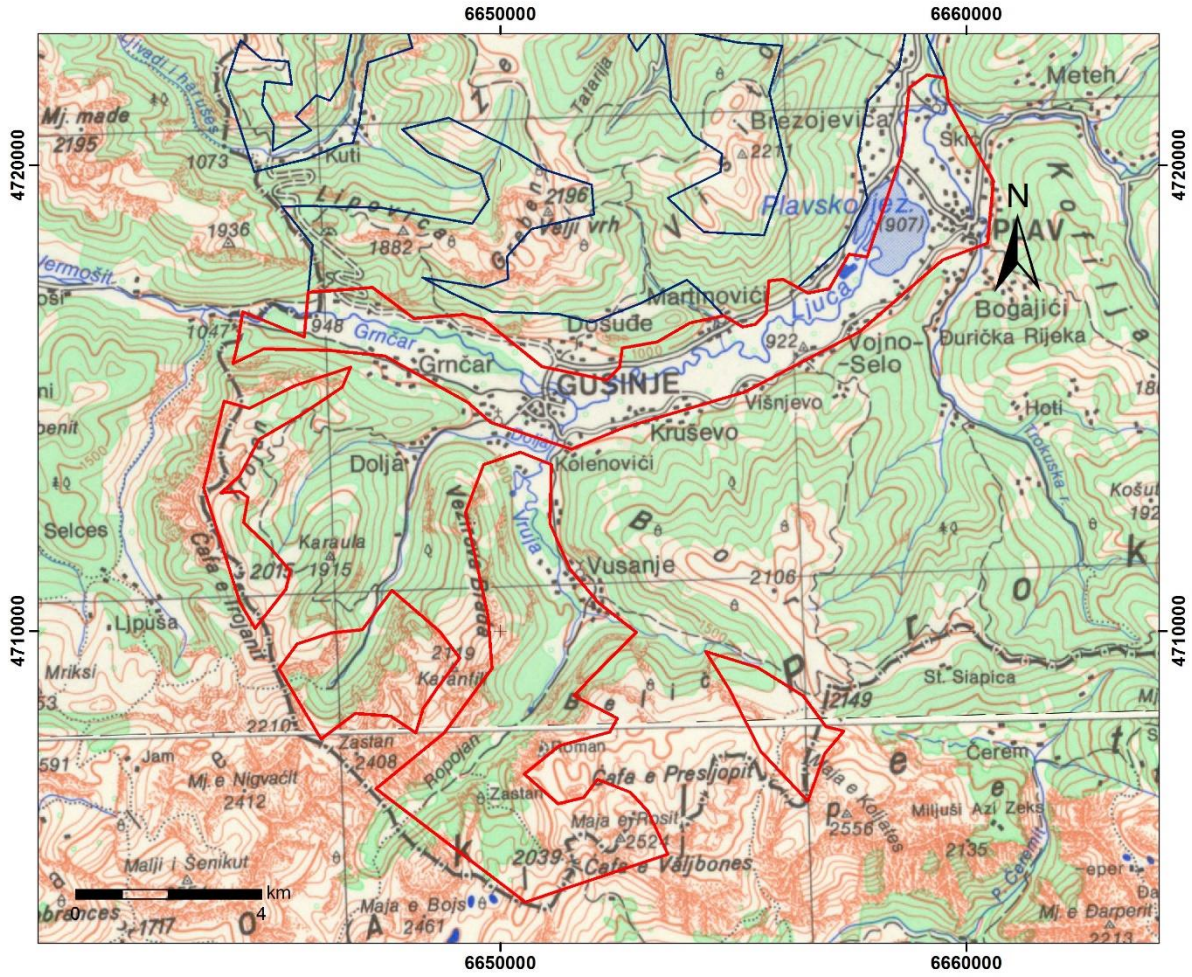
The area is represented by hilly-mountainous karst terrains and valley along the Grnčar and Ljuca River. An elevation ranges from 920 m.a.s.l. in the area of Plavsko Lake to 2,190 m.a.s.l. at the top of Prokletije Mountain. There are numerous surface and subsurface karst landforms in this area. The main rivers are Grnčar, Vrulja and Ljuca.

This area belongs to tectonic unit "Durmitor". According to the Geological Map of Montenegro 1:200,000, the Mesozoic limestone and dolomite (T, J) have the dominant distribution. Besides the carbonate rocks, the alluvial and glacial sediments are also present (Fig. 8 in Annex 1).

The karst aquifer is represented by karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water. The aquifer is mostly uncovered. The mean annual precipitation amounts 1,600 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 1,120 mm/year. A significant part of recharge area is outside the territory of Montenegro. According to a rough assessment the depth to groundwater level is over 100 m at most of GGWBs. There are no tracer tests conducted in this area. General groundwater flow direction is from S to N.

The karst springs are mostly distributed along the rivers. There are several karst springs such as: Alipašini Springs (Q_{min}=2.0 m^3/s; Q_{max}=7 m^3/s), Bajrovića Springs (Q_{min}=0.02 m^3/s), Springs along Crna Dolja, Springs along Skakavac, Springs along Berički stream.

Figure 3.13 Geographical position of the group of groundwater bodies "Prokletije"

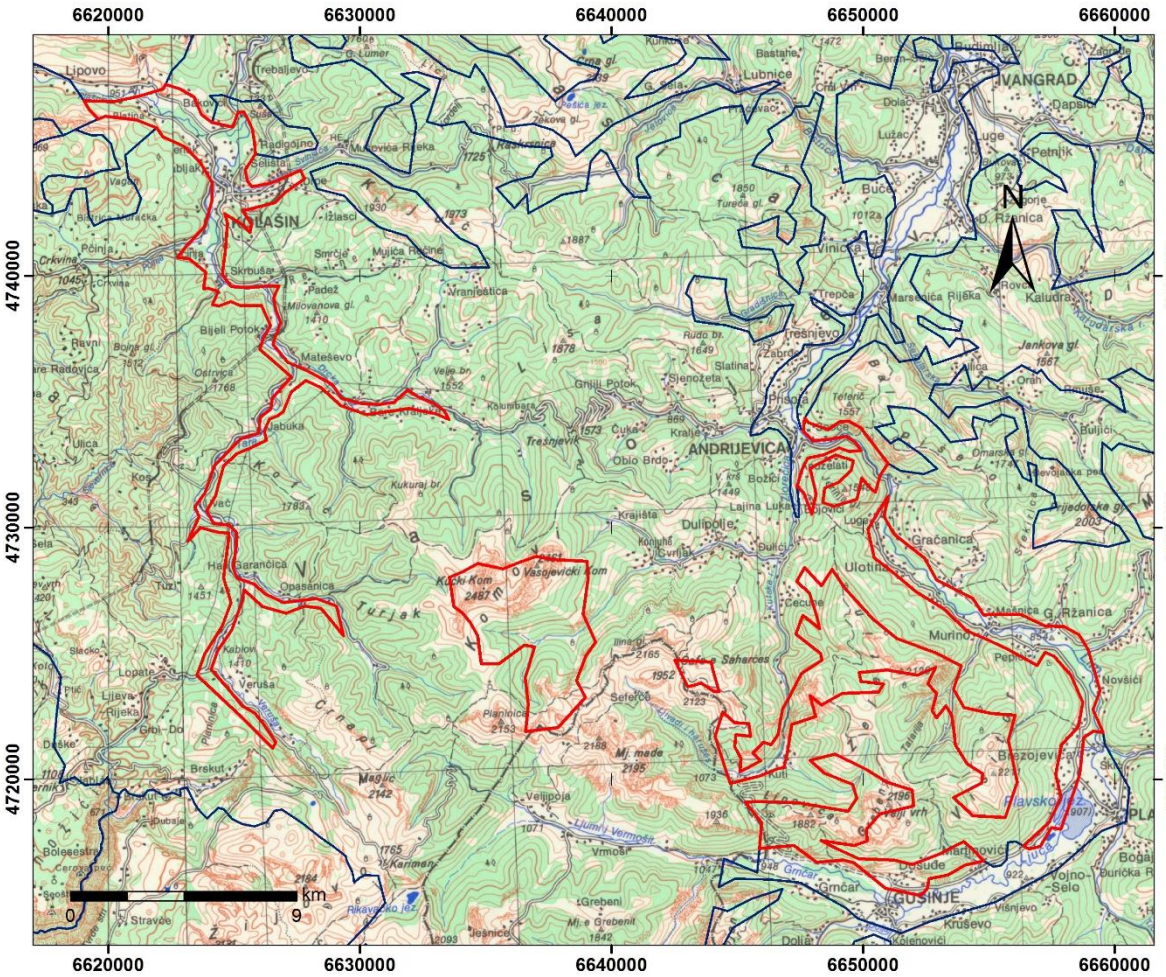


Groundwater body No. 9: "Komovi"

The group of transboundary groundwater bodies "Komovi" (ME_DB_GGW_K_7) is located in the eastern part of Montenegro. This GGWB is distributed from Tara River in the west to Lim River in the east, and from Gusinje in the south to Andrijevica in the north. The total area of this group of groundwater bodies in the territory of Montenegro is 127.7 km^2.

The area is represented by hilly-mountainous karst terrains and valley along the Tara River. An elevation ranges from 902 m.a.s.l. in the area of Kolašin to 2,461 m.a.s.l. at the top of Komovi mountains. There are numerous surface and subsurface karst landforms in this area. The main rivers are Tara and Kutska rivers.

Figure 3.14 Geographical position of the group of groundwater bodies "Komovi"



This area belongs to tectonic zones "High Karst" and "Durmitor". According to the Geological Map of Montenegro 1:200,000 the Triassic limestone and dolomite (T) have the dominant distribution. Besides the carbonate rocks, the alluvial and glacial sediments are also present (Fig. 9 in Annex 1).

The karst aquifer is represented by karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water. The aquifer is mostly uncovered. The mean annual precipitation amounts 1,451 mm/year. An assessed recharge rate (effective infiltration) is around 65% of precipitation rate, i.e. around 943 mm/year. One part of recharge area is outside the territory of Montenegro. According to a rough assessment the depth to groundwater level at most of GGWBs is over 200 m. There are no tracer test conducted for this area.

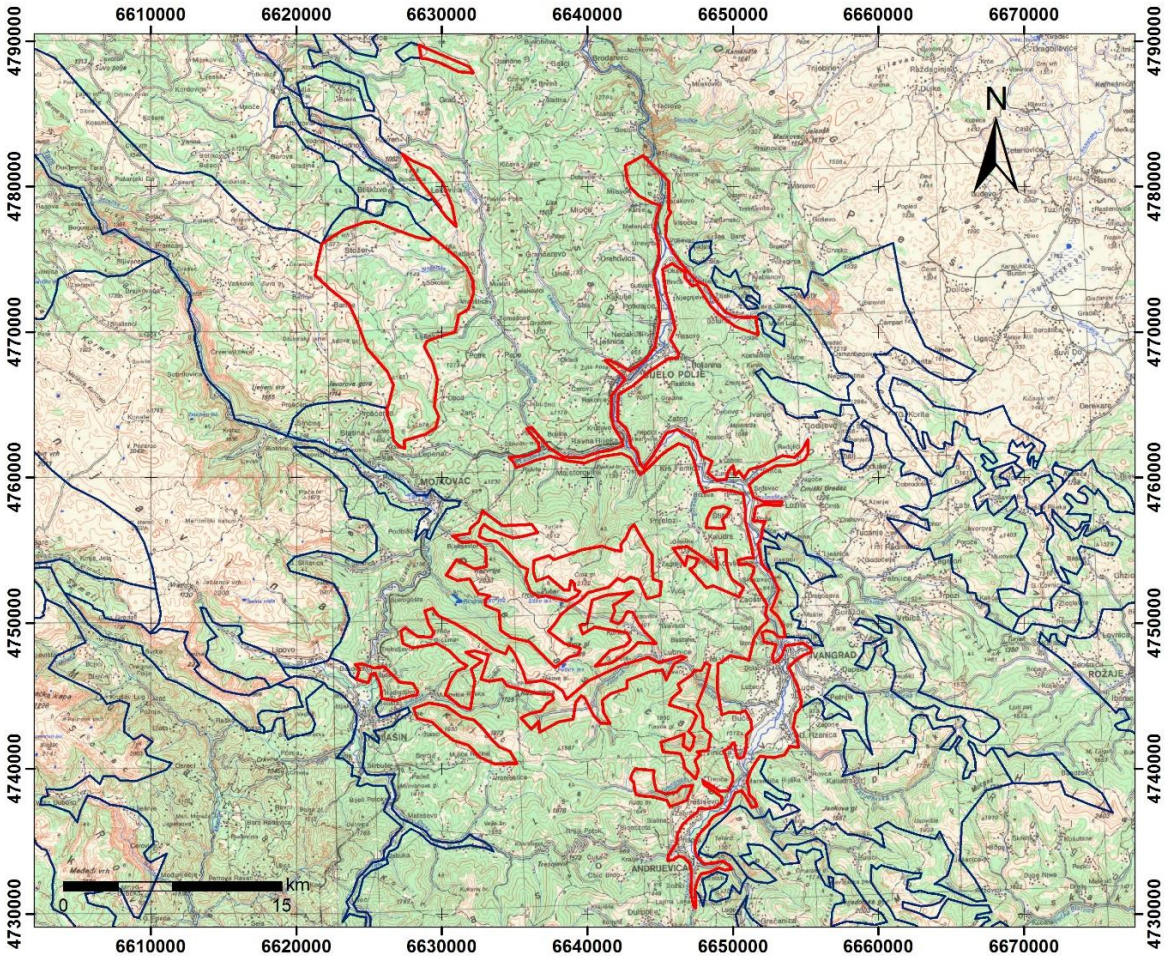
The karst springs are mostly distributed along the rivers. There are several karst springs such as: Krkori Spring (Q_{min}=0.1 m^3/s); Pipuran Spring (Murino) (Q_{min}=0.01 m^3/s; Q_{av}=0.04 m^3/s; Q_{max}=0.1 m^3/s).

Groundwater body No. 10: "Beranska Bistrica - Ljubovića"

The group of complex and relatively dispersed groundwater bodies "Bistrica-Ljubovića" (ME_DB_GGW_C_2) is located in the north-eastern part of Montenegro. This GGWB is distributed from Radigojna in the west to Berane in the east, and from Andrijevica in the south to Dobrakovo in the north. The total area of this group of groundwater bodies is 327.7 km^2.

The area is represented by hilly-mountainous karst terrains and valley along the Lim River. An elevation ranges from 517 m.a.s.l. to 2,122 m.a.s.l. There are numerous surface and subsurface karst landforms in this area. The main rivers are Lim River, Beranska Bistrica and Ljubovića.

Figure 3.15 Geographical position of the group of groundwater bodies "Bistrica-Ljubovića"



This area belongs to tectonic unit "Durmitor" of Internal Dinarides. According to the Geological Map of Montenegro 1:200,000 the Triassic limestone and dolomite (T) have the dominant distribution. Besides the carbonate rocks, alluvial and glacial sediments are also present (Fig. 10 in Annex 1).

The karst aquifer is represented by karstified limestone and dolomite. A groundwater recharge mainly occurs by infiltration of atmospheric water. The aquifer is mostly uncovered (unconfined). The mean annual precipitation amounts 1,236 mm/year. An assessed recharge rate (effective infiltration) is

around 65% of precipitation rate at the karstic terrains, i.e. around 803 mm/year. One part of recharge area is outside the territory of Montenegro. According to a rough assessment the depth to groundwater table at most of GGWBs is over 200 m. There are tracer test undertaken in this area.

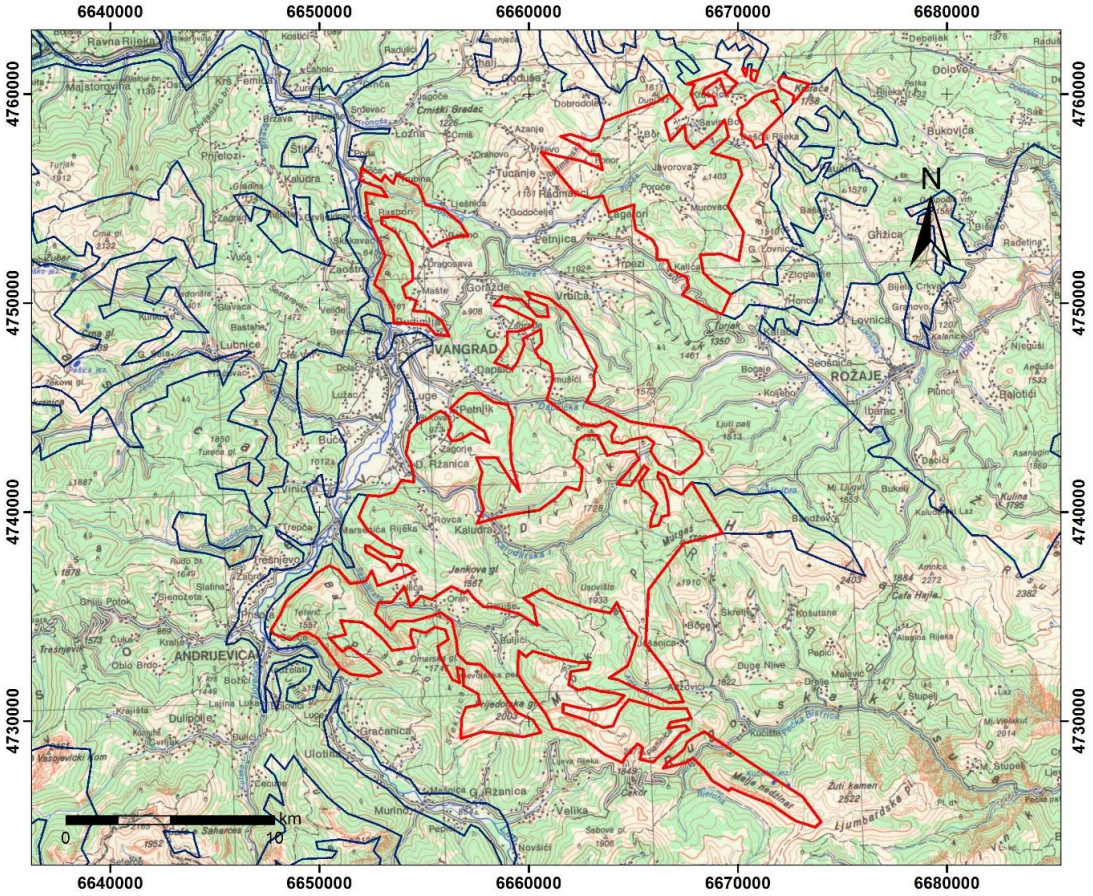
The karst springs are mostly distributed along the rivers. There are numerous karst springs such as: Vrelo (Mušovića Rijeka) (Q_{min}=0.08 m^3/s), Vrelo Bistrice (Majstorovina, Ljubovića) (Q_{min}=0.5 m^3/s), Manastirski Spring (Q_{min}=0.1 m^3/s), Merića Vrelo (Q_{min}=0.2 m^3/s), Daspićko Vrelo (Q_{min}=0.045 m^3/s), Vinicka Spring (Q_{min}=0.03 m^3/s), Bjelezi Spring (Q_{min}=0.003 m^3/s), Trepča Spring (Q_{min}=0.03 m^3/s), Komčar Spring (Q_{min}=0.0025 m^3/s).

Groundwater body No. 11: "Lješnica"

The group of transboundary groundwater bodies "Lješnica" (ME_DB_GGW_K_8) is located in the eastern part of Montenegro. This GGWB is distributed from Lim River in the west to country border with Serbia in the east, and from Surdup in the south to Radmanci in the north. The total area of this group of groundwater bodies is 239.9 km^2.

The area is represented by hilly-mountainous karst terrains and valley along the Lim River. An elevation ranges from 633 m.a.s.l. to 2,003 m.a.s.l There are numerous surface and subsurface karst landforms in this area. The main rivers are Lim River and Lješnica River.

Figure 3.16 Geographical position of the group of groundwater bodies "Lješnica"



This area belongs to tectonic unit “Durmitor” of Inner Dinarides. According to the Geological Map of Montenegro 1:200,000 the Triassic limestone and dolomite (T) have the dominant distribution. Besides the carbonate rocks, alluvial and glacial sediments are also present.

The karst aquifer is represented by karstified limestone and dolomite (Fig. 11 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water. The aquifer is mostly uncovered, unconfined. The mean annual precipitation amounts 877 mm/year. An assessed recharge rate (effective infiltration) is around 60% of precipitation rate, i.e. around 526 mm/year. One part of recharge area is outside the territory of Montenegro, in Serbia. According to a rough assessment the depth to groundwater level is mostly over 200 m. There are no tracer test carried out in this area. General groundwater flow direction is from east to west.

The karst springs are mostly distributed along the rivers. There are numerous karst springs such as: Popča Sping (Q_{min}=0.07 m^3/s), Pusta Vrata Spring (Q_{min}=0.027 m^3/s), Soca Spring (Q_{min}=0.01 m^3/s), Bijela Vrela (Andrijevica) (Q_{min}=0.1 m^3/s), Pjaninica Spring (No. 2267/07) (Q_{min}=0.1 m^3/s), Navotila Spring (Q_{min}=0.01 m^3/s).

Groundwater body No. 12: “Pešter”

The group of transboundary groundwater bodies “Pešter” (ME_DB_GGW_K_9) is located in the north-eastern part of Montenegro. This GGWB is elongated from Bistrica in the west to country border with Serbia in east, and from Radmanci in the south to Stolovi in the north. The total area of this group of groundwater bodies in the territory of Montenegro is 117 km^2.

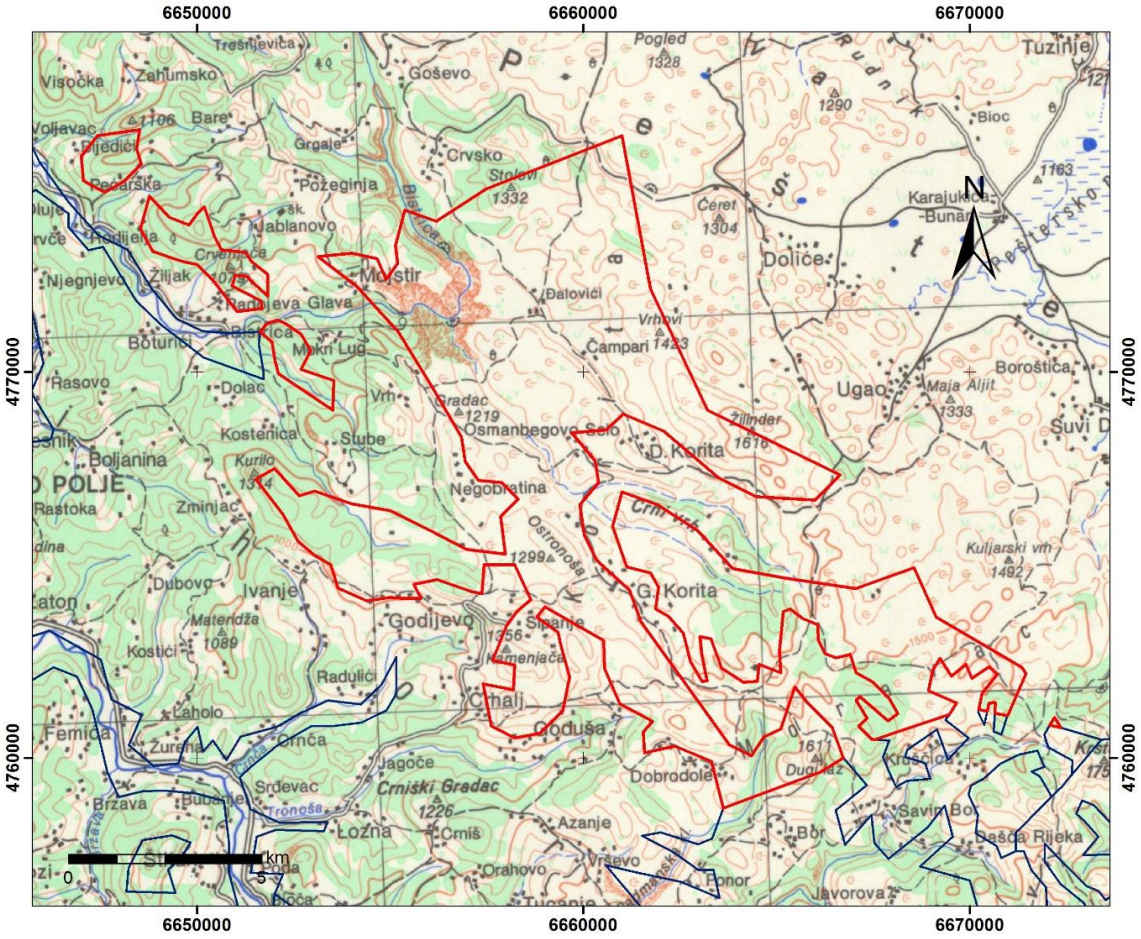
The area is represented by hilly-mountainous karst terrains. An elevation ranges from 644 m.a.s.l. in the area of Bistrica to 1,631 m.a.s.l. at the Pešter Plateau. There are numerous surface and subsurface karst landforms in this area. Dolines are often densely arranged in the form of polygonal karst. The longest cave of Montenegrin karst (“Pećina nad Vražjim Firovima”) is located in this area (its length is around 17.5 km). The main river is Bistrica River (Bijelo Polje).

This area belongs to tectonic unit “Durmitor” of Inner Dinarides. According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T) have the dominant distribution. Besides the carbonate rocks the glacial sediments are also present (Fig. 12 in Annex 1).

The karst aquifer is represented by karstified limestone and dolomite mostly of Triassic age. A groundwater recharge mainly occurs by infiltration of atmospheric water. The aquifer is mostly uncovered. The mean annual precipitation amounts 855 mm/year. An assessed recharge rate (effective infiltration) is around 70% of precipitation rate, i.e. around 598 mm/year. A significant part of recharge area is outside the territory of Montenegro. According to a rough assessment the depth to groundwater level at the plateau is over 300 m. Presence of spacious caves and rapid fluctuations of discharge on karst springs indicate that the karst aquifer is very permeable. According to the results of tracer tests the following hydraulic connections between swallow holes and springs have been determined: swallow hole in Kasapnica-Glava Bistrice, swallow hole in Milovo Polje-Glava Bistrice, swallow hole in Milovo Polje-Springs in Stube. General groundwater flow direction is from E to W.

The karst springs are mostly distributed along the Bistrica River. There are several karst springs such as: Glava Bistrice (Q_{min}=0.2 m^3/s; Q_{max}=3 m^3/s), Juriška Springs (Qmin=1 m^3/s) and Springs in Stube.

Figure 3.17 Geographical position of the group of groundwater bodies "Pešter"

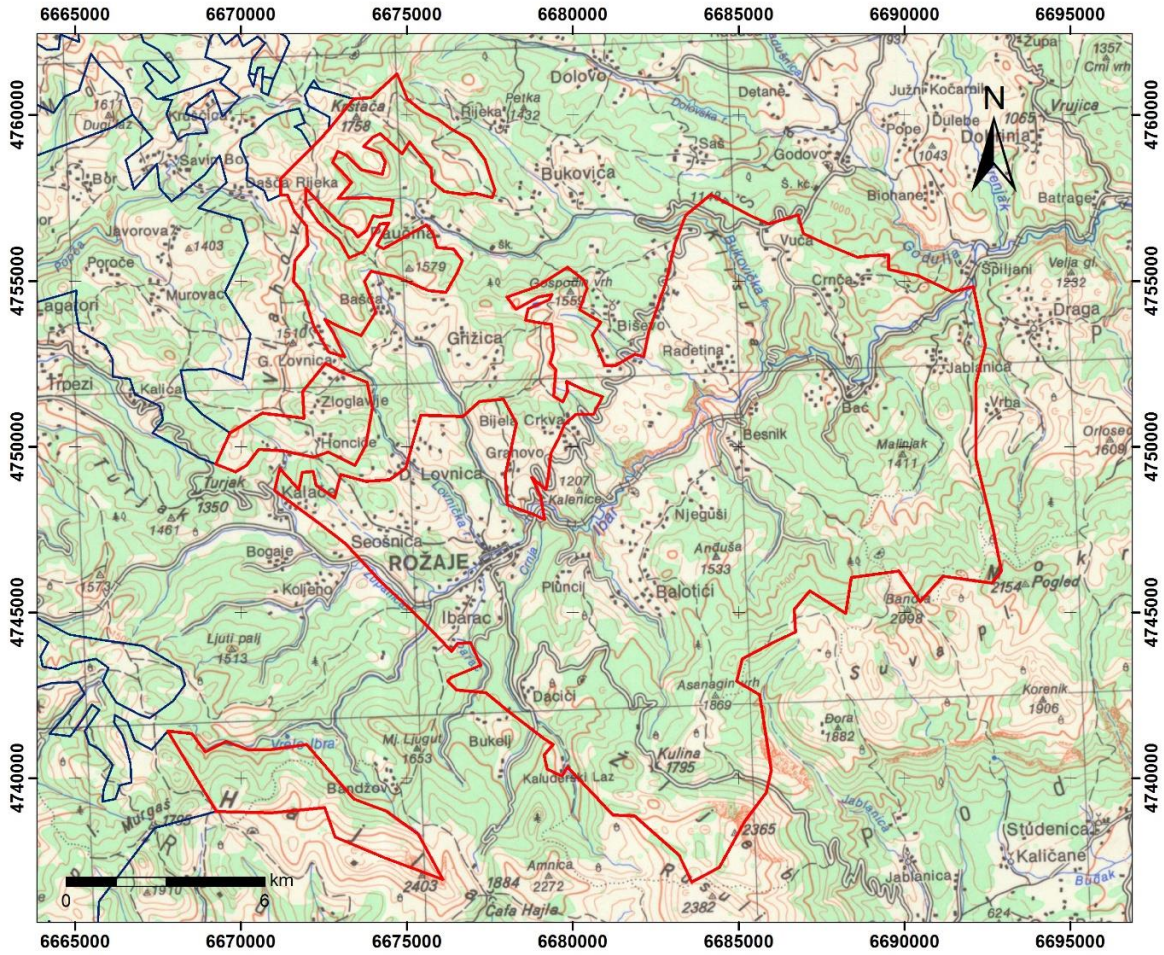


Groundwater body No. 13: "Gornji Ibar"

The group of groundwater bodies "Gornji Ibar" (ME_DB_GGW_K_10) is located in the north-western part of Montenegro. This GGWB is distributed from Koljeno in the west to Draga in the east, and from Suva Mountain in the south to Biševo in the north. The total area is 253 km^2, of which 206 km^2 is karst.

The area is represented by hilly-mountainous terrains and valley along Ibar River. The elevations range from 784 m.a.s.l. in the area of Draga to 2,382 m.a.s.l. at the top of Rusulija Mountain. There are numerous surface and subsurface karst landforms in this area. The main river is Ibar River with tributaries (Lovnička River, Crnja River, Bukovička River, Njeguški stream and Baćanska River).

Figure 3.18 Geographical position of the group of groundwater bodies "Gornji Ibar"



This area belongs to Inner Dinarides and tectonic zone "Durmitor". According to the Geological Map of Montenegro 1:200,000 the Mesozoic limestone and dolomite (T, K) have the dominant distribution. Besides the carbonate rocks, the Diabase-chert formation (J_{2+3}), Neogene sediments (clay, marl, sand, coal), glacial (gl) and glacial-fluvial sediments (glf) are also present.

The karst aquifer is represented by highly karstified limestone and dolomite (Fig. 13 in Annex 1). A groundwater recharge mainly occurs by infiltration of atmospheric water and sinking of streams in the karst plateau. The aquifer is mostly uncovered (just small part of this area is covered by the Neogene sediments and Diabase-chert formation). The mean annual precipitation amounts 1,089 mm/year. An assessed recharge rate (effective infiltration) is around 55% of precipitation rate, i.e. around 599 mm/year. According to a rough assessment the depth to groundwater level is over 200 m in most of catchment area of springs. There are no results of tracer tests from this area. General groundwater flow direction is from E to W.

The karst springs are mostly distributed along the rivers. There are several karst springs such as: Vrelo Ibra (Q_{min}=0.1 m^3/s), Plunačko Vrelo (Q_{min}=0.01 m^3/s), Grlja Spring (Q_{min}=0.005 m^3/s), Grahovska Vrela and Topljik 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[20].

Monitoring and measuring of hydro-meteorological phenomena in the Danube River Basin is officially conducted by the hydro-meteorological service (IHMS). There is a network of 51 meteorological stations and 32 hydrological stations currently in operation. The current network of hydrological stations is illustrated in Section 6.2.2.

Efforts have previously been made to invest in the development of a hydrological forecasting model with daily time-step for forecasting of the major hydro-profiles in the Danube River Basin[21]. The model forecasts high and medium discharges, with a somewhat less reliable forecast of low discharges that is still satisfactory.

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 was calculated in distributed manner for the entire basin area.

A very good statistical relationship was 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 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 Danube River Basin, and that they exert significant influence on estimation of average discharges. Discharge downtrends were registered on all stations for the period from 1946 to 2012, and statistically significant trend at significance threshold $\alpha = 0.05$ was registered in the upper course of the Lim River. The majority of hydrological stations registered annual discharge trend close to the confidence threshold $\alpha = 0.05$. Negative annual discharge trends in the basins of South-East Europe have presented similar findings.

Table 3.8 provides the numerical regime indicators for water regime in the Danube River Basin, including the sub-basin areas, the period of analysis together with the minimum and the mean and maximum annual discharges (Q).

[20] EU Project starting in 2019. 'Support to implementation and monitoring of water management'. EuropeAid/139429/IH/SER/ME

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

Table 3.8 Long term analysis of hydrological stations in the Danube 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}
Lim	Plav	364	1948-2012	0.244	3.212	19.23	145.5	324
	Bijelo Polje	2 183	1948-2014	8.20	12.14	57.14	512.8	1 077
Tara	Crna Poljana	247	1957-2014	0.72	1.448	12.01	175.7	468
	Trebaljevo	506	1959-2014	1.55	2.668	24.64	307.8	701
Ćehotina	Ćirovići	120	1978-2006	0.248	0.487	2.117	38.41	106
	Pljevlja	361	1948-2007	0.320	1.274	6.31	65.11	145
	Gradac	810	1963-2011	2.10	3.737	12.90	160.6	414

Graphical illustrations of multiyear average monthly, as well as the minimum and maximum annual water flows (inter-annual distibution) for each hydrological station (HS) for the stations analysed above in Table 3.8 are shown below in Figures 3.19 to 3.21.

Lim River

Figure 3.19 reveals that the driest period in river of Lim is during August and September, and absolute minimum is registered in August. The period of high waters is during April and May, and absolute maximum is registered in May. Figure 3.19 below illustrates the average annual water flows at HS Bijelo Polje for the entire monitoring period. Since 1983 there was a negative trend of average annual water flows. The average annual water flow for the period 1948-1983 (36 years) is 68.1 m^3/s , and for the peirod 1986-2014 (31 years) is 57.7 m^3/s. The difference in water quantity between these two periods is approximately 15%.

Tara River

Figure 3.20 shows that water shortage in the Tara River is during July-August-September. The minimum water flow is registered in August. There are two water periods, April-May and November-December. The maximum water flow was observed in October 1992. A graphical illustration of the trends of srednjih annual water flows from HS Trebaljevo for the entire monitoring period is shown in Figure 3.20 below. Since 1986 there was a negative trend of average annual water flows. The average annual water flow for the period 1959-1986 is 26.5 m^3/s, and for the period 1987-2014 it was 22.8 m^3/s. The difference in water amount in these two peirods is some 14%.

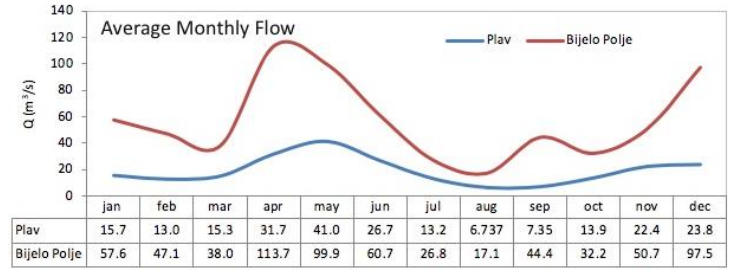
Ćehotina River

For all stations monitore in this watercourse, the driest month is August. The priod of water shortage is during July-August-September. The most water occurs in March and April, and the most extreme maximum are registered in April (Figure 3.21).

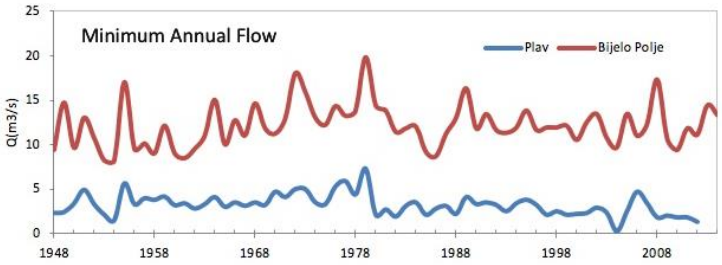
The trend of average anual water flows at HS pljevlja for the entire monitoring period is negative and began slightly earlier (1978) than measured at the other hydrological stations. The average annual

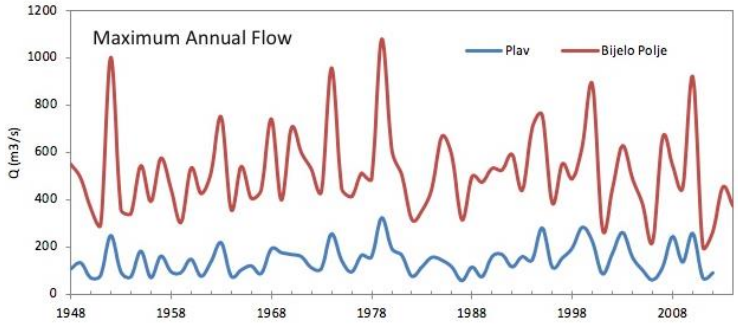
water flow for the period 1948-1978 was 6.8 m^3/s, and for the period 1988-2007 was 5.7 m^3/s. The difference in water flows for these two periods is 16%.

Figure 3.19 Average monthly, minimum, maximum, and trend of water flows at HS Lim



	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Plav	15.7	13.0	15.3	31.7	41.0	26.7	13.2	6.737	7.35	13.9	22.4	23.8
Bijelo Polje	57.6	47.1	38.0	113.7	99.9	60.7	26.8	17.1	44.4	32.2	50.7	97.5





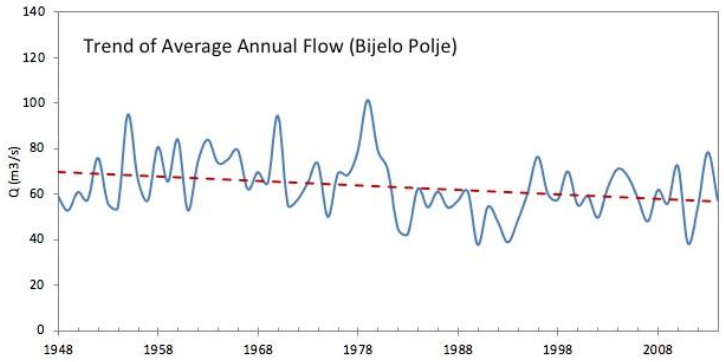
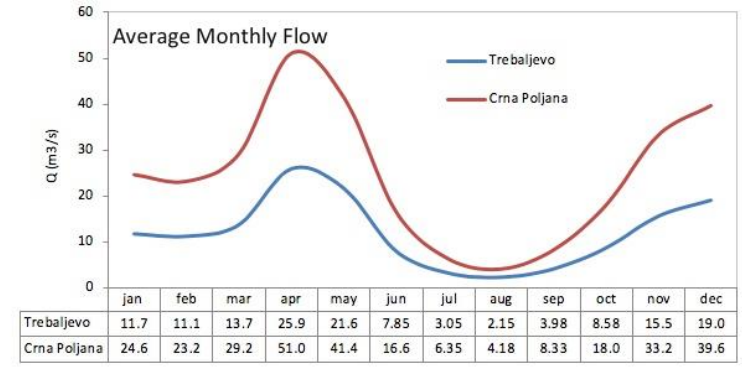
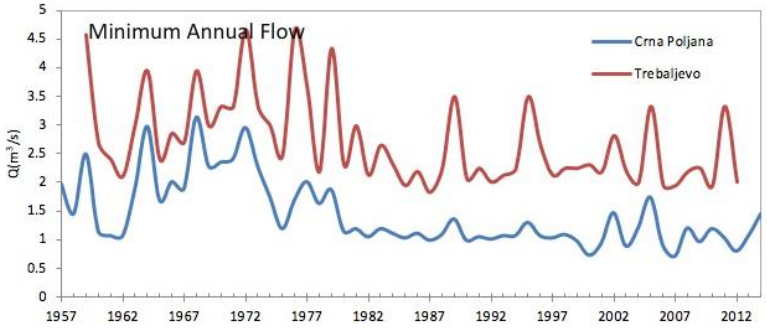
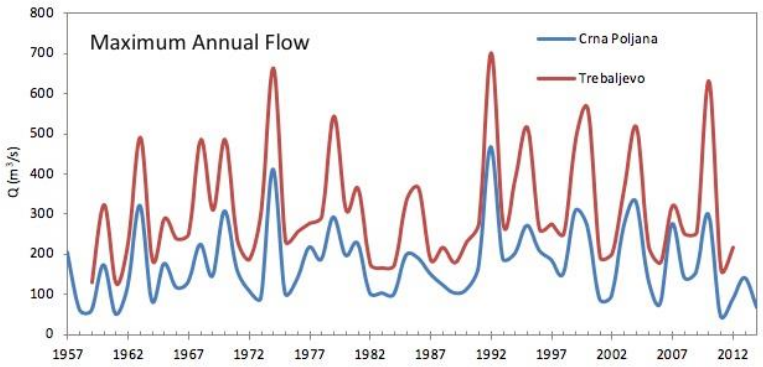


Figure 3.20 Average monthly, minimum, maximum, and trend of water flows at HS Tara



	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Trebaljevo	11.7	11.1	13.7	25.9	21.6	7.85	3.05	2.15	3.98	8.58	15.5	19.0
Crna Poljana	24.6	23.2	29.2	51.0	41.4	16.6	6.35	4.18	8.33	18.0	33.2	39.6





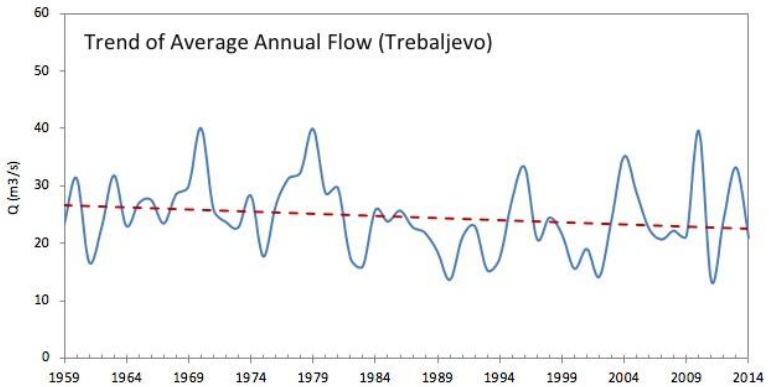
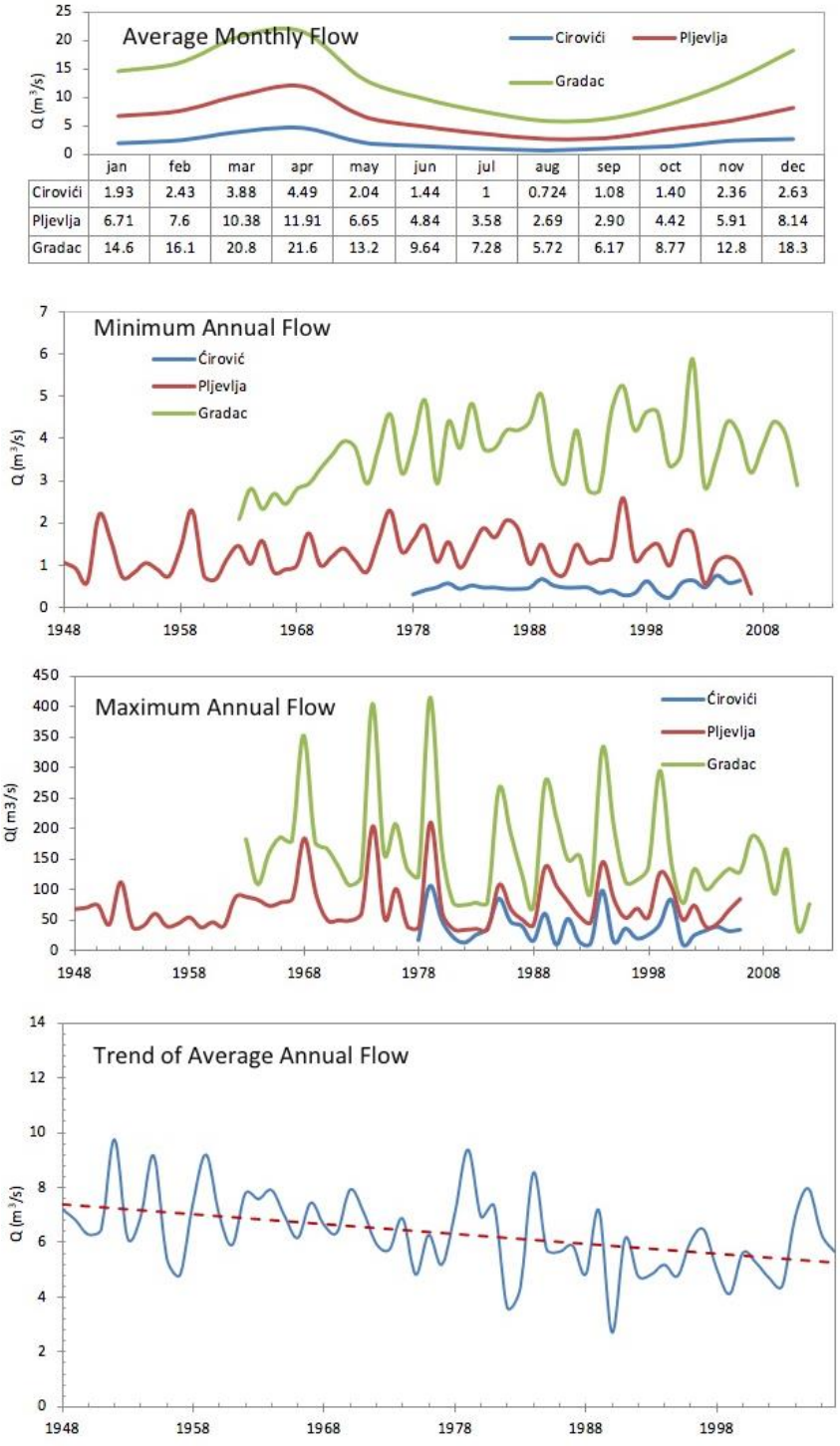


Figure 3.21 Average monthly, minimum, maximum, and trend of water flows at HS Ćehotina



	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Cirovići	1.93	2.43	3.88	4.49	2.04	1.44	1	0.724	1.08	1.40	2.36	2.63
Pljevlja	6.71	7.6	10.38	11.91	6.65	4.84	3.58	2.69	2.90	4.42	5.91	8.14
Gradac	14.6	16.1	20.8	21.6	13.2	9.64	7.28	5.72	6.17	8.77	12.8	18.3

Despite the work carried out by IHMS in the Danube 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 PoMs. 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 Danube 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 (EF) has been studied only on Ćehotina, Lim, Piva and Tara Rivers in the Danube 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)/

[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

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

The monthly estimation of the EF in the Ćehotina, Lim, Piva and Tara Rivers are shown in Table 3.9, whilst the values minimum flow values for the sub-basins of the Ćehotina, Lim, Tara and Piva sub-basins is shown in Table 3.10.

Table 3.9 Estimation of the Environmental Flow and monthly variation in rivers of the Danube River Basin

Rivers	Monthly EF Values (m^3/sec)											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Ćehotina												
Upstream	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27
Downstream	2.12	2.12	2.12	4.28	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12
Lim												
Upstream	3.57	3.57	3.57	3.57	8.15	3.57	3.57	3.57	3.57	3.57	3.57	3.57
Downstream	10.4	10.4	10.4	25.2	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Piva												
Upstream	1.82	1.82	1.82	5.80	6.04	1.82	1.82	1.82	1.82	1.82	4.82	1.82
Downstream	12.7	12.7	12.7	29.2	30.2	12.7	12.7	12.7	12.7	12.7	12.7	12.7
Tara												
Upstream	2.33	1.10	3.17	5.01	3.05	1.10	1.10	1.10	1.10	1.10	2.96	3.73
Downstream	13.7	13.7	13.7	28.8	32.2	13.7	13.7	13.7	13.7	13.7	13.7	13.7

Table 3.10 Minimum Environmental Flow values calculated for sub-basins in the Danube River Basin[24]

Sub-Basin	Minimum EF Value (m^3/sec)	
	Upstream	**Downstream**
Ćehotina	1.3	2.1
Lim	3.6	10.4
Piva	1.8	12.7
Tara	1.1	13.7

The methodology to calculate the environmental flow of the rivers in the Danube 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.

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

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

3.6 Climate effects

The highest segments of the Drina River basin (source area) are under the influence of the Mediterranean climate. Durmitor Mountain is located in the source part between Piva River and Tara River, at the point of contact of the Mediterranean and continental climate. The basin of the Piva River on the southern and western sides of Durmitor Mountain is under the influence of Mediterranean climate, while its northern and eastern sides (the Tara River basin) are under the influence of the continental climate. The influence of orientation and altitude on other high mountains in the Drina River basin also determines climate features. Commonly, river valleys are characterized by temperate continental climate, up to 1,200 meters above sea level, the climate is sub-mountainous, and above 1,200 meters above sea level, it is mountainous.

On high mountains and medium-height mountains, summers are fresh and winters are long and cold. Temperatures are negative for 3 to 4 months during the year. If high mountains in the source area of the basin are to be compared, medium-height mountains in the upper and middle segment of the river basin receive significantly less rainfall than the others. More rainfall is present in May, June and July, and the least rainfall is present in January and February, with precipitation mainly occurring in the form of snow. Ravines surrounded by mountains on all sides are characterized by specific climate. In summer, the temperature in them is higher than the one on the surrounding mountains, spring starts earlier, autumn is warmer, and annual rainfall is lower. Pljevaljska ravine is specific. The town of Pljevlja is the place of low air circulation and, thus, temperature inversion is frequent.

The Danube River Basin stretches south to north from the area of high mountains under the influence of Mediterranean pluviographic regime. The snow regime on the high mountains is very important. Large quantities of snow accumulate during winter to melt down and drain during the spring.

Average annual rainfall in the Danube River basin is approximately 1,030 mm. Average multi-annual rainfall ranges between 700 mm in the east segment of the basin and 2,500 to 3,000 mm in the source area of Piva on Durmitor Mountain and the Lim River on the Prokletije Mountain. The area of the Ćehotina basin has the lowest amount of precipitation in the basin.

The south-western part of the basin overall is more abundant in rainfall than the north-western part. Most rainfall occurs during November and the least during July.

In the northern segment of the basin, mean annual air temperatures range between 10.5 and 11.1°C. In the southern segment of the basin in the source areas of Lim River, Piva River and Tara River, mean annual air temperatures range between 4 and 5°C, reaching up 2°C on mountain tops. Mean annual air temperature on Žabljak Mountain is 5°C, with the highest temperature is in August, 14 °C, and the lowest in January, -5°C.

Projected changes in temperature and in precipitation will inevitably impact on and create changes in the water balance in the Danube River Basins. 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, the precipitation that falls as snow in winter months would be expected to 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.

The analysis of maximum annual flows has not produced a uniform change, but rather has resulted in a different set of results for each of the hydrological stations. The overall number of hydrological droughts is not expected to increase during the period before 2100 in the Lim River Basin but is expected to increase in the upper stream of the Tara River Basin.

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.

4 SIGNIFICANT PRESSURES IDENTIFIED IN THE DANUBE 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 (quality) objective.

4.1.1 Surface Waters

The DSPIR framework (Driving Force, Pressures, State, Impacts and Response) has been applied to the surface waters in the Danube 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 (See Section 9). The approach undertaken follows 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;

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 an assessment for all surface water bodies with a final proposed risk categorized 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 48 surface water bodies identified in Section 3.2 (See Table 3.5).

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.

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

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

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 EU 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 status 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, the 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, which refers to 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' and "roughly assessed" as explained in tables I-XIII of Annex 1.

For the purpose of the RBMP, the quantitative and qualitative pressures on each of the delineated Groundwater Bodies (GWB) and Group of Groundwater Bodies (GGWB) are provided in Sections 4.13 and 4.14, respectively.

Section 4.13 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 Annex V, item 2.1.1 of the WFD, good quantitative status is identified when the groundwater level in

[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. This statement is based on numerous references listed in Annex 1 of this RBMP.

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

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 13 delineated groundwater bodies (GWB) and group of groundwater bodies (GGWB) because in case of Montenegro consequential respect of the 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 4.14 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 Information limitations and 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 EU 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 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

[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.

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 or at least approximated. 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.
- **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.

[30]Surveillance monitoring measures long-term changes in natural conditions and allows for the effective design of future monitoring programmes.

- **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).
- **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 EU requires that Montenegro 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: The EU requires that Montenegro has to assess the susceptibility of the status of water bodies to the pressures identified above. This exercise aims at identify 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 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.

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.

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

Inclusion on the River Basin Management Plan	Article /Annex of WFD	Information Flow
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) 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 as the programme of monitoring and the Water Information System (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, included the following:

- 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 DRB.
- 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 (CLC), 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

Type of information	Description of Data
Population	Census 2011 and evaluation
Economic indicators	Evolution and analysis of indicators (World Bank;
Report of international institutions	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
Report on water tariff	Water price and cost recovery

4.4.4 Information required 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.	MSDT
1.2 Point - Storm Overflows	Urban development	Overflows from separated or combined sewers identified as point sources.	MSDT
1.3 Point - IED plants[31]	Industry	Industrial point sources from plants included in the E-PRTR[32].	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 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 point source.	MSDT/EPA
1.6 Point - Solid 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

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

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

Table 4.4 Diffuse source pressures

Pressure	Main Drivers	Clarification on Pressures	Data Sources
2.1 Diffuse - Urban runoff	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
2.6 Diffuse - Discharges not connected to sewerage network	Urban development; Rural settlements; Touristic settlements	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; Energy non-hydro; Industry; Transport; Urban development	Diffuse pollution from atmospheric deposition from any 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/ 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 and rural 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 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 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 to water bodies	MSDT; MARD; IHMS
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; IHMS
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 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

Pressure	Main Drivers	Clarification on Pressures	Data Sources
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; Municipalities
4.2.6 Dams, barriers and locks for industry	Industry; 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; Transport	A change in the flow regime (e.g., due to land drainage)	MARD
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,	Expert Judgment
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; Urban development		IHMS; DIKTAS; Municipalities
6.2 Groundwater – alteration of water level or volume	Industry 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; Academic Studues; MARD; WA
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	MSDT

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 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 the 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 Further information and data on status of water bodies

In addition to the sources of information listed in Section 4.4.4, Table 4.8 highlights further sources of information used in this report for the analysis of pressures on the surface waters in the Danube River Basin.

Table 4.8 Further sources of information on status of water bodies

Type	Data Processing	Outputs
- Climatic and hydrological data - Level at monitoring station - 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:

- 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.
- Pressure will continue due to the further development of tourism;

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

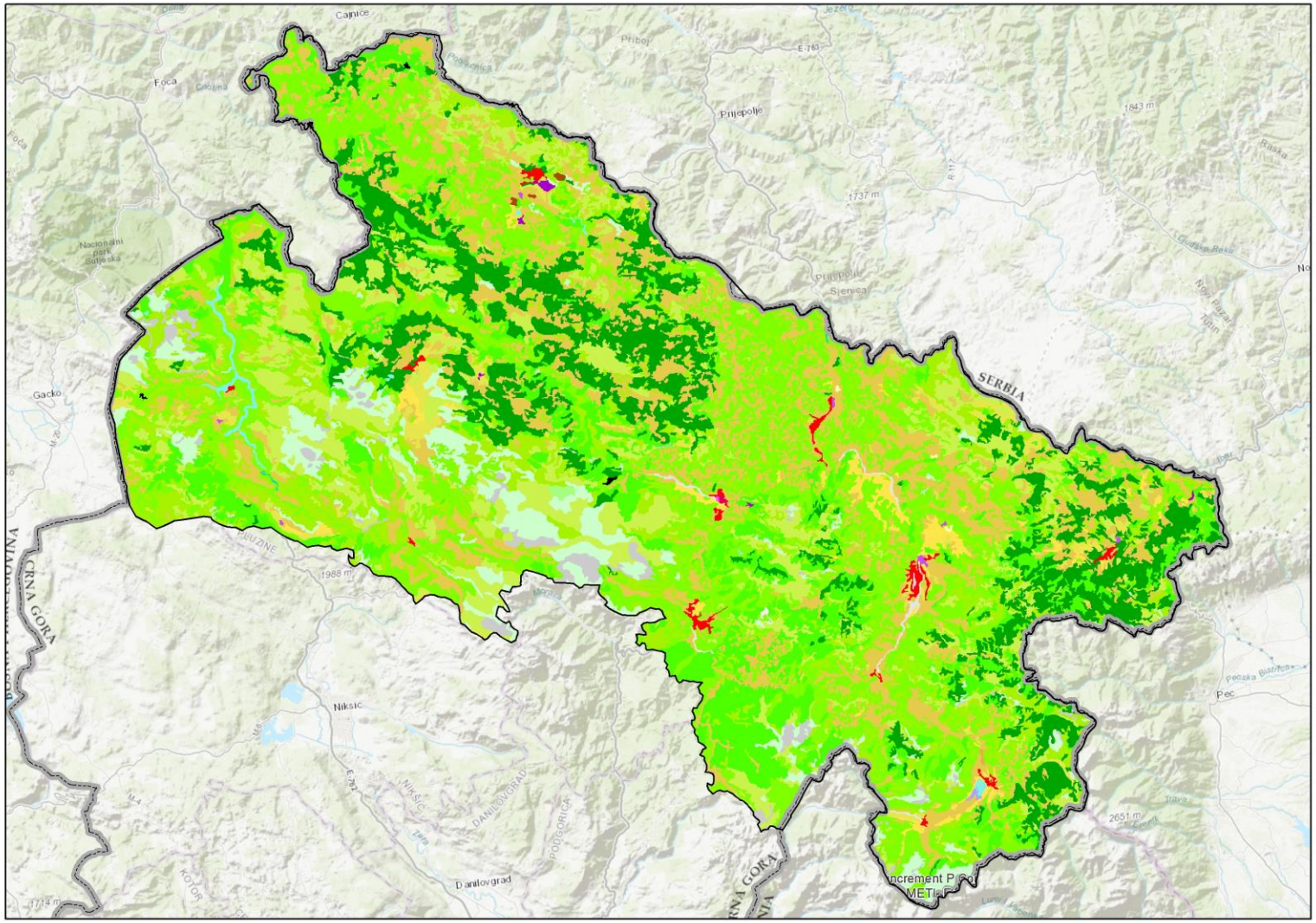
4.5.1 Magnitude of pressure using land use

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)[33], was used as primary source of information. Figure 4.1 shows the main distribution of land uses for the Danube 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 classes of land use types present in the Danube River Basin were established as shown in Table 4.9.

[33]Corine land cover assessment is based on data from 2012

Figure 4.1 Land use map of the Danube River Basin (Corine land cover classes)



Corine land cover classes



Table 4.9 Corine land cover types allocated by pressures groups

Corine Land Cover Class	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 1 covers all urban, industrial and constructions. 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:

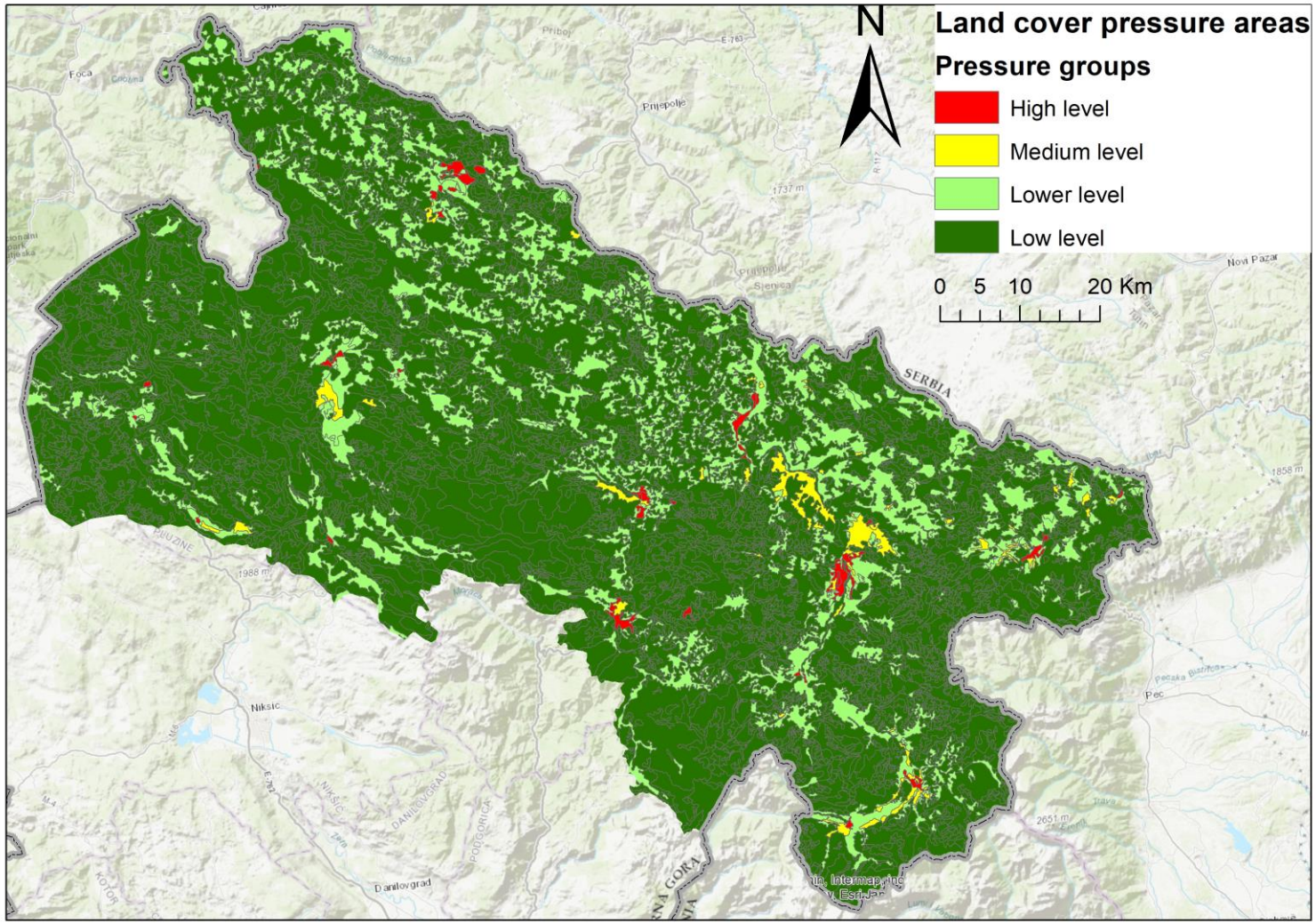
- Catchments and water bodies exposed to a high level of pressures, i.e. with a significant share of Corine land cover pressures types falling under the Classes 1 and 2. Those water bodies are consequently likely to be at risk;
- Catchments and water bodies under low level of land used related pressures, i.e. with a significant share of low-level land use related pressures Classes 3 and 4.

Figure 4.2 illustrates the computational analysis of the high, medium and low pressure on water bodies in the Danube 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 sections.

Figure 4.2 High, medium and low pressure on water bodies in the Danube 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 620,030 inhabitants[34]. The surface of the Danube River Basin (DRB) covers 7,260 km^2 or 52.5% of the national territory with 177,837 inhabitants (Census, 2011), which is 28.6% of the total population (Table 4.10).

The density of population in the Danube River Basin is, on average value, 25 inhabitants per km^2, which is smaller than the average value for the whole country of 45 (Census 2011) and below the value for EU28.

The State territory is administratively divided into 24 municipalities, with municipal centers that are bearers of local self-government. There are 13 main municipalities in the Danube River Basin. 10 municipalities are located completely in the Danube River Basin. Kolašin (53%), Plužine (95.5%) and Šavnik (98.9%) are also located in the Danube River Basin but with some territory in the Adriatic River Basin. Similarly, the municipalities of Niksic and Podgorica also reside in the Danube River Basin although only at 4% and 11.8%, respectively. 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 Danube River Basin. The figures 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 Danube River Basin[35]

Municipality	Surface (km^2)	Population[24]	Density (Inhabitants/km^2)
Andrijevica	283	5,071	18
Berane	544	27,284	51
Bijalo Polje	924	46,051	50
Gusinje	157	4,027	26
Kolašin[36]	479	8,380	9
Mojkovac	367	8,622	23
Niksic[37]	103	No data	No data

[34] Data gathered from census 2011

[35] The figures in Table 4.10 do not take into account the fact that 5 municipalities share their territory in two river basins.

[36] 53% of Kolašin Municipality is inside the Danube River Basin. The accurate calculation of the population residing in the Danube River Basin is not possible.

[37] 4% of the Niksic Municipality is inside the Danube River Basin. The accurate calculation of the population

Municipality	Surface (km^2)	Population[24]	Density (Inhabitants/km^2)
Petnjica	173	6,686	34
Plav	328	9,081	28
Pljevlja	1,346	30,786	23
Plužine[38]	853	3,246	4
Podgorica[39]	136	No data	No data
Rožaje	432	22,964	53
Šavnik[40]	556	2,070	4
Žabljak	445	3,569	8
Danube River Basin	**7,260[41]**	**177,837**	**25**
Montenegro	**13,910**	**620,030**	**45**

residing in the Danube River Basin is not possible. 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.

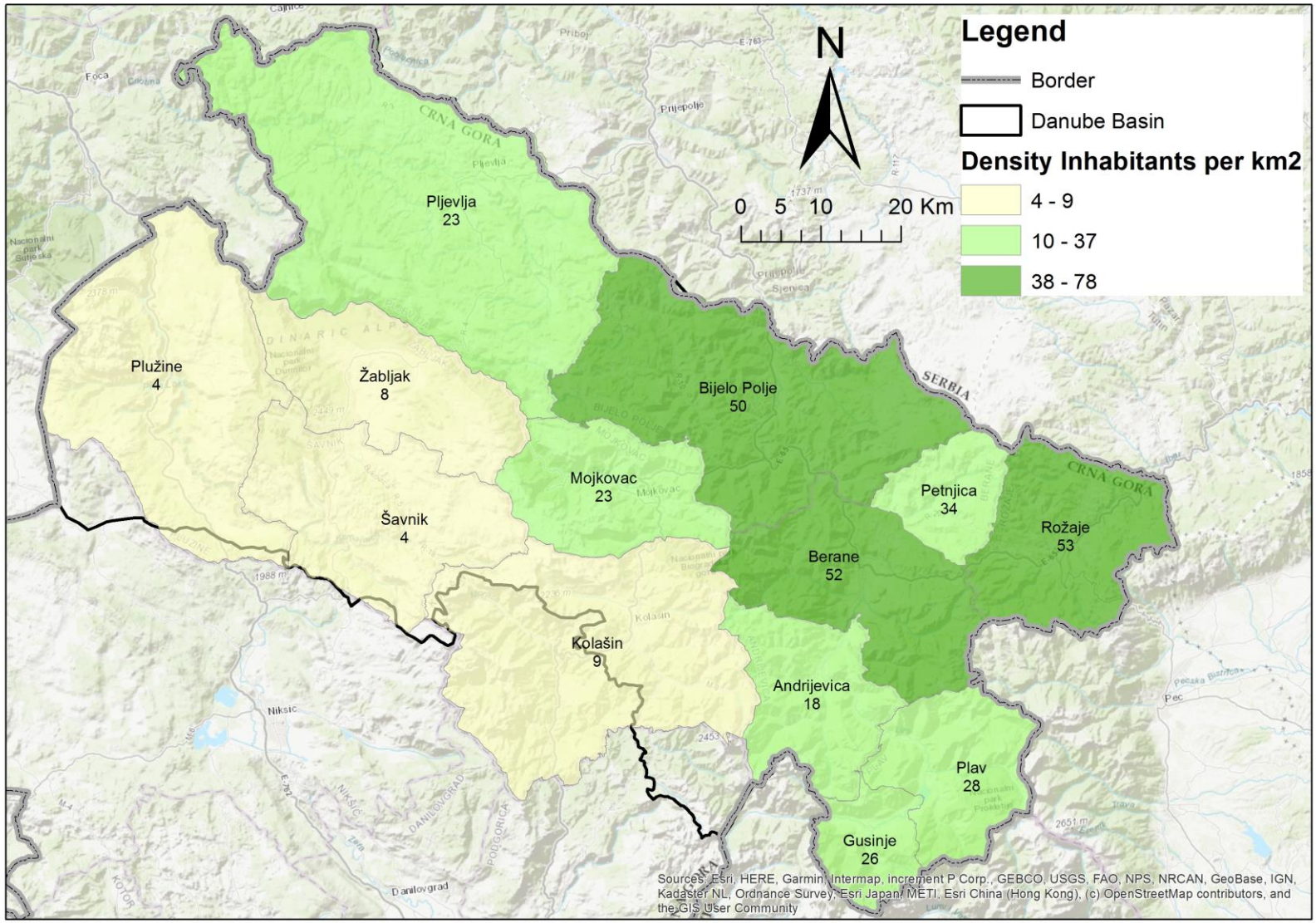
[38] 95% Plužine Municipality has the vast majority of its territory in the Danube River Basin.

[39] 11.8% of the Podgroica Municipality is partly within the Danube River Basin. The accurate calculation of the population residing in the Danube River Basin is not possible. 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.

[40] Šavnik Municipality has the vast majority of its territory in the Danube River basin (99.9%)

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

Figure 4.3 Population density by municipalities



4.5.3 Driving forces

The Gross Domestic Product (GDP) 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 of 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%.[42]

In 2016, the Agriculture accounted for 8% of the GDP, Industry for 32.9% and services for 59.1%.[43]

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, which is located outside of the Danube River Basin.

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

[43]Statistical Yearbook 2017

4.6 Point sources of pollution in surface waters

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 Danube River Basin is 177,837 inhabitants (28.6% of total population of Montenegro). Although territorially occupying much of Montenegro, the Danube River Basin is less populated with a population density of 25 inhabitants per km^2. A larger part of the population -in the Danube River Basin (55%) is the rural population and only 2 cities have more than 10,000 inhabitants.

The Urban Wastewater Treatment Directive (91/271/EEC) set a schedule for the treatment of agglomeration according to their size. Agglomerations areas first had to be delineated. In November 2017, the Government adopted the Rules on the agglomerations ("Official Gazette of Montenegro", 78/17).

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 Danube 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 Danube River Basin

Municipality	Agglomeration	Settlements	Agglomeration Population	Maximum Capacity of Agglomeration (PE)
Andrijevica	Andrijevica 1	Andrijevica, Božići, Prisoja, Seoca, Slatina, Trešnjevo, Zabrđe	2,865	3,000
Berane-Petnjica	Berane 1	Berane, Beran Selo, Buče, Dolac, Donje Luge, Lužac, Pešca, Budimlja, Petnjica, Lagatore, Radmanci	23,974	27,000
Bijelo polje	Bijelo polje 1	Babića Brijeg, Centar Grada, Ćukovac, Gornji dio grada, Kruševo, Lipnica, Lješnica, Medanovići, Nedakusi, Nikoljac, Obrov, Potkrajci,	26,088	28,000

Municipality	Agglomeration	Settlements	Agglomeration Population	Maximum Capacity of Agglomeration (PE)
		Pripčići, Pruška, Rakonje, Rasovo, Resnik, Strojtanica, Loznica		
Kolašin	Kolašin 1	Žabljak, Bakovići, Breza, Drijenak, Dulovine, Kolašin, Radigojno, Smailagića polje	5,303	7,500
Mojkovac	Mojkovac 1	Mojkovac, Podbišće, Polja, Tutići	5,571	6,000
Plav-Gusinje	Plav 1-Gusinje1	Bogajiće, Brezojevica, Dosuđe, Gusinje, Vojno selo Mateh, Martinovići, Kruševo, Plav, Prnavor, Skić	9,513	16,000
Pljevlja	Pljevlja 1	Pljevlja, Kominii, Židovići	20,601	25,000
Plužine	Plužine 1	Plužine	1,353	2,000
Rožaje	Rožaje 1	Ibarac, Koljeno, Rožaje	13,462	16,000
Šavnik	Šavnik 1	Šavnik	456	500
Žabljak	Žabljak 1	Žabljak	1,737	4,316

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 Danube River Basin are shown in Table 4.12 and 4.13, respectively.

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

Population	Danube River Basin
>100,000	-
100,000 – 50,000	-
50,000 – 20,000	1
20,000 – 10,000	2
10,000 – 5,000	2
5,000 – 2,000	4

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

Rank	City/Town	Urban Population	Urban Sewage Network Coverage (%)[44]	Sub-River Basin[45]
1.	Bijelo Polje	23,100	65 (S) / 60 (P)	Lim
2.	Pljevlja	19,620	80 (S) / 80 (P)	Ćehotina
3.	Berane	11,190	93 (S) / 93 (P)	Lim
4.	Rožaje	9,560	67 (S) / 70 (P)	Ibar
5.	Plav	5,520	75 (S) / 75 (P)	Lim
6.	Mojkovac	3,630	40 (S) / 75 (P)	Tara
7.	Kolašin	2,740	7.5 (S) / 10 (P)	Tara
8.	Žabljak	1,940	64 (S) / 68 (P)	Tara
9.	Plužine	1,494	80 (S) / 80 (P)	Piva

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 Danube River Basin, during 2005, the Government of Montenegro adopted an important strategic document in the field of waste water, i.e. a strategic master plan for sewerage and waste water treatment in the central and northern region of Montenegro. This document is accordance 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 Danube 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 Danube River Basin is presented in Tables 4.15.

[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 Danube River Basin are shown in Figure 3.1

[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

Table 4.14 Existing Wastewater treatment plants in the Danube River basin

Municipality	Location	Design capacity (PE)	Type of treatment	Comment
Mojkovac	Mojkovac	5,250	• Primary treatment • Secondary treatment	• No effluent disinfection • 308,542 m^3/day volume of wastewater treated • 391 tons/annum of sludge produced
Žabljak	Žabljak	2,000	• Primary treatment • Secondary treatment	• No effluent disinfection • 114,562 m^3/day volume of wastewater treated • 162 tons/annum of sludge produced • No sludge treatment (sludge stored on-site)
Šavnik	Šavnik	500	• Primary treatment • Secondary treatment • Tertiary treatment – N & P removal[47]	
Berane	Berane	20,000 1st Phase 27,000 2nd Phase	• Primary treatment • Secondary treatment	It was completed at the end of April 2019 was put into operation (probation period)
Pljevlja	Pljevlja	28,000 1st Phase 42,000 next Phase	• Primary treatment • Secondary treatment	It was completed at the 19. December, 2019 was put into operation (probation period)

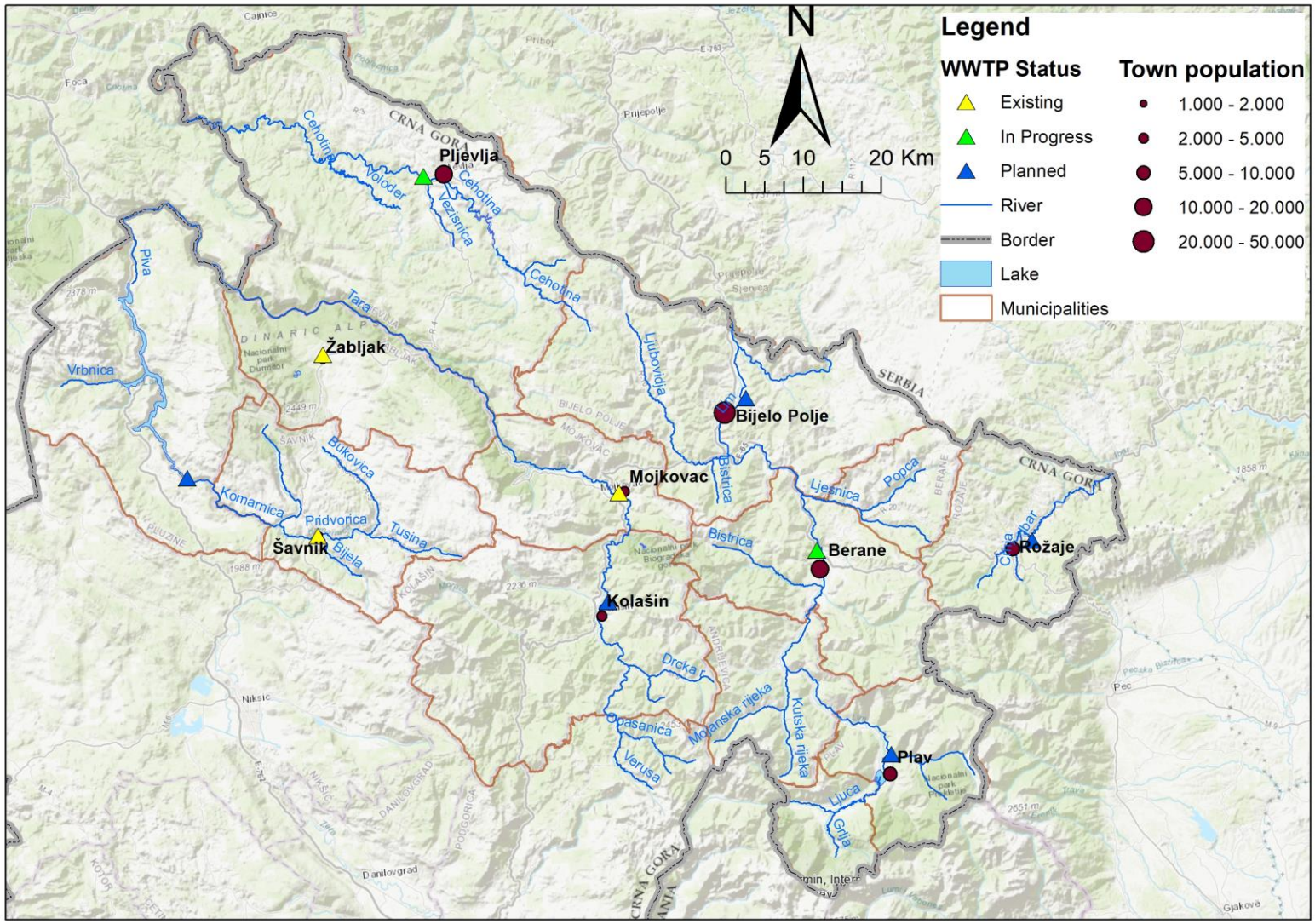
Table 4.15 Wastewater treatment plants planned in the Danube River Basin

WWTP	Design Capacity (PE)	Start Date
Bijelo Polje	20,000 1st Phase 40,000 Final Phase	Not Specified
Kolašin	4,000 1st Phase 11.000 Final Phase	Not Specified
Plav	12,000 1st Phase 18,000 2nd Phase	2019
Plužine	2,300 1st Phase	Not Specified

[47] Tertiary treatment is performed using reed bed technology

WWTP	Design Capacity (PE)	Start Date
	3,500 2nd Phase	
Rožaje	20,000	2020
Andrijevica	No data	Not Specified

Figure 4.4 Urban wastewater point pressures and location of functional WWTPs in the Municipalities of the Danube 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 Danube River Basin are presented in Table 4.16 together with the rivers which are the recipient of any potential pollution.

Table 4.16 Main enterprise types and recipient rivers in the Danube River Basin

Main Enterprise Types (Number of Enterprises)	Recipient River of Potential Pollution
Bakery Products (1), Cement (1), Coal (1), Electricity (1), Intensive livestock – pigs (1), Lead and zinc (1), Meat processing (1), Wood processing (3)	Ćehotina
Dairy - milk and cheeses (1), Paper and cardboard (2), Water bottling and juices production (1), Wood processing (1)	Ibar
Aquaculture (1), Electrodes, wire products (1), Intensive livestock- cow (1), Tannery (1), Water bottling (1)	Komarnica – Piva
Aquaculture (1), Brickyard (1), Dairy - milk and cheeses (2), Chicken farm (2), Explosives production (1), Farm of sheep and goats (1), Plastic packaging (1), Slaughter house (2); Intensive livestock (3), Meat processing (3), Mineral water (1), Paper and cardboard (2), Water bottling and juices production (1), Wood processing (6), Gravel extraction	Lim
Metal processing (1), Mineral water (2), Processing of fruits and vegetables (1), Weapons and ammunition (1), Wood processing (8), Gravel extraction	Tara

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.

Neither the EPA nor the Water Administration has established a pollutant cadaster. In order to form a database, the Water Administration has prepared and recently sent questionnaires to the municipalities to provide data from operators 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 Sewerage and Wastewater Strategic Masterplan for the Central and Northern Region of Montenegro, which was adopted in 2005. At the moment, this document is being revised, so the data presented will be updated if is necessary.

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 issue with point source pressure originated from industry (IED and non IED plants): Tara_4 (SWB 7), Lim_1 (SWB 24), Lim_2 (SWB 27), Popča/Vrbička rijeka (SWB 29), Lim_3 (SWB 34), Bistrica_2 (SWB 36), Ibar_2 (SWB 39), Ćehotina_4 (SWB 44), Vezišnica (SWB 45) and Ćehotina_5 (SWB 46) (Tables 4.35 and 4.26).

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

The location of potential industrial enterprises that can cause pollution to both surface and groundwaters in the Danube River Basin are illustrated in Figure 4.5.

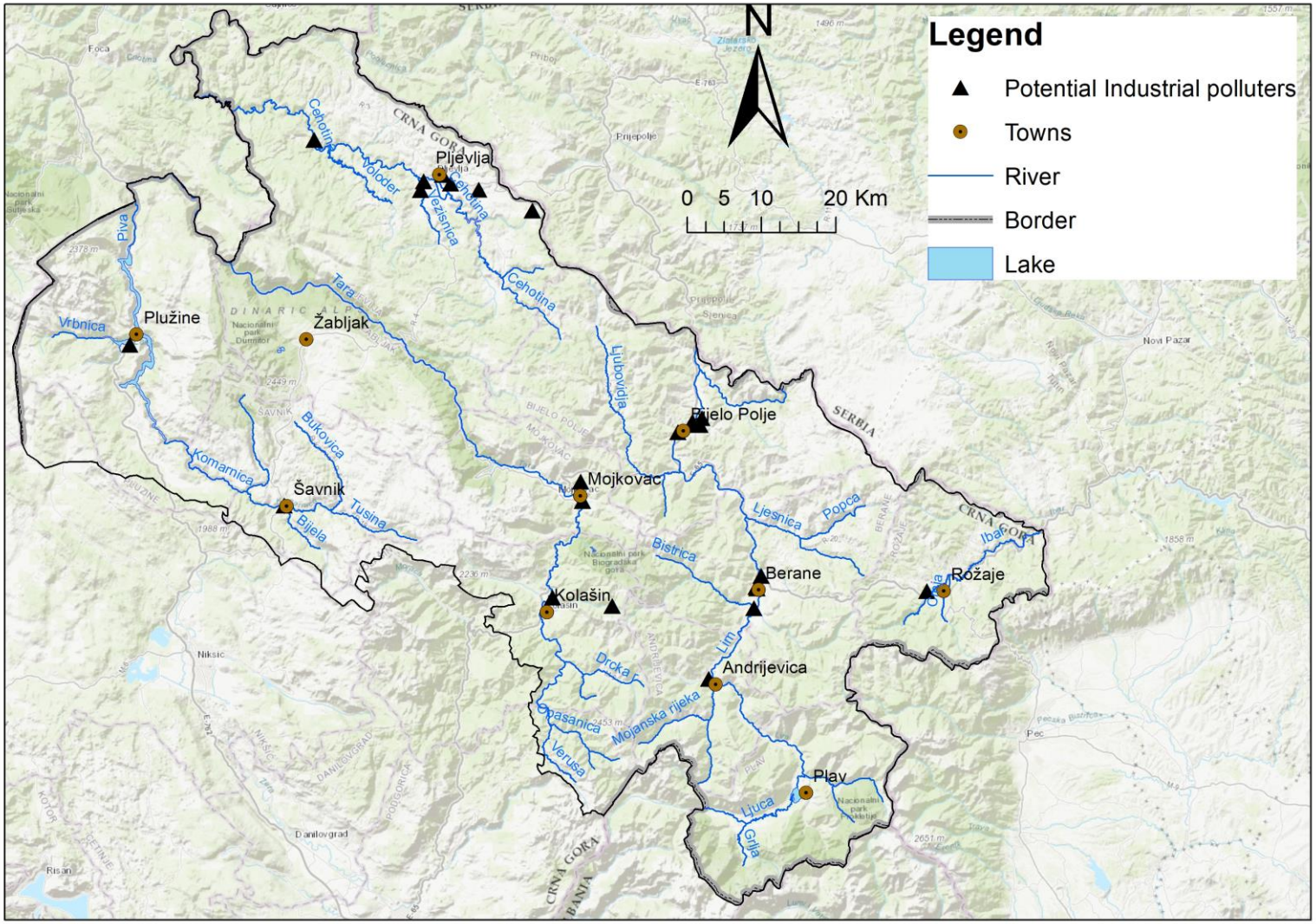
Table 4.17 Point source pollution of importance to groundwater

Point Source	Pressure	Data Used
Mine Sites	Abandoned 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

[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

Point Source	Pressure	Data Used
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
License wastewater discharges to groundwater	Wastewater effluents	List of licensed water discharge sites (water discharge permits/ IPPC permits)
Licensed industrial effluent discharges to groundwater	Industrial effluents	List of licensed water discharge sites (water discharge permits/IPPC permits)

Figure 4.5 The location of potential industrial polluters in the Danube River Basin



4.6.3 Invasive Aquatic Species

In the Danube River Basin, the following invasive fish species occur: Rainbow trout (Oncorhynchus mykiss), Arctic char (Salvelinus alpinus), the Grass Carp (Ctenopharyngodon idella), the Brown Bullhead (Ameiurus nebulosus).

A widely introduced species in Montenegro is the Rainbow Trout (Oncorhynchus mykiss) from California and Arctic Char (Salvelinus alpinus). Both species have been introduced into the mountain glacial lakes where they have been feeding on newts: aquatic salamanders of the Pleurodelinae subfamily, leading to their extinction or significant population decrease on these sites.

Introduction of fish to glacial lakes is a common problem in Durmitor area, although this directly violates National Park regulations. Triturus alpestris serdarus, an endemic subspecies of Alpine Newt, Triturus alpestris found only on the locality of Zminjicko Lake in Montenegro between the Sinjajevina and Durmitor Mountains might become extinct because of the introduction of fish to glacier lakes.[49]

Due to inadequate and illegal stocking for angling purpose, several SWBs now have problems with alien species. These include: Biogradsko Lake (SWB 6), Crno Lake (SWB 9), Piva Reservoir (SWB 15), Otilovići Reservoir (SWB 42) (Tables 4.35 and 4.36).

4.6.4 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)[50].

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, the ratio of BOD_5 for the main agglomerations in the River Basins in Montenegro have been calculated (Table 4.18 and Figure 4.6).

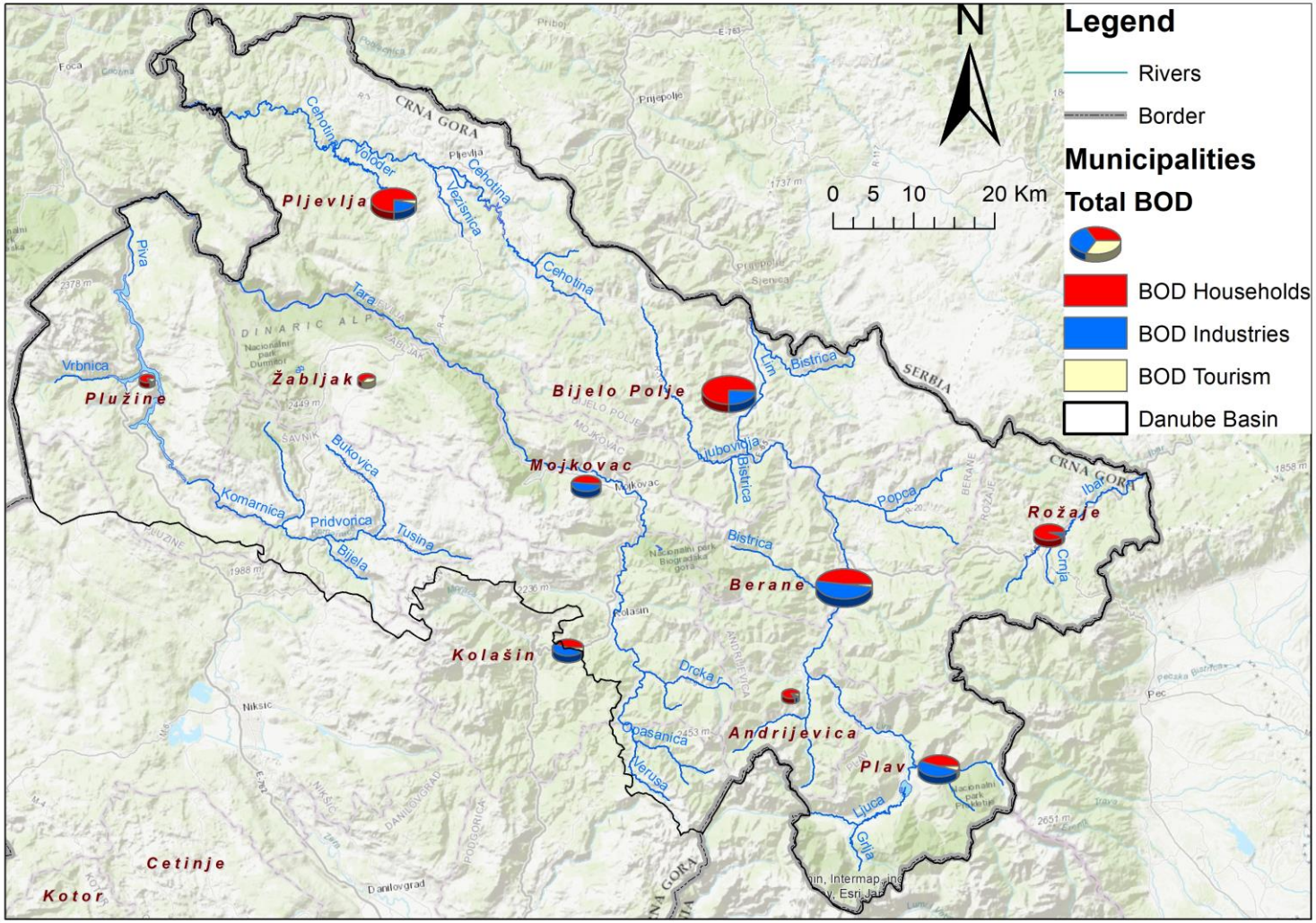
[49] IUCN 2005, Saving the Montenegrin endemic subspecies from extinction, IUCN South-Eastern European e-Bulletin, Issue 4 · March 2005

[50] 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)

Table 4.18 Population of main towns (over 2,000 PE) and BOD_5 demand share of households, industries and tourism in the Danube River Basin

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)
Andrijevica	Lim	1,050	405	36	35	476
Berane + Petnjica	Lim	11,190	2,354	2,466	112	4,932
Bijelo Polje	Lim	23,100	3,341	1,065	59	4,465
Kolašin	Tara	2,740	681	769	88	1,538
Mojkovac	Tara	3,630	653	681	28	1,362
Plav + Gusnije	Lim	5,520	1,161	1,304	143	2,608
Pljevlja	Ćehotina	19,620	2,406	678	109	3,193
Plužine	Piva	1,350	324	15	52	391
Rožaje	Ibar	9,560	1,384	72	20	1,476
Žabljak	Tara	1,740	306	-	174	480

Figure 4.6 Estimation of Biological Oxygen Demand (BOD5) from industries and households in the towns over 10,000 inhabitants and from 2,000 to 10,000 inhabitants



4.6.5 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 riverbed 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 riverbeds, 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 Danube catchment rivers in MNE, the river Tara and Lim are under biggest pressure caused by gravel extraction. Following WBs are negatively impacted by this activity: Tara_2 (SWB 3), Tara_4 (SWB 7), Grnčar (SWB 21), Lim_2 (SWB 27) and Lim_3 (SWB 34) (Tables 4.35 and 4.36).

4.6.6 Solid waste disposal

It is clear that leakages (leachates) from uncontained landfills and 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 20% is in the Danube River Basin (Table 4.19).

Table 4.19 Quantities of municipal waste produced and collected[51]

City	Generated waste (tons)	Collected waste (tons)	Collection (%)
Bijelo Polje	12,053	9,642	80
Berane + Petnjica	9,928	7,942	80
Pljevlja	8,532	7,000	82
Rožaje	5,910	2,955	50
Plav + Gusnije	3,430	1,715	50
Kolašin	2,300	2,150	93
Mojkovac	2,240	1,442	64
Andrijevica	1,186	700	60
Plužine	1,173	625	53
Žabljak	1,127	850	75
Šavnik	517	500	96
Danube River Basin	**48,396**	**35,521**	**73**
Montenegro	**243,941**	**218,233**	**89**

Almost the entire amount of collected waste is deposited in some type of landfill. Only one sanitary landfill is in currently in operation in the Danube River Basin: Sanitary landfill "Klještine" in the municipality of Žabljak.

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 4.20 reflects the situation in the Danube River Basin. **The largest 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 4.7 shows the outcome of the selection of river segments close by landfills, indicating a potential pressure from the entry of leachate production into both surface and groundwaters.

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

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: Lim_1 (SWB 24), Komarača (SWB 25), Lim_2 (SWB 27), Lješnica (SWB 30), Ljubovića_2 (SWB 32), Lim_3 (SWB 34), Ibar_2 (SWB 39) and Ćehotina_5 (SWB 46) (Tables 4.35 and 4.36).

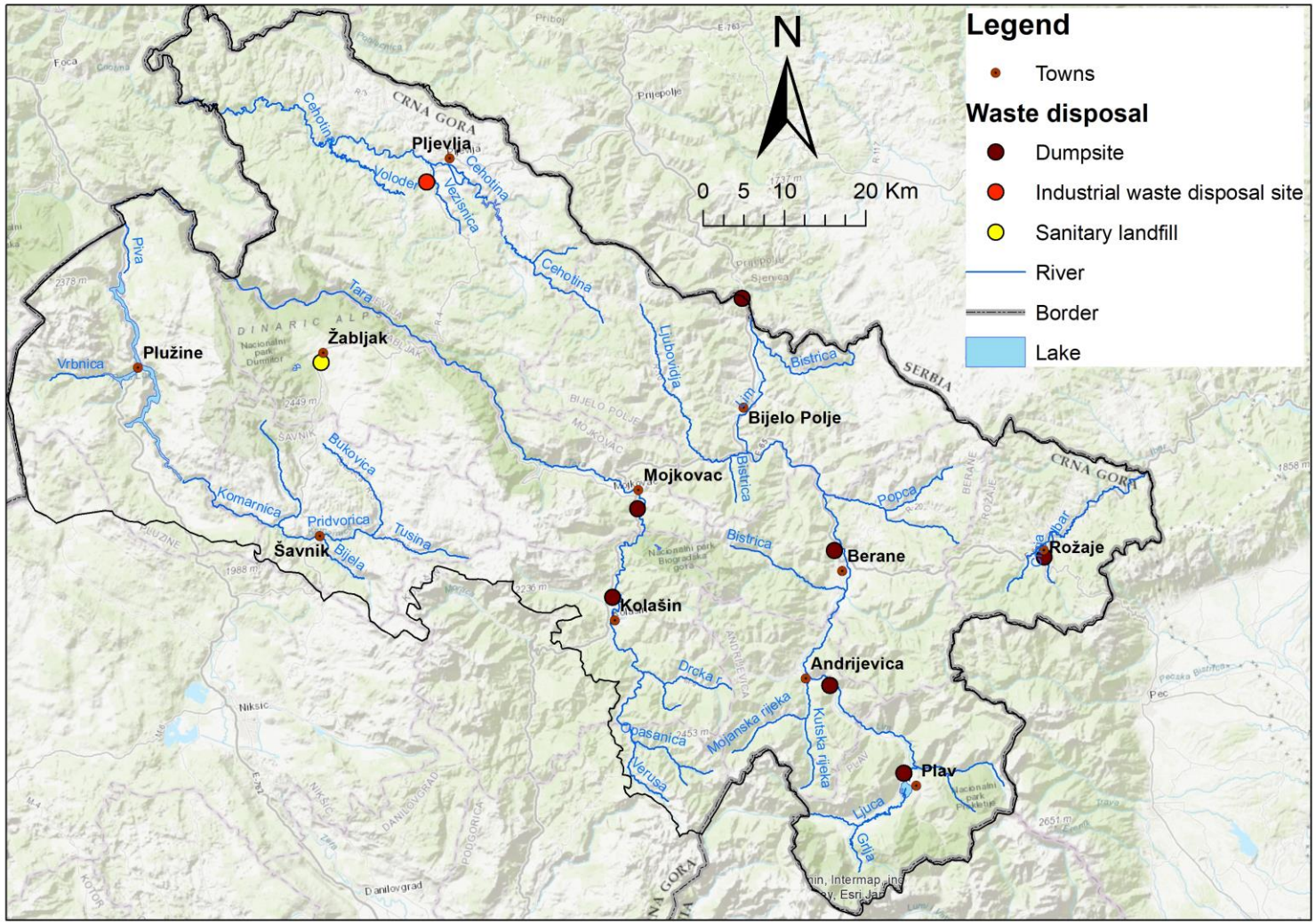
Table 4.20 Landfills and waste dumps in the Danube River Basin

Municipality		Name of Location	Type of Waste	Capacity of Disposal Sites (m^3)
Andrijevica				
	1.	Glavica Rive	Municipal waste	1,000
	2.	Prla	Wood waste	2,000
	3.	Sućeska (city dump)	Mixed municipal waste	3,000
	4.	Gnjilišta	Wood waste	5,000
	5.	Bojoviće	Different types of waste	1,000
Berane				
	1.	"Vasove vode" (Former City Dumpster)	Municipal, electrical, medical and animal waste	>55,000
	2.	Vinicka	Municipal waste	100
	3.	Donja Rženica, close to the cemetery	Wood and municipal waste	>200
	4.	Donja Rženica, near the sawmill	Wood waste	>500
	5.	Pobljenici, near asphalt base	Municipal, wood and construction waste	>2,000
	6.	Sawmill Praščević	Wood waste	>1,300
	7.	Libnice	Municipal waste	100
	8.	Klisura	Municipal waste	200
	9.	Stjenice	Municipal waste	200
	10.	Dapšica river	Different types of waste	200
	11.	Sawmill Andjic	Wood waste	300
Bijelo polje				
	1.	Kumanica	Municipal, industrial and wood waste	10,450 t/year
Gusinje				
	1.	Lugovi	Wood waste	2,500

Municipality		Name of Location	Type of Waste	Capacity of Disposal Sites (m^3)
Kolašin				
	1.	Bakovići	Municipal waste	2,500
Mojkovac				
	1.	Zakršnica (MZ Podbišće)	Mixed municipal waste	32,000
Plav				
	1.	Komarača	Wood waste	40,000
	2.	Brezojevice (old city landfill)	Wood waste	10,000
Plužine				
	1.	Donjebrezna	Wood waste	700
Petnjica				
	1.	“Duljkova stanica“	Municipal waste	150
Pljevlja				
	1.	Gotovuša	Different types of waste	>1,000
	2.	Dajevića Han	Different types of waste	>1,000
	3.	Židovići	Different types of waste	>1,000
	4.	Komini	Different types of waste	>1,000
	5.	Vodice	Different types of waste	>1,000
	6.	Odžak	Different types of waste	>1,000
	7.	Jugopetrol	Different types of waste	>1,000
	8.	Naselje Gradac	Different types of waste	>1,000
	9.	Vektra"	Wood waste	>100,000
Rožaje				
	1.	City landfill Besnik	Different types of waste	
	2.	The riverbed of the Ibar	Different types of waste	
	3.	Lovnička	Different types of waste	
	4.	Ibarčanska	Different types of waste	
	5.	Županica	Different types of waste	
	…	Over 100 unregulated dumps	Different types of waste	2-100
Šavnik				
	1.	Area of the former quarry	Different types of waste	>1,000
Žabljak				
	1.	Klještina, city landfill	Different types of waste	53,000

Municipality		Name of Location	Type of Waste	Capacity of Disposal Sites (m^3)
	2.	Njegovuđa	Different types of waste	80,000

Figure 4.7 Waste disposal point pressures in the Danube River Basin



4.7 Aquaculture

There are 11 fish farms in the Danube River Basin, primarily rearing rainbow trout (Table 4.21). Given the ecology of the trout as a species, all the fish farms are located near or on water bodies providing a clear, cold, abundant and constant supply of water. The trout farms are all generally situated in the central and northern parts of the country (the latter region predominantly the location of the Danube River Basin), on rivers or on the lakes, but there is no precise data on the surface areas that they occupy.

Substantial amounts of free-flowing water are required which are diverted from rivers and streams, but then returned to the system. There are no water losses in the Danube River Basin from fish farming. The largest fish farm in the Danube River Basin is on Lake Piva where cages are used. 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 DRB) that produce 40–130 tones per year, run by private companies.

Although there is no intensive aquaculture within the Danube drainage area, there are 10 SWBs where this activity has significant impact during summer months during lowest water level regime. These include: Opasanica/Verušica (SWB 1), Tara_1 (SWB 2), Tara_3 (SWB 5), Tušina/Bukovica (SWB 10), Pridvorica (SWB 11), Piva Reservoir (SWB 15), Lim_1 (SWB 24), Lim_2 (SWB 27), Ljubovića_1 (SWB 32) and Bistrica_2 (SWB 36) (Tables 4.35 and 4.36).

Table 4.21 The main fisheries in the Danube River Basin, 2011[52]

Name of Farm	Location	Area (m^2)	Production (tones/year)		Water Requirement (m^3/24h)
			Total Capacity	Actual	
Rabrenović (Owner)	Andrijevica	NA	NA	NA	NA
Buče	Berane	6,000	200	40	NA
Bistrica	Bijelo Polje	550	20	15	NA
Bistrica	Bijelo Polje	500	30	15	NA
Trebaljevo	Kolašin	600	NA	10	NA
Radenko (Owner)	Mojkovac	NA	NA	NA	NA
Novaković (Owner)	Mojkovac	NA	NA	NA	NA
Rabrenović (Owner)	Mojkovac	NA	NA	NA	NA

[52] Ref. No: Europe Aid/128947/C/SER/ME; Report 34 Fishery Sector Study for the IPARD Program; October 2011

Name of Farm	Location	Area (m^2)	Production (tones/year)		Water Requirement (m^3/24h)
			Total Capacity	Actual	
Vukojičić (Owner)	Pljevlja	NA	NA	NA	NA
Aqua d'Or	Plužine	1,000 (22 cages)	250	130	168,000
Šavnik	Šavnik	1,100	10	NA	18,500
Marić (Owner)	Žabljak	NA	NA	NA	NA

4.8 Diffuse sources of pollution in surface waters

4.8.1 Agricultural activities

The total available agricultural land in the Danube River Basin covers a total area of 185,843 ha, making up 13.3% of the total are of the River Basin (Table 4.22). The structure of agricultural land use is relatively unfavorable for cultivation because pastures and natural meadows that have a dominant share are most suited to livestock breeding.

As can be seen from Table 4.22, Bijelo Polje municipality has the most agricultural land followed by Pljevlja, Plužine, and Berane. The municipalities of the Danube River Basin have more than 97% of the land in permanent meadows and pastures; indicating the limitations that exist in terms of good soils for crop production. Around 1% of the utilized agricultural land is used for arable farming. There are no sizeable vineyards in the Basin and very limited holding of orchards and nurseries, the majority being located in Bijelo Polje and Berane.

Approximately 21% of the agricultural land in the Danube River Basin is classified as un-utilized. However, this varies between municipalities - with Kolašin and Šavnik having almost 40% and 35% un-utilized agricultural land, respectively. Conversely, Andrijevica, Berane and Plužine have only 15%, 14% and 12%, of un-utilized agricultural land, respectively.

Table 4.22 Total agricultural land in the Danube River Basin[53]

Municipality	Total Agriculture Holdings	Total available agricultural land (ha)	Total used agriculture land (ha)	Total used agriculture land (%)
Andrijevica	1,417	10,257	8,710	**85**
Berane + Petnjica	4,509	25,475	21,870	**86**
Bijelo Polje	6,407	36,387	29,011	**80**
Žabljak	623	9,610	7,480	**78**
Kolašin	1,575	14,242	8,629	**60**
Mojkovac	1,214	10,144	7,873	**77**
Plav + Gusnije	2,479	14,122	10,749	**76**
Plužine	859	26,336	23,186	**88**
Pljevlja	4,001	29,364	22,901	**78**
Rožaje	2,089	No data	11,985	**No data**
Šavnik	800	9,901	6,506	**65**
Total	**25,973**	**185,843**	**158,903**	

Based on Corine data, forests cover 47% of the total area in the Northern region, amounting to 4,590 km². As a mountainous region there is a lack fertile land in the Danube River Basin.

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 on an annual basis in Montenegro as a whole is approximately 4,000 tons with approximately 3,000 tons manure. The amount of chemical plant protection products used in agriculture in Montenegro is 185 tons per year[54]. The exact figures for the Danube River Basin are unknown.

Using the land use pressure groups of the Corine land cover (Section 4.5.1, Table 4.9), the percentage of Class 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

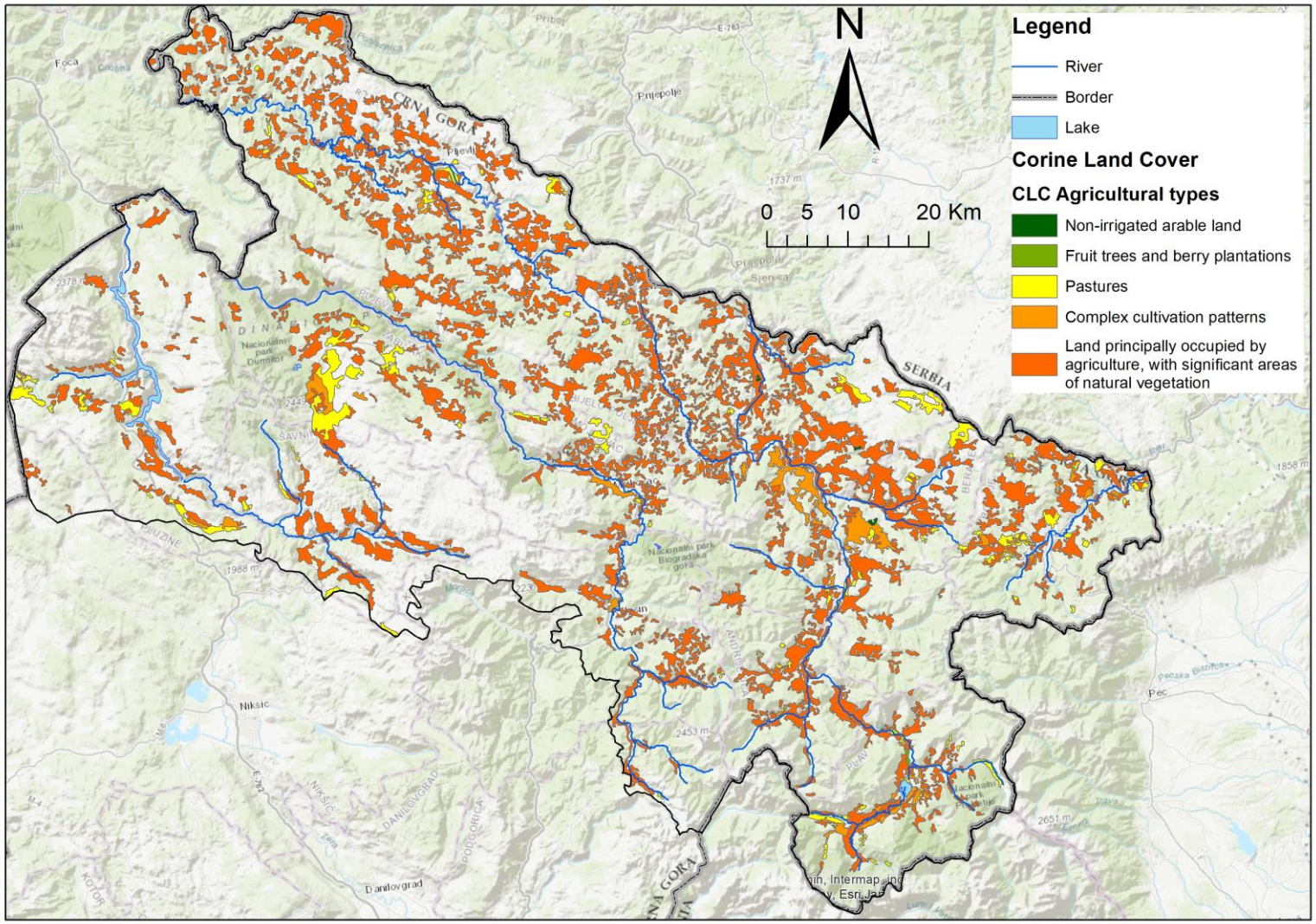
[53] Source: MONSTAT, Census 2011, Statistical Yearbook

[54] 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

activities. Figure 4.8 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 Danube River Basin are in the vicinity of lowland rivers (Figure 4.8) The highest impacts of agricultural production are as follows: Tara_4 (SWB 7), Lim_1 (SWB 24), Lim_2 (SWB 27), Popča /Vrbička Rijeka (SWB 29), Ljubovića_2 (SWB 32), Lim_3 (SWB 34), Bistrica_2 (SWB 36), Ibar_2 (SWB 39), Ćehotina_4 (SWB 44), Vezišnica (SWB 45) and Ćehotina_5 (SWB 46) (Tables 4.35 and 4.36).

Figure 4.8 Localization and types of agricultural land uses in the Danube River Basin



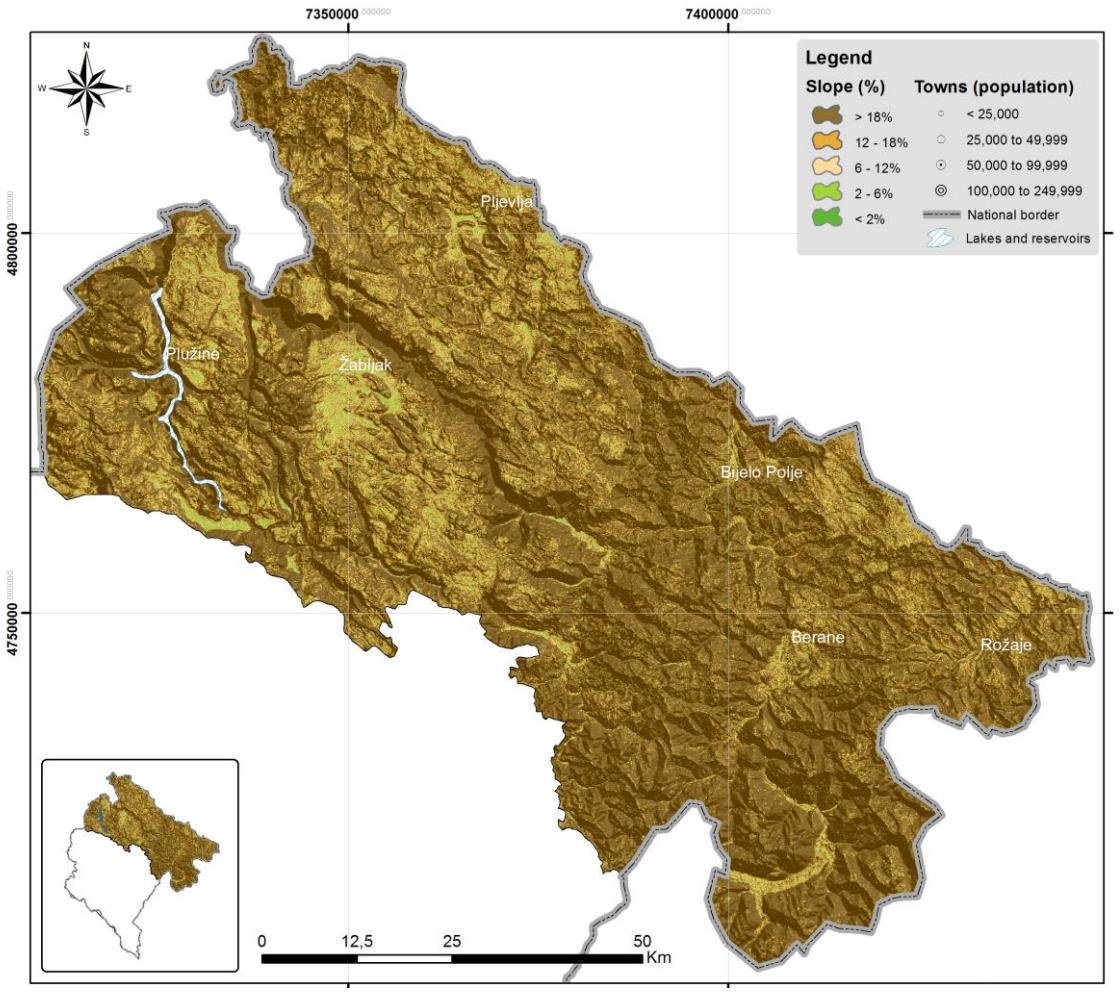
4.8.2 Erosion

Soil erosion is a natural process that is causing environmental concerns such as land degradation, soil loss, water pollution and ecosystem alteration. Water erosion affects 95% of Montenegro. Alluvial accumulation characterizes 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 4.9).

Erosion caused by water is dominant in terrain with high slopes due to complex physical and geographical conditions paired with logging activities. The mean annual intensity of soil erosion in Montenegro has been estimated at more than 10 tons per hectare[55].

Sediment erosion and loading is recognized in two SWBs within the Danube watershed, i.e. Plavsko lake (SWB 23) and Lim_2 (SWB 27) (Table 4.36).

Figure 4.9 Land slope in the Danube River Basin (%)



[55]Blinkov, I. (2015): The Balkans: The most erosive part of Europe? Glasnik Sumarskog fakulteta. 111: 9-20. DOI: 10.2298/GSF1511009B

A study undertaken in the Polimlje Region[56] 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 Gavrilović[57]. 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 studies on soil erosion processes in the Danube River Basin (Polimlje Region - 40.23 km^2) were carried out in 2016[58]. The computer-graphic IntErO model was used to calculate soil erosion intensity, taking data of Forest Management Plans, Cadaster, Landsat images and Statistical Yearbooks into account. The calculated net soil loss was equivalent to an annual loss of 327m^3 per km^2.

Soil erosion in the Danube 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.

4.9 Water abstraction and demand

For consumers, approximately 92% of water is supplied from underground sources with the remaining 8% supplied with water from surface accumulations.

Table 4.23 shows the actual water demand for all municipalities in the Danube River Basin. The springs and wells designated for human consumption are shown in Figure 4.10.

It is estimated that 26.6 Mm^3/year of water is necessary to cover consumption needs for the domestic, industrial and agricultural sectors making up the municipalities in the Danube River Basin.

The available quantities of water in the existing sources in the future will be sufficient for the water supply of all municipalities as shown in Table 4.24.

Currently only 670 ha of agricultural land is commercially irrigated in the Danube River Basin.

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.

More detailed information regarding the water sources and quantitative pressure assessment in the Danube 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 SWBs where water abstraction plays a significant negative role: Opasanica/Verušica (SWB 21), Kutska/Mojanska/Zlorečica (SWB 26), Lim_2 (SWB 27), Bistrica (SWB 28), Lim_3 (SWB 34) and Ibar_2 (SWB 39) (Table 4.36).

[56]Spalević, 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

[57]Gavrilović, S. (1972): Inzenjering o bujicnim tokovima i eroziji. Izgradnja. Beograd

[58]Vujačić, D and Spalević, V. (2016) Assessment of runoff and soil erosion in the Radulicka Rijeka watershed, Polimlje, Montenegro. Agriculture & Forestry, Vol. 62 Issue 2: 283-292, 2016

Table 4.23 Water use by urban areas, industries and agriculture in the Danube River Basin

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)
Andrijevica	5,071	151,077	52,814	115,900	319,791
Berane + Petnjica	33,970	5,225,817	748,968	1,824,737	7,799,522
Bijelo Polje	46,051	3,591,095	809,072	2,463,687	6,863,854
Kolašin	8,380	791,965	72,391	126,166	990,522
Mojkovac	8,622	590,140	309,259	1,235,765	2,135,164
Plav + Gusnije	13,108	648,777	759,497	531,343	1,939,617
Plužine	3,246	38,422.00	173,591	161,116	373,129
Pljevlja	30,786	3,487,930	30,000	217,028	3,734,958
Rožaje	22,964	1,558,225	120,772	131,857	1,810,854
Šavnik	2,070	22,650	173,843	84,772	281,265
Žabljak	3,569	90,787	181,010	133,808	405,605
Total	**177,837**	**16,196,891**	**3,430,587**	**7,026,180**	**26,654,281**

Table 4.24 Water demand by urban areas and industries and water availability

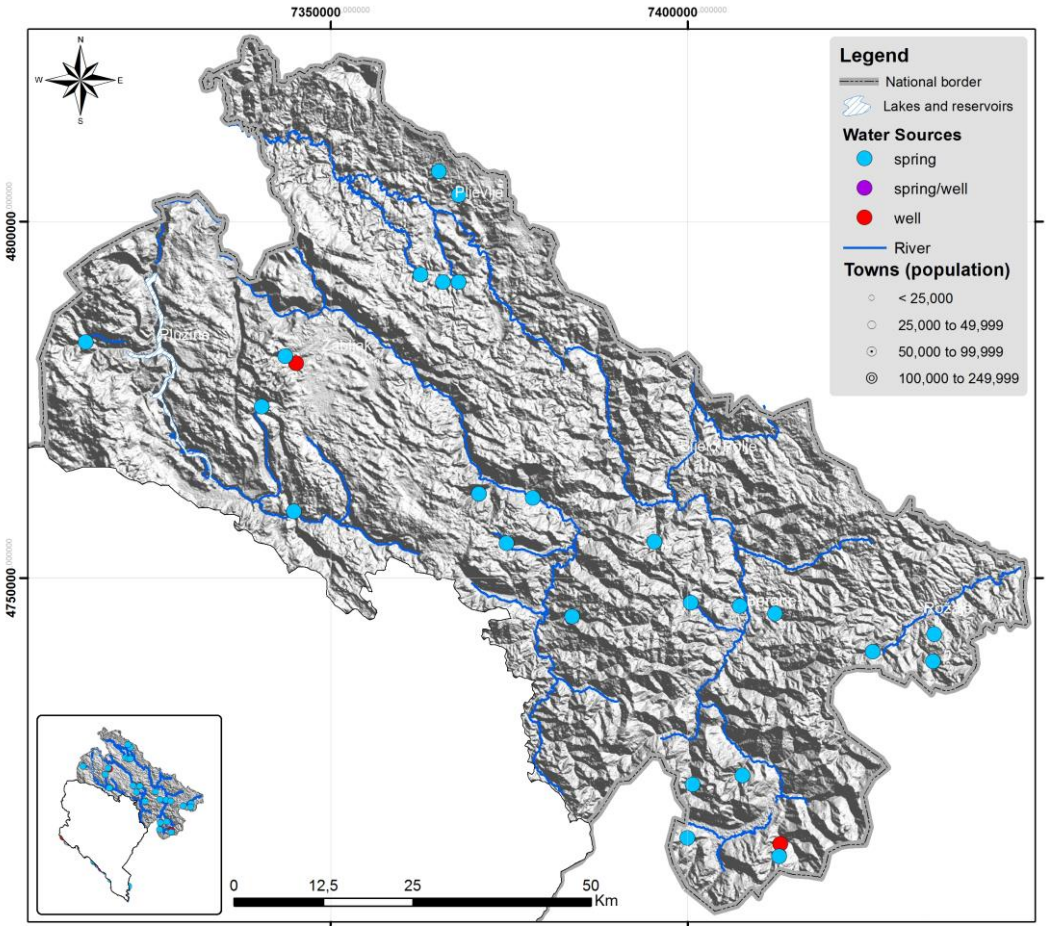
Municipality	Total Demand (m^3/year)	Total Availability[59,60] (m^3/year)
Andrijevica	319,791	3,153,600
Berane + Petnjica	7,799,522	10,406,880
Bijelo Polje	6,863,854	15,768,000
Kolašin	990,522	2,459,808

[59] 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.

[60] The results undertaken for quantitative assessment of the groundwater bodies in 2018 for this RBMP confirm available water resources of +10% more than presented in the 2015 report.

Municipality	Total Demand (m^3/year)	Total Availability[59,60] (m^3/year)
Mojkovac	2,135,164	3,973,536
Plav + Gusnije	1,939,617	3,815,856
Pljevlja	3,734,958	4,225,824
Plužine	373,129	20,498,400
Rožaje	1,810,854	3,942,000
Šavnik	281,265	1,576,800
Žabljak	405,605	1,955,232
Total	**26,654,281**	**67,960,080**

Figure 4.10 Springs and wells tapping groundwater designated for human consumption



4.10 Physical pressures on surface waters

4.10.1 Major hydropower plants and water supply dams

The major dams in the Danube River Basin constitute HMWBs since they form impenetrable barriers and act as major discontinuities on the river system. Two main dams in located in the basin: (i) "Piva" on the Piva River, with an installed power of 342 MW, and (ii) above Pljevlja on the river Ćehotina there is dam Otilovići with a large lake, which serves the needs for water supply of the thermal power plant and the city of Pljevlja.

Figure 4.11 HPP "Piva"



HPP “Piva” is a reservoir dam facility with one of the largest concrete arch dam in the world. It was built in 1976. Structural concrete arch dam height is 220 m, hydraulic height of 190 m, arc length on the crown is 268.6 m, long arc in level of the bed 40 m. The total storage capacity is 824 x 10 ^{3} x 10 ^{3} m^{3}; catchment area of HPP "Piva" is 1,760 km^{2}.

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 hydropower and irrigation dams. The typical impacts are termed as either ‘altered habitat morphology’ and ‘altered habitat hydrology’.

In accordance with WFD Annex V, although reservoirs are technically heavily modified rivers, they most closely resemble the category of Lakes, and therefore their potential should be assessed against Lake parameters provided in Annex V of the WFD.

A further development in the Danube River Basin is noted, but not included in the RBMP, namely the plan for another upstream hydropower dam on Piva, section "Lonci", with tail up to Komarnica confluence. The investigation is completed and the development, which indicates that the development is likely to be tendered soon.

An older and much discussed project is also noted, i.e. the transfer of Tara River water to the Adriatic River Basin to support the building several dams along Morača River. Such inter-basin water transfers (IBTs) are a major form of river basin manipulation used primarily to tackle situations arising from conditions of drought and usually on an intermittent basis, which would not be the case here. It is important to note that the WFD stipulates that there should be no deterioration in water quality status, meaning that a river in good status must not become one in poor status as a result of the transfer. In addition, Article 7.3 of the WFD requires no deterioration below the 2007-08 baseline in Drinking Water Protection Areas. Compliance with the Directive is a key consideration, and the potential mitigation measures would undoubtedly increase bulk water transfer costs in this case. Obviously, the linkages between the groundwater bodies and the surface water bodies would be undergo severe stress if such a scheme were in operation. In addition, compliance to the EU nature legislation must not be overlooked and would undoubtedly prevent such a scheme from taking place due to the deleterious effect it would have on the Tara Sub-Basin and also the open possibility of transferring species between the two river basins.

4.10.2 Small hydropower plants

Small Hydropower Plants (SHPPs) have potentially significant impacts on downstream water bodies, which include the following[61]:

- 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 Danube River Basin to explore the potentials for the development of SHPPs[62]. 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 4.25, up to now, in the Danube River Basin, SHPPs have either been constructed (7), under construction (13) or planned (26).

Based on the implemented tender procedures, concession contracts are currently being implemented in the Lim and Tara sub-basins, which envisage the construction SHPPs of approximately 58 MW (constructed and in construction), equating to an annual production of 186 MWh (Table 4.25).

[61] Guidance on the requirements for hydropower in relation to Natura 2000, European Commission (2018)

[62] http://www.mek.gov.me/files/1196083302.pdf

A further 26 SHPPs (20 <1MW) are planned in the Danube River Basin in the Lim, Ibar, Piva and Tara sub-basins, which will produce a further 29 MW and an annual expected increase in energy production of just over 100 MWh (Table 4.25).

The location of the large and small hydropower plants in the Danube River Basin are illustrated in Figure 4.12.

Table 4.25 National register of SHPPs in the Danube River Basin[63]

No.[64]	SHPP Name	Design Capacity (MW)[65]	Annual Production Expected (GWh)[66]	River/ Stream	Sub-Basin	Related Surface Waterbody[67]
	Constructed					
1.	mHE "Vrelo"	0.59	2.76	Vrelo	Lim	Ljubovića_1
2.	mHE "Rijeka"	2.97	3.82	Bradavac	Lim	Kutska/Mojanska / Zlorečica
3.	mHE "Piševska rijeka"	0.95	2.91	Piševska rijeka	Lim	Kutska/Mojanska /Zlorečica
4.	mHE "Babiono-poljska"	7.09 (2 SHPPs)	21.41	Babino-poljska rijeka	Lim	Komarača
5.	mHE "Bistrica - Majstorovina"	3.50	11.30	Bistrica (Majstorivina)	Lim	Bistirca (Lj)
6.	mHE "Šeremet potok"	0.80	3.46	Šermetski potok	Lim	Kutska/Mojanska /Zlorečica
7.	mHE "Bistrica"	8.20 (8 SHPPs)	30.65	Bistrica (Beranska)	Lim	Bistrica
	Sub-Total	**24.10**	**76.31**			
	Under Construction					
8.	mHE "Šekularska"	3.74 (5 SHPPs)	13.80	Šekularska rijeka	Lim	Lim_2
9.	mHE "Trepačaka"	11.80 (2 SHPPs)	33.18	Trepačka rijeka	Lim	Lim_2
11.	mHE "Crnja"	5.83	15.11	Crnja	Tara	Drcka

[63] Information obtained from the Ministry of Economy

[64] Numbering according to the national register of SHPPs

[65] Values rounded up to 2 decimal points

[66] Values rounded up to 2 decimal points

[67] Rivers or streams related to surface water body designations shown in Section 3.3

No.[64]	SHPP Name	Design Capacity (MW)[65]	Annual Production Expected (GWh)[66]	River/ Stream	Sub-Basin	Related Surface Waterbody[67]
13.	mHE "Mojanska rijeka"	6.10 (3 SHPPs)	22.70	Mojanska rijeka	Lim	Kutska/Mojanska /Zlorečica
14.	mHE "Kutska rijeka"	2.50 (2 SHPPs)	11.60	Kutska rijeka	Lim	Kutska/Mojanska /Zlorečica
15.	mHE “Vinicka”	0.72	2.62	Vinicka rijeka	Lim	Lim_2
16.	mHE “Bistrica”	0.99	3.15	Bistrica (Lipovksa)	Tara	Tara_3
17.	mHE “Bukovica”	0.28	1.17	Bukovica (Kolašin)	Tara	Tara_3
18.	mHE “Pecka”	0.82	2.84	Pecka	Tara	Drcka
19.	mHE “Krkori”	0.37	2.17	Kutska rijeka	Lim	Kutska/Mojanska /Zlorečica
20.	mHE “Meteška	0.68	1.60	Meteška rijeka	Lim	Komarača
	Sub-Total	**33.83**	**109.94**			
	Planned					
23.	mHE “Paljevinska”	0.54	2.10	Paljevinska rijeka	Tara	Tara_3
24.	mHE “Ljevak”	0.55	2.51	Ljevak	Tara	Tara_4
26.	mHE “Miolje polje”	0.30	2.20	Merica vrelo	Lim	Lim_2
27.	mHE “Štitska”	0.84	2.45	Štitska rijeka	Lim	Kutska/Mojanska /Zlorečica
28.	mHE “Umska”	0.44	2.21	Umski potok	Lim	Kutska/Mojanska /Zlorečica
29.	mHE “Lazanjska”	0.55	1.25	Lazanjska	Ibar	Crnja
30.	mHE “Bukovička vrela”	0.30	0.95	Bukovačko vrelo	Tara	Tara_3
31.	mHE “Pješčanica”	0.18	0.64	Pješčvanica	Tara	Tara_3
32.	mHE “Bukeljka”	0.50	1.14	Bukeljka	Ibar	Crnja
33.	mHE “Varin potok”	0.18	0.68	Varin potok	Tara	Drcka
34.	mHE “Elektrana Mišnića”	0.22	0.99	Mišnjića potok	Tara	Tara_3
35.	mHE “Dapsićka rijeka”	0.58	2.03	Dapsićka rijeka	Lim	Lim_2
36.	mHE “Vođenički potok”	0.20	0.43	Vođenički potok	Lim	Lim_2
37.	mHe ”Zagradska”	0.70	2.70	Zagradska rijeka	Lim	Lim_3

No.[64]	SHPP Name	Design Capacity (MW)[65]	Annual Production Expected (GWh)[66]	River/ Stream	Sub-Basin	Related Surface Waterbody[67]
38.	mHE “Brzava”	0.63	2.15	Brzava	Lim	Lim_3
39.	mHE “Stubljanska"	0.40	1.85	Stubljanska rijeka	Lim	Lim_3
40.	mHE “Brzava 1”	0.65	2.27	Brzava	Lim	Lim_3
41.	mHE “Čelinska”	0.30	1.10	Čellinska rijeka	Lim	Lim_3
42.	mHe “Skrbuša”	0.90	3.43	Skrbuša	Tara	Tara_3
43.	mHe ”Bare Kraljske”	0.99	3.36	Vranještica	Tara	Drcka
44.	mHE "Grlja"	1.70	5.70	Grlja	Ljuča	Grlja
45.	mHE "Murinska rijeka"	2.07 (2 SHPPs)	8.30	Murinska rijeka	Lim	Lim_1
46.	mHE "Komarača"	4.00	10.80	Komarača	Lim	Komarača
47.	mHE "Đurička rijeka"	4.90 (2 SHPPs)	15.50	Djurička rijeka	Lim	Lim_1
48.	mHE "Vrbnica"	5.35 (2 SHPPs)	20.30	Vrbnica	Piva	Vrbnica_1
49.	mHE "Kaludra"	1.05	5.50	Kaludra	Lim	Lim_2
	Sub-Total	**29.02**	**102.54**			
	Total	**86.95**	**288.79**			

The definition of impacts (significantly adverse to significantly positive) of SHPPs on the environment are clearly outlined by the EU[68], as shown below in Table 4.26.

Table 4.26 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.

[68] Guidance on the requirements for hydropower in relation to Natura 2000, European Commission (2018)

Term	Description	Examples
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 have been constructed and those in the process of construction in the Danube River Basin in terms of impacts to the environment is summarized in Table 4.27.

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 all criteria examined. The one 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 4.27 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.

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Figure 4.12 The location of hydropower plants in the Danube River Basin

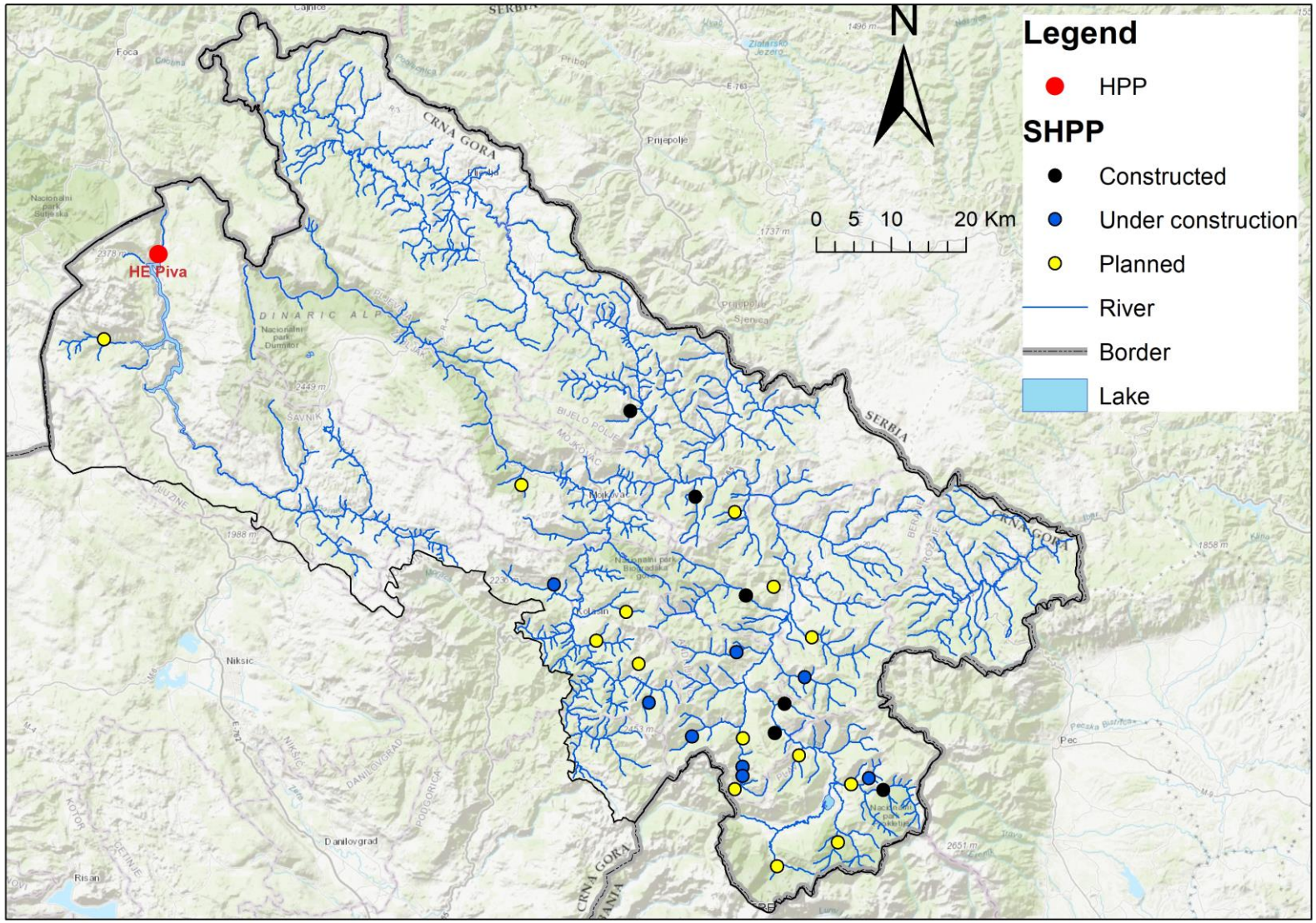


Table 4.27 Assessment of potential impacts of small hydropower plants constructed or under construction in the Danube River Basin

Key:

Potential Significant Adverse Impact

Potential Moderate Adverse Impact

Potential Zero Impact

No.[69]	SHPP Name[70]	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
1.	Vrelo									
2.	Rijeka									
3.	Piševska rijeka									
4.	Babiono-poljska									
5.	Bist - Majst									
6.	Šeremet potok									
7.	Bistrica (L)									
8.	Šekularska									
9.	Trepačaka									
11.	Crnja									

[69] Numbering according to the national register of SHPPs

[70] SHPPs No. 1-7 are constructed; SHPPs Nos. 8-20 are under construction. No impacts are provided for SHPPs in the early stages of plannng

No.[69]	SHPP Name[70]	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
13.	Mojanska rijeka									
14.	Kutska rijeka									
15.	Vinicka									
16.	Bistrica (B)									
17.	Bukovica									
18.	Pecka									
19.	Krkori									
20.	Meteška									

4.10.3 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. River Tara at Kolašin and River Lim at Berane. These, as well as works on some other rivers, were carried out after the floods of 2011.

Figure 4.13 Canalization of the River Tara for conveyance and flood protection in Kolašin



Under the WFD 2016 reporting classification scheme 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. River banks 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 it is suspected 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 Danube catchment area there are only two WBs that have the riverbed made of concrete (channelized river flow): Tara_3 (SWB 5) and Ćehotina_4 (SWB 44) (Table 4.36).

4.11 Assessment of water quality in surface waters

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 as 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 4.28.

Table 4.28 Required classes and category of surface waters

River Reach or Lake	Class	Category
Piva downstream Pivsko lake	A2, C, K2	II
Komarnica	A1, S, K1	I
Tara	A1, S, K1	I
Piva downstream Pivsko lake	A2, C, K2	II
Ćehotina		
Upstream Pljevlja	A1, S, K1	I
Downstream Pljevlja	A2, C, K2	II
Ibar		
Upstream Rožaje	A1, S, K1	I
Downstream Rožaje	A2, C, K2	II

Table 4.29 shows the definition of water quality status that was applied to assess the quality of surface waters:

Table 4.29 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 Danube River Basin (Table 4.30) are monitored regularly by IHMS, which conform only to 14 out of the 48 surface water bodies designated (See Section 3.3, Table 3.5).

Table 4.30 IHMS surface water monitoring stations in the Danube River Basin

IHMS Monitoring Station	SWB No.	Surface Water Body (ECRIN Code)
Plav	24	Lim_1
Andrijevica	27	Lim_2
Skakavac	27	Lim_2
Zaton	34	Lim_3
Bijelo Polje	34	Lim_3
Dobrakovo	24	Lim_3
Gusinje	22	Ljuča
Kuti	26	Kutska/Mojanska/Zlorečica
Rožaje	39	Ibar_2
Bac	39	Ibar_2
Crna Poljana	5	Tara_3
Kolašin	5	Tara_3
Trebaljevo	5	Tara_3
Mojkovac	7	Tara_4
Djurdjevica Tara	8	Tara_5
Šćepan polje	18	Piva

IHMS Monitoring Station	SWB No.	Surface Water Body (ECRIN Code)
Rabitlja	43	Ćehotina_3
Pljevlja	44	Ćehotina_4
Ispod usca Vezisnice	44	Ćehotina_4
Gradac	48	Ćehortina _6
Vezisnica	45	Vezišnica

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 4.31 and 4.32, respectively.

Table 4.31 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 4.32 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}	mgO_2/l	1	2	4	8	>8
Iron	Fe	mg/l	0.05	0.1	0.3	1	>1

Measurement of priority substances and metals has not yet been carried out by IHMS. Based on an 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 4.33. The link between the categories of pressures and the discharges from agricultural, industrial and municipal sectors is summarized in Table 4.34.

Table 4.33 Preliminary summary of classification of physico-chemical parameters at main rivers[71]

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
Lim	Plav	Lim_1	G	B	H	M	P	M	G
	Andrijevica	Lim_2	H	B	H	G	M	M	G
	Skakavac	Lim_2	G	B	H	B	B	M	M
	Zaton	Lim_3	G	B	H	B	P	G	M
	Bilelo Polje	Lim_3	G	B	H	B	P	M	G
	Dobrakovo	Lim_3	G	B	H	P	M	M	M
Tara	Crna Poljana	Tara_3	G	P	H	G	M	G	G
	Kolašin	Tara_3	G	M	H	H	P	M	G
	Trebaljevo	Tara_3	H	P	H	G	P	G	G
	Mojkovac	Tara_4	G	P	H	G	P	M	G
	Đurđevića Tara	Tara_5	H	P	H	H	P	G	P

[71]Quality state water in main river in the Danube River Basin assessed for years 2015, 2016 and 2017 by the Institute for Hydrometeorology and Seismology, Podgroica, Montenegro.

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
	Šćepan polje	Tara_5/Piva	G	P	H	H	P	G	M
Ćehotina	Rabitlja	Ćehotina_3	M	M	H	P	P	M	M
	Pljevlja	Ćehotina_4	P	B	H	B	B	M	G
	Vizisnica**	Vezišnica	P	B	G	B	B	P	M
	Gradac	Ćehortina _6	M	P	H	G	P	M	M

*Status: H-High, G-Good, M-Moderate, P-Poor, B-Bad

**Below the mouth of the Vizisnica

Table 4.34 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 4.14). • 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 4.14) • Larger industries often discharge directly into the river, in principle after treatment.

Pressures (selection)	Organic pollution	Nutrients	Salinity	Transparency	Other specific pollutants	Priority substances	Pathogens	Remarks
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. • Use of specific pesticides depends on the type of crops. • 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 Ćehotina, Lim and Tara[72].

Data in table 4.33 show that in general there are problems with ppoint source organic pollution in the Danube River Basin and the negative effect of municipal discharge of urban discharges are clear. In termsof diffuse source pollution, phosphate pollution is evidenced, and to a much lesser extent nitrate pollution, the former being derived from erosion and agriculture, while the latter is derived primarily from agricultural pollution.

4.12 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.

[72] Report on Environment in Montenegro for 2016, EPA, 2017

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'.

4.12.1 Preliminary assessment of pressures on surface waters

Table 4.35 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 4.36 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 48 surface water bodies.

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'.

Table 4.35 Point source pressures in surface water bodies in the Danube River Basin[73]

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[74]
1	Opasanica / Verušica	Natural								√	
2	Tara_1	Natural								√	
3	Tara_2[75]	HMWB									
4	Drcka	Natural									(√)
5	Tara_3	Natural	√							√	(√)
6	Biogradsko Lake	Natural									
7	Tara_4	Natural	√		√			√			
8	Tara_5	Natural									
9	Crno Lake	Natural									
10	Tušina/Bukovica	Natural								√	

[73] Point sources pressures are categorized in Section 4.4

[74] Values in parenthesis relate to SHPPs under construction only.

[75] Construction of highway causing modification to Tara River

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[74]
11	Pridvorica	Natural								√	
12	Bijela	Natural									
13	Komarnica_1	Natural									
14	Komarnica_2	Natural									
15	Piva Reservoir	HMWB	√							√	√
16	Vrbnica_1	Natural									
17	Vrbnica_2	Natural									
18	Piva[76]	Natural									
19	Grlja_1	Natural									
20	Grlja_2	Natural									
21	Grnčar	Natural									
22	Ljuča	Natural									
23	Plavsko Lake	Natural	√								
24	Lim_1	Natural	√		√		√			√	

[76] Under pressure of hydropeaking on daily basis

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[74]
25	Komarača [77]	HMWB					√				√
26	Kutska/Mojanska/Zlorečica	Natural									√
27	Lim_2	Natural	√	√	√		√	√		√	(√)
28	Bistrica[78]	HMWB									√
29	Popča / Vrbička rijeka	Natural			√						
30	Lješnica	Natural					√				
31	Ljubovića_1	Natural								√	√
32	Ljubovića_2	Natural					√				
33	Bistrica (Lj)[79]	HMWB									√
34	Lim_3	Natural	√		√		√				

[77] River substantially altered by small hydropower development

[78] River substantially altered by small hydropower development

[79] River substantially altered by small hydropower development

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[74]
35	Bistrica (L)_1	Natural									
36	Bistrica (L)_2	Natural			√					√	
37	Ibar_1	Natural									
38	Crnja	Natural									
39	Ibar_2	Natural	√		√		√				
40	Ćehotina_1 /Kozička rijeka	Natural									
41	Ćehotina_2	Natural									
42	Otilovići Reservoir	HMWB									
43	Ćehotina_3	Natural									
44	Ćehotina_4[80]	HMWB	√	√	√				√		
45	Vezišnica	Natural		√	√						
46	Ćehotina_5	Natural			√		√				

[80] Alteration of the river flow

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[74]
47	Voloder	Natural									
48	Ćehotina_6	Natural				√			√		

Table 4.36 Pressures affecting surface water bodies in the Danube River Basin and identification of risk[81]

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
1	Opasanica / Verušica	26.51 km	• Fish farm-nutrients and organic matter loading • Other-Sediment erosion due to forest cutting in spring areas • Urban waste water – Veruša village		• Fish farm • Agriculture (low insensitivity but significant during low summer flows)			Possibly at risk
2	Tara_1	6.03 km	• Fish farm-nutrients and organic matter loading				• Removal of animals-Illegal fishing[82]	Likely not at risk
3	Tara_2[83]	6.97 km				• Riverbed altered due to highway construction	• Dirt and cement from construction machine washing • Potential sediment spillage from construction material dumpsites	At risk
4	Drcka	18.87 km						Likely not at risk

[81] Pressures on the surface water bodies are categorized in Section 4.4

[82] See Section 4.4: Pressure No. 5.2 Exploitation of/removal of animals/plants

[83] Construction of highway causing modification to Tara River

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
5	Tara_3	29.96 km	• Urban waste water from Kolašin municipality	• Overflows and discharges in urbanized and non-urbanized areas • Diffuse pollution from road and train traffic • Leakage from surrounding households and animal farms • Agriculture in some parts of SWB			• Removal of animals-Illegal fishing	At risk
6	Biogradsko Lake	0.23 km^2					• Introduction of invasive rainbow trout and lake char [84]	Likely not at risk
7	Tara_4	19.35 km	• Urban waste water from Mojkovac municipality • Discharge from non-IED plants • Gravel extraction	• Overflows and discharges in urbanized and non-urbanized areas • Leakage from surrounding households and animal farms			• Removal of animals-Illegal fishing (poachers)	Possibly at risk
8	Tara_5	79.77 km						Likely not at risk
9	Crno Lake	0.52 km^2					• Introduction of invasive rainbow trout [76]	Likely not at risk

[84] See Section 4.4: Pressure No. 5.1 Introduced species and disease

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
10	Tušina/ Bukovica	30.93 km	• Fish farm-nutrients and organic matter loading					Likely not at risk
11	Pridvorica	14.89 km	• Fish farm-nutrients and organic matter loading					Likely not at risk
12	Bijela	9.00 km						Likely not at risk
13	Komarnica_1	18.13 km						Likely not at risk
14	Komarnica_2	17.07 km						Likely not at risk
15	Piva Reservoir	12.5 km^2	• Fish farm-nutrients and organic matter loading • Urban waste water from Plužine municipality			• Hydropower dam	• Introduction of invasive rainbow trout [76] and some other species (cyprinid)	Likely not at risk
16	Vrbnica_1	4.93 km						Likely not at risk
17	Vrbnica_2	3.22 km						Likely not at risk

[76] See Section 4.4

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
18	Piva[85]	9.72 km				• Hydropeaking on daily basis (changing of flow several times during one daily cycle)		Possibly at risk
19	Grlja_1	5.61 km						Likely not at risk
20	Grlja_2	2.08 km						Likely not at risk
21	Grnčar	6.71 km			• Agriculture (low insensitivity but significant during low summer flows)			Likely not at risk
22	Ljuča	12.76 km						Likely not at risk
23	Plavsko Lake	1.99 km^2	• Urban waste water from Plav municipality	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Sediment loading				Possibly at risk

[85] Under pressure of hydropeaking on daily basis

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
24	Lim_1	26.02 km	• Urban waste water from Andrijevica municipality • Discharge from non-IED plants • Waste disposal • Gravel extraction • Small scale fish farm (illegal)	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Leakage from surrounding households and animal farms			• Removal of animals-Illegal fishing (poachers)	Possibly at risk
25	Komarača[86]	20.49 km	• Waste disposal • Small Hydropower			• Barrier for small hydropower water redirecting in to the tube system		At risk
26	Kutska/ Mojanska/ Zlorečica	28.02 km			• Public water supply			Likely not at risk
27	Lim_2	44.14 km	• Urban waste water from Berane municipality • Discharge from IED plants • Discharge from non-IED plants • Waste disposal	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Diffuse pollution from road • Sediment erosion from surrounding terrain	• Agriculture (low insensitivity but could be significant during lowest summer flows)		• Removal of animals-Illegal fishing (poachers) • Illegal dumpsites	Possibly at risk

[86] River substantially altered by small hydropower development

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
			• Fish farm- nutrients and organic matter loading • Gravel extraction	• Leakage from surrounding households and animal farms				
28	Bistrica[87]	17.29 km	• Small Hydropower		• Water supply • Agriculture (low insensitivity but could be significant during lowest summer flows)	• Barrier for small hydropower water redirecting in to the tube system		At risk
29	Popča / Vrbička rijeka	24.18 km	• Discharge from non-IED plants	• Leakage from surrounding households and animal farms				Likely not at risk
30	Lješnica	9.31 km	• Waste disposal (illegal)	• Mining (stone mining) • Diffuse pollution from road				Likely not at risk
31	Ljubovića_1	25.30 km	• Fish farm in sidelong spring region • Small Hydropower in					Likely not at risk

[87] River substantially altered by small hydropower development

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
			sidelong spring region					
32	Ljubovića_2	7.11 km	• Waste disposal (illegal)	• Leakage from surrounding households and animal farms			• Removal of animals-Illegal fishing (poachers)	Likely not at risk
33	Bistirca (Lj)[88]	5.89 km	• Small Hydropower			• Barrier for small hydropower water redirecting in to the tube system		At risk
34	Lim_3	23.84 km	• Urban waste water from Bijelo Polje municipality • Discharge from non-IED plants • Waste disposal	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Diffuse pollution from road and train traffic • Leakage from surrounding households and animal farms	• Industry • Agriculture (low insensitivity but could be significant during lowest summer flows)		• Removal of animals-Illegal fishing (poachers)	At risk
35	Bistrica (L)_1	5.21 km						Likely not at risk
36	Bistrica (L)_2	14.83 km	• Fish farms-nutrients and organic matter loading	• Overflows and discharges in urbanized and non-urbanized areas and			• Removal of animals-Illegal fishing (poachers)	Possibly at risk

[88] River substantially altered by small hydropower development

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
			• Discharge from non-IED plants	organic matter loading • Leakage from surrounding households and animal farms			• Illegal dumpsites	
37	Ibar_1	11.21 km						Likely not at risk
38	Crnja	7.33 km		• Forestry – Sawmill				Likely not at risk
39	Ibar_2	21.48 km	• Urban waste water from Rožaje municipality • Discharge from non-IED plants • Waste disposal	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Leakage from surrounding households and animal farms • Forestry – Sawmill	• Industry • Agriculture (low insensitivity)		• Removal of animals-Illegal fishing (poachers) • Illegal dumpsites	At risk
40	Ćehotina_1 /Kozička rijeka	21.49 km						Likely not at risk
41	Ćehotina_2	7.58 km						Likely not at risk
42	Otilovići Reservoir				• Industry – cooling water for thermo plant	• Dam	• Introduction of invasive rainbow trout and some other species (cyprinid)	Likely not at risk

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
43	Ćehotina_3	6.80 km						Likely not at risk
44	Ćehotina_4[89]	10.13 km	• Urban waste water from Pljevlja municipality • Discharge from IED plants • Discharge from non-IED plants • Waste disposal • Discharge from Surface coal mine	• Mining (surface coal mine) • Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Forestry, sawmill and wood processing • Diffuse pollution from road	• Drinking water supply	• Alternation of riverbed and river flow • Two tunnels and one artificial waterfall		At risk
45	Vezišnica	11.33 km	• Discharge from IED plants • Discharge from non-IED plants	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Leakage from surrounding households and animal farms				At risk
46	Ćehotina_5	19.32 km	• Discharge from non-IED plants • Waste disposal	• Overflows and discharges in urbanized and non-urbanized areas and				At risk

[89] Alteration of the river flow

No.	SWB Name	Length Or Area	identification of Pressure					Assessment of Status
			Point	Diffuse	Abstraction	Physical	Other	
				organic matter loading • Leakage from surrounding households and animal farms				
47	Voloder	21.23 km						Likely not at risk
48	Ćehotina_6	38.43 km	• Discharge from lead and zinc mining • Sludge dumping sight from lead and zinc mining	• Overflows and discharges in urbanized and non-urbanized areas and organic matter loading • Leakage from surrounding households and animal farms				At risk

4.13 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)[90] 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) developed the Guidance for Water Budgeting in 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)[91] "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 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, "providing more than 10 m^3 a day as an average or serving more than fifty persons as well as water

[90] Margat J. Gun van der J., 2013: Groundwater around the World: A Geographic Synopsis. CRC Press, Taylor & Francis Group, Boca Raton, pp. 348

[91] 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

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 13 delineated groundwater bodies (GWB) and group of groundwater bodies (GGWB) in the Danube River Basin.

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 Institute of Hydrometeorology and Seismology of Montenegro (IHMS). 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 (IHMS, 2007-2016). 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 (approximately 20) of the national network maintained by IHMS, which are rarely located close to the river sources (upper catchments where springs exist)
- Poor 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 has presented in each characterization table for evaluated GWBs or GGWBs (Annex 1). 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 and only a few with transition between RA and LL.

4.13.1 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)[92]. The annual extraction of groundwater for the **public water supply** in entire Montenegro is around 100 MCM (millions cubic meters). There are 24 groundwater sources located in karst aquifers and 2 sources in intergranular

[92] SWMM, 2017: Strategy for water management in Montenegro. MARD, Government of Montenegro

aquifers in the Danube River Basin as shown in Table 4.37. 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 4.37.

Table 4.37 Groundwater sources used for water Supply in the Danube River Basin

Municipality	Location	Type of Source	Type of Aquifer	Quantity of water (l/sec)[93]	Population [94]
Andrijevica	Krkori	spring	karst	100	5,071
Berane + Petnjica	Merića Vrelo	spring	karst	200	34,991
	Manastirsko Vrelo	spring	karst	85	
	Dapsića Vrelo	spring	karst	45	
Bijelo Polje	Vrelo Bistrice	spring	karst	500	46,051
Kolašin	Mušovića Vrelo	spring	karst	78	8,380
Mojkovac	Gojakovića Springs	spring	karst	36	8,622
	Vrelo Štitarice[1]	spring	karst	50	
	Ravnjak	spring	karst	40	
Plav + Gusinje	Bajrovića Springs	spring	karst	30	13,105
	Jasenica (Lugovi)	well	inter-granular	44	
	Pusta Vrata	spring	karst	27	
	Murinska River	spring	karst	20	
Pljevlja	Breznica	spring	karst	50	30,786
	Jugoštica (Petrova Česma)	spring	karst	5	
	Zmajevac	spring	karst	45	
	Mandovac	spring	karst	10	
	Bezarska Vrela	spring	karst	24	
Plužine	Sutulija	spring	karst	650	3,246
Rožaje	Vrelo Ibra	spring	karst	100	22,964
	Grlja	spring	karst	5	
	Plunački Stanovi	spring	karst	20	
Šavnik	Šavnička Glava	spring	karst	50	2,070
Žabljak	Oko (Zminje Lake)	spring	karst	40	3,569
	Mlinski Potok (Crno Lake)	well	inter-granular	17	
	Sopot	spring	karst	5	

[93] Based on field research in 2018 during the preparation of the RBMPs it is estimated that the total of groundwater is available is 73,352,736 m^3/year, which is 10% more than previous quoted.

[94] After MONTSTAT, for the year 2011

Groundwater is used for the bottling on seven locations in the Danube River Basin. The summary extraction rates on these locations are up to 10 l/s:

- Bukovica Spring ("Suza", Trebaljevo, Kolašin);
- Ropušica Spring ("Aqua Monta", Lipovo, Kolašin);
- Đedov Spring ("Aqua Bianca", Kolašin);
- Jeremija Spring ("Gorska", Kolašin)
- Gusarevci Spring ("Diva", Šavnik)
- Borehole in Župa Dobrska ("Božija voda", Cetinje)
- Čeoče Spring ("Rada", Bijelo Polje).

With regard to 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 (1,805 mm/year)[95] 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[96].

4.13.2 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

[95] FAO, Rome: www.fao.org/nr/aquastat

[96] FAO, Rome: www.fao.org/nr/aquastat

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).[97,98,]

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 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, the results obtained from the separation of hydrographs have been compared, 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 is given to these exploitable GW reserves and the relation between them and the total of demanded waters (or extracted waters where demands are stable).

[97] 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

[98] 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

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 utilized 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 compari*ng* Water Demands with Exploitable Water Reserves (Approach 1), or *Demands in Groundwater* 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*[99]*)*, when GW demands = 20 – 33 % of GW exploitable reserves;
- *At risk*, when GW demands > 33 % of GW exploitable reserves.

Considering the fact that Guidance for GW status[100] as well as some EU countries' reports compare *Demands in Groundwater* 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 extraction < 12 % of GW dynamic (renewable) reserves;
- *Not at risk (Potentially at risk),* when GW extraction = 12–25 % of dynamic (renewable) reserves;
- *At risk*, when GW extraction > 25 % of dynamic (renewable) reserves.

Considering that there were almost no differences regardless of which approach applied in the risk assessment of GWB, the analysis proceeded with Approach (1); the results presented in Tables 4.38 and 4.39 refer to the comparison between GW Demands and GW Exploitable Reserves.

Table 4.38 contains input parameters for all 13 delineated GWBs and GGWBs in the Danube River Basin. These parameters are also included in the characterization tables and refer to the catchment

[99] The category '*Potentially at Risk*' is not recognized in WFD or EU reference application documents (CIS). 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.

[100] WFD CIS Guidance Document No. 18 (2009), *Guidance on Groundwater Status and Trend Assessment*

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 4.39 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.

Table 4.38 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 (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)
1	ME_DB_GW_K_1	TBA	Brezna - Maglić	Piva	Tušinja/ Bukovica Pridvorica Bijela Komarnica_1 Komarnica_2 Piva reservoir Piva Vrbnica_1 Vrbnica_2	702.9	1,712 / 1068	60 / 20.3	29	20	2.52	0.01	0.012
2	ME_DB_GW_K_2	N	Pivska Mountain	Piva	Tušinja/ Bukovica Pridvorica Bijela Komarnica Piva reservoir Piva	629.9	1,584 / 998	70 / 22.2	35.2	20	2.5	0.05	0.06
3	ME_DB_GW_K_3	N	Sinjajevina	Tara	Tara_4	406.0	1,889 / 767	60 / 14.6	36	14	2.5	0.061	0.073
4	ME_DB_GGW_K_4	TBA	Durmitor	Tara	Tara_5 Crno Lake	429.1	1,555 / 667	60 / 12.7	29.6	10	2.2	0.057	0.068

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)
5	ME_DB_GW_K_5	TBA	Kosanica	Tara	Tara_3,Tara_4 Tara_5 Draga	377.5	1,400 / 528	60 / 10	26.5	10	1.7	0	0.01
6	ME_DB_GGW_C_1	TBA	Maoče	Ćehotina	Ćehotina 1/ Kozička Rijeka Ćehotina_2 Ćehotina_3 Ćehotina_4 Ćehotina _5 Ćehotina_6 Otilovici reservoir Voloder Vezišnica Sjevernica_1 Sjevernica_2	526.7	1,021 / 330	60 / 6.3	16.7	6	1.5	0.045	0.054
7	ME_DB_GGW_I_1	TBA	Pljevlja basin	Ćehotina	Ćehotina 1/ Kozička Rijeka Ćehotina_2 Ćehotina_3 Ćehotina_4 Ćehotina _5 Ćehotina_6	554.0	866 / 377	60 / 7.1	12.8	7	1.75	0.055	0.066

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)
					Otilovici reservoir								
8	ME_DB_GGW_K_6	TBA	Prokletije	Lim	Ljuca Lim_1 Plavsko Komaraca	69.1	1,600 / 111	70 / 2.47	22.2	5	0.9	0.03	0.036
9	ME_DB_GGW_K_6	TBA	Komovi	Lim	Tara_1 Tara_2 Tara_3 Drcka Ljuča Plavsko Lim_1 Lim_2	127.7	1,451 / 185	65 / 3.81	29.8	3.5	0.67	0.18	0.22
10	ME_DB_GGW_C_2	TBA	Beranska Bistrica - Ljubovića	Lim	Lim_1 Lim_2 Kutska/ Mojanska/ Zlorečica Bistrica (L)_1 Bistrica (L)_2	327.7	1,236 / 405	65/ 8.35	25.5	8	1.32	0.908	1.09
11	ME_DB_GGW_K_8	TBA	Lješnica	Lim	Lim_2 Lješnica	239.9	877 / 210	60 / 4	16.7	4	0.63	0.141	0.17

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)
					Popča / Vrbička rijeka								
12	ME_DB_GGW_K_9	TBA	Pešter	Lim	Bistrica (L)_1 Bistrica (L)_2	117.0	855 / 100	70 / 2.2	18.8	3	0.39	0	0.01
13	ME_DB_GGW_K_10	TBA	Gornji Ibar	Ibar	Ibar_1 Ibar_2 Crnja	253.0	1,089 / 224	55 / 3.9	15.4	3.5	0.56	0.105	0.126

***Legend**:* ME – Montenegro; DB – Danube 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 4.39 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_DB_GW_K_1	TBA	Brezna - Maglić	Piva	20	2.52	17.4	0.01	0.012	0.0007	<1	**N**			
2	ME_DB_GW_K_2	N	Pivska Mountain	Piva	20	2.5	17.5	0.05	0.06	0.003	<1	**N**			
3	ME_DB_GW_K_3	N	Sinjajevina	Tara	14	2.5	11.5	0.061	0.073	0.006	<1	**N**			
4	ME_DB_GGW_K_4	TBA	Durmitor	Tara	10	2.2	7.8	0.057	0.068	0.009	1	**N**			
5	ME_DB_GW_K_5	TBA	Kosanica	Tara	10	1.7	8.3	0	0.01	0.001	<1	**N**			
6	ME_DB_GGW_C_1	TBA	Maoče	Ćehotina	6	1.5	4.5	0.045	0.054	0.012	1	**N**			
7	ME_DB_GGW_I_1	TBA	Pljevlja basin	Ćehotina	7	1.75	5.2	0.055	0.066	0.012	1	**N**			
8	ME_DB_GGW_K_6	TBA	Prokletije	Lim	5	0.9	4.1	0.03	0.036	0.009	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
9	ME_DB_GGW_K_7	TBA	Komovi	Lim	3.5	0.67	2.8	0.18	0.22	0.079	8	**N**			
10	ME_DB_GGW_C_2	TBA	Beranska Bistrica - Ljubovića	Lim	8	1.32	6.6	0.908	1.09	0.165	16.5	**N**	14%	N	Control irrigation, domestic. use
11	ME_DB_GGW_K_8	TBA	Lješnica	Lim	4	0.63	3.3	0.141	0.17	0.052	5	**N**			
12	ME_DB_GGW_K_9	TBA	Pešter	Lim	3	0.39	2.6	0	0.01	0.004	<1	**N**			
13	ME_DB_GGW_K_10	TBA	Gornji Ibar	Ibar	3.5	0.56	2.9	0.105	0.126	0.043	4	**N**			

Legend: ME – Montenegro; DB - Danube 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 4.38 and 4.39 and the performed evaluation:

1. The analysis confirms the richness in water availability and groundwater resources in the Danube River Basin. 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 the 13 evaluated GWBs and GGWBs is 24.16 l/s/km^2. The highest rate of 36 l/s/km^2 is at the Sinjajevina GWB, which is also characterized by the highest rainfall rate. The minimal specific discharge of 12.8 l/s/km^2 is at the northernmost GWB – the Pljevlja basin.

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 114 m^3/s. Breza-Maglić and Pivska Mountain are characterized by the largest reserves of ca. 20 m^3/s, while minimal reserves were found in the karst aquifers of GGWB Pešter: 3 m^3/s.

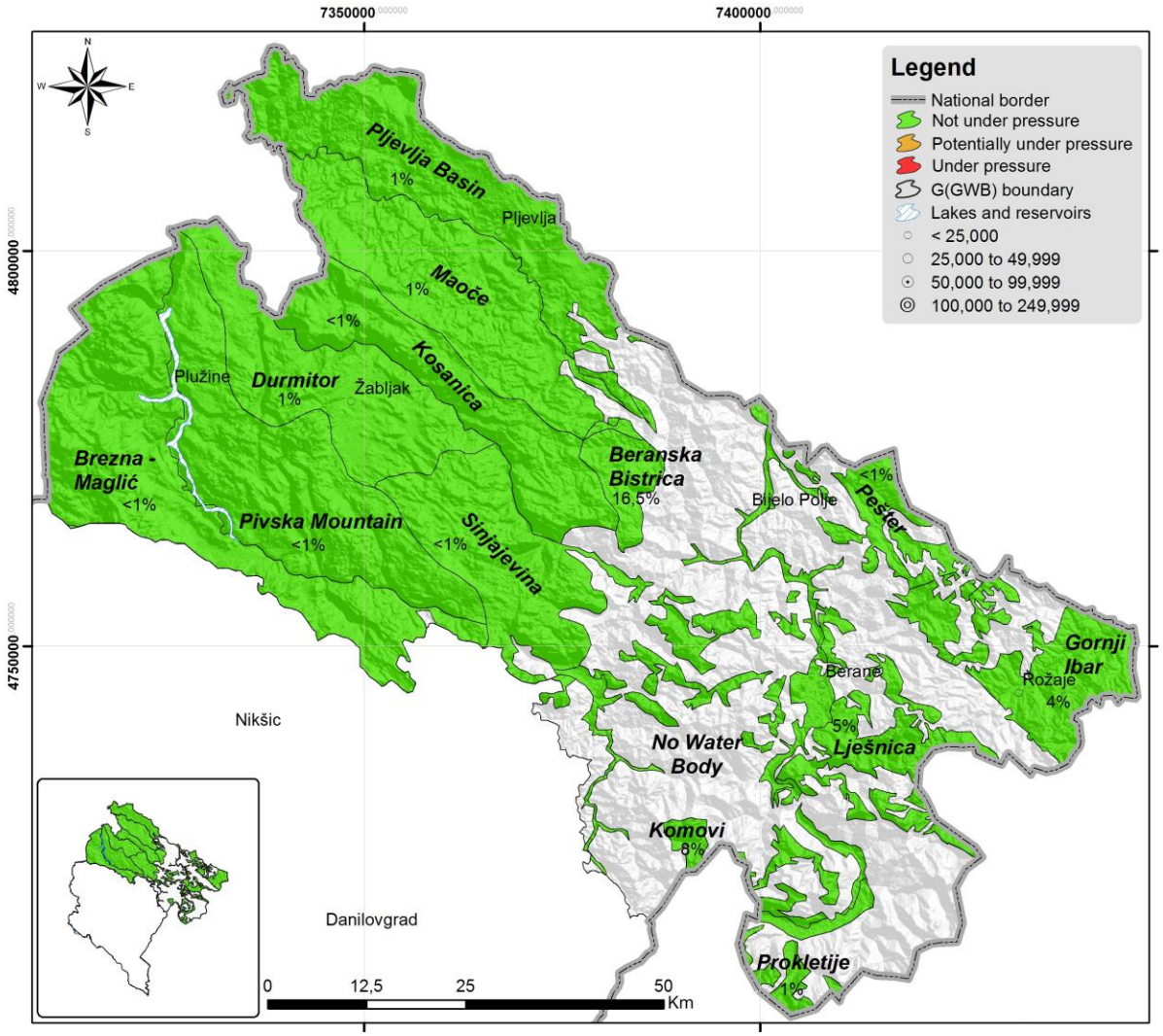
3. The total minimal discharge of all the springs is estimated to be 19.1 m^3/s, which is 9x more than the projected water demands for all GWBs and GGWBs of the Danube River Basin. However, the Qav: Qmin ratio shows a large disproportion - 1:6, typical for karst regions and aquifers.

4. As regards minimal springs' discharge as an equivalent of ecological flow (required for a dependent ecosystem), the situation is quite similar. The GWBs with the largest dynamic reserves in Breza-Maglić and Pivska Mountain have the largest total Qmin of ca. 2.5 m^3/s. The GWB Pešter is characterized by a minimal ecological flow of only 0.39 m^3/s although groundwater extraction is not currently utilized from this spring.

5. The comparison of water demands (actual extraction + 20%) and exploitable GW reserves shows that no GWBs or GGWBs are at risk (Figure 4.14). However, one GGWB, namely Beranska Bistrica - Ljubovidja (16.5%) should also exploit their groundwater reserves with caution.

6. 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 9 GWBs and GGWBs require less than 1% of their available water reserves.

Figure 4.14 Levels of quantitative pressures on GWBs and GGWBS in the Danube River Basin[101]



[101] Map indicating levels of quantitative pressures on GWBs and GGWBs of the Danube River Basin (% is ratio between projected water demands (enlarged actual use by 20%) and exploitable groundwater reserves (total average springs discharge minus ecological flow)

4.14 Assessment of qualitative pressures on groundwater

4.14.1 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[102]. 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 performed 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 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 waste water 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 in the Danube River Basin is recorded in Pljevlja coal basin as result of mining activities.

[102] 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 Danube River Basin.[103]

- **Karst aquifer of inner Dinarides** (Lim and Ibar basin). The tested waters of karst aquifer show dominancy of Ca and HCO_3 ions. The water temperature in in range of 5 -15 °C. A few mineral water occurrences are also registered.
- **Karst aquifers of plains, plateaus and high mountains** (Piva basin, Tara and Ćehotina). In this typical karst region, the chemical composition of the source waters completely reflects the karst aquifer chemistry with prevailing content of Ca-HCO_3 ions. These waters are generally clear, without taste and odour, while water temperature ranges within the limit of 15-18 °C, and from 1-18 °C in Tara and Ćehotina basins, respectively.

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, in German degree).

4.14.2 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[104,105] 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 River Basin Management Plan for Danube by the ICPDR[106] 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.

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

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

[104] 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

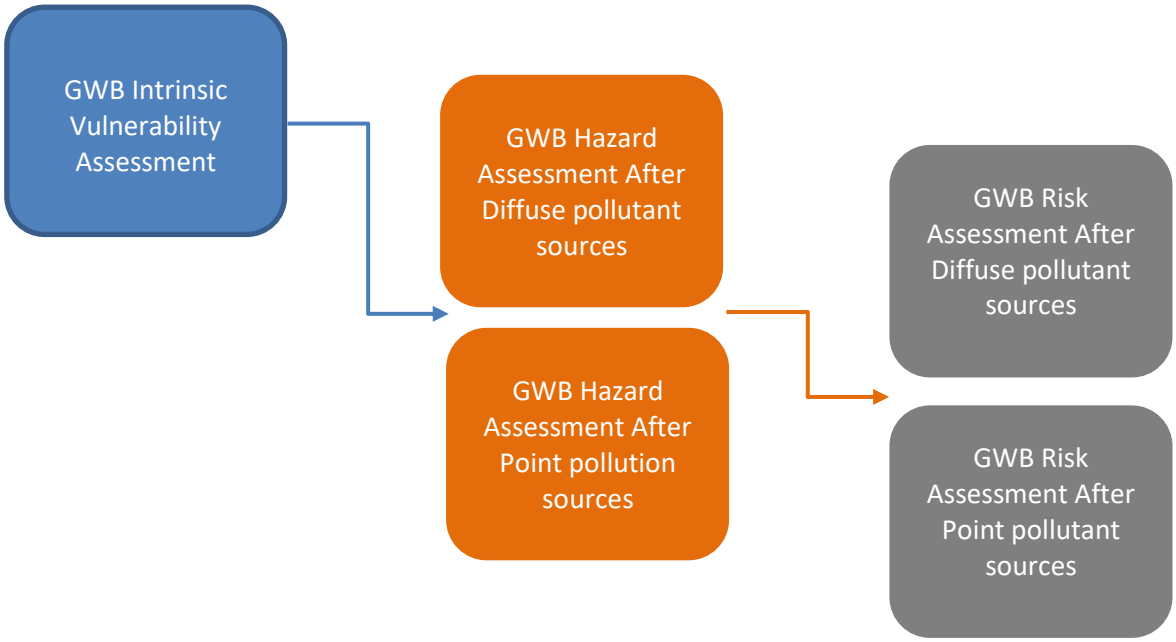
[105] United Kingdom Technical Advisory Group, 2005b: Methodology for Risk Characterization of Ireland's Groundwater, Paper by the Working Group on Groundwater, Guidance document no. GW8

[106] ICPDR 2014: Danube River Basin Management Plan, Vienna Austria, www.icpdr.org

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 in Figure 4.15.

Figure 4.15 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 4.40:

Table 4.40 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[107] 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
< 15 PE load vs. Vulnerability < 40	Conditionally at Risk
PE load vs. Vulnerability > 40	At Risk

4.14.3 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.

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

[107] PE – Population Equivalent , also abbrieviated as p.e.

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[108] is shown in Table 4.41.

Table 4.41 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
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[109])
- Methods, applicable for other aquifers with special emphasis on karst (e.g. PI method[110])

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. The authors of these maps and originally

[108] 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

[109] 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

[110] Goldscheider N., 2005: Karst groundwater vulnerability mapping: application of a new method in the Swabian Alb, Germany, Hydrogeology Journal, 13, 4: 555-565

applied the SODA method and as such suggest their application for vulnerability mapping is valid for the Danube River Basin in Montenegro 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[111], [112]:

- 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 4.42 to 4.45. 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.

Slope layer (Figure 4.16) 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 4.42 Weight factor (S) - Slope and inclination

Slope / Inclination (%)	Weight Factor (S)
over 18	1
Between 12 - 18	3
Between 6 - 12	5

[111] Stevanović Z., Marinović V., Merdan S., Skopljak F., Jolović B., 2015 Conception of creating basic documents in hydrogeology for river basin management plans, Proceedings of I Geological Congress of Bosnia & Herzegovina, Tuzla, p. 150-151

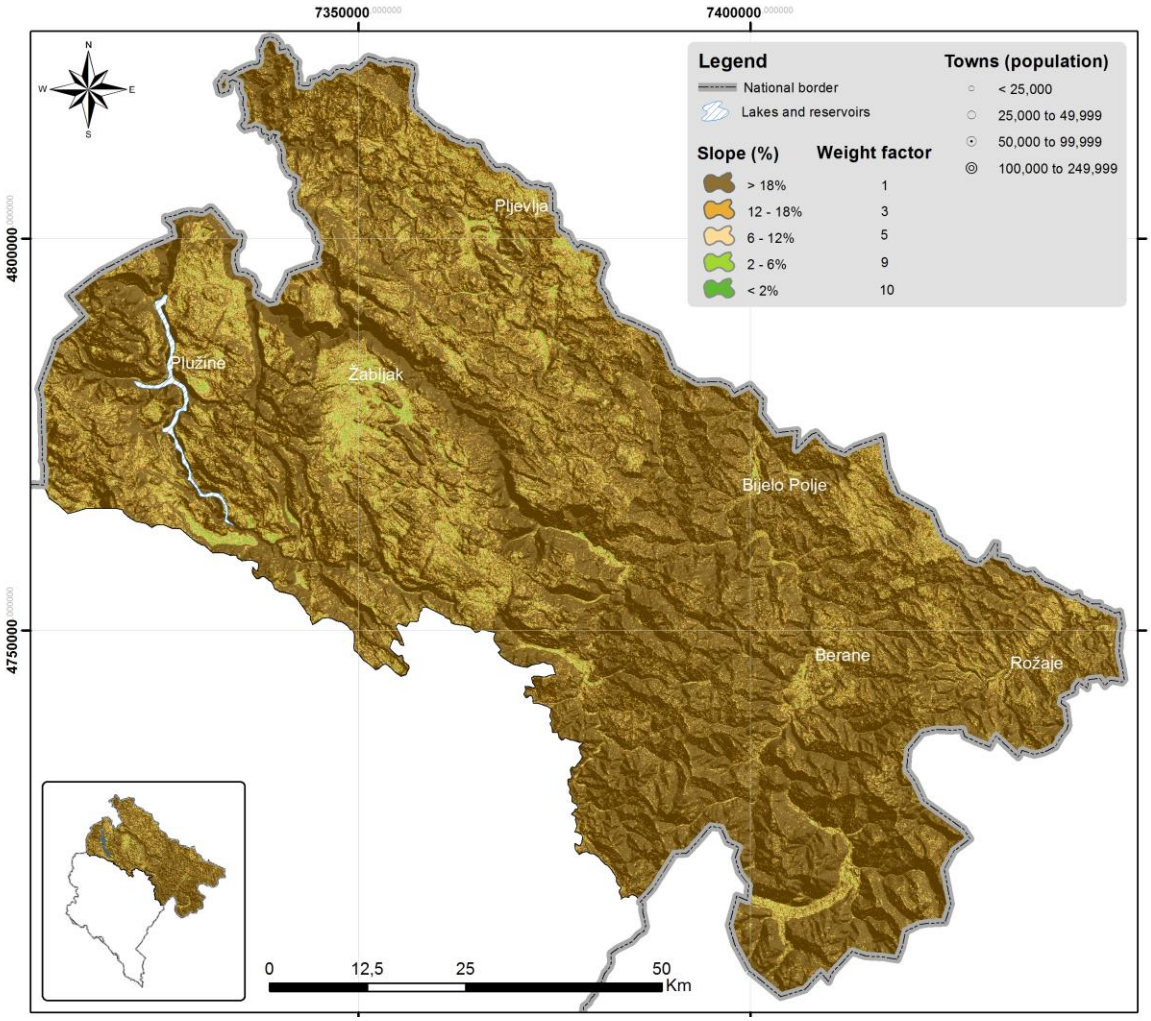
[112] Agency for Sava River Basin (ASRB), 2016: Sava River Basin Management Plan in Federation of B&H, draft version, Sarajevo (Available at: www.voda.ba)

Government of Brčko Distrikt, 2016: Sava River Basin Management Plan in Brčko Distrikt, draft version, Brčko (Available at: www.bdcentral.net)

Public Institute "Vode Srpske" ("Water of Srpska"), 2016: Sava River Basin Management Plan in the Republic of Srpska, draft version, Bijeljina (Available at: www.voders.org)

Slope / Inclination (%)	Weight Factor (S)
Between 2 - 6	9
Less than 2	10

Figure 4.16 Base layers created for Final Vulnerability Map of the Danube River Basin according the SODA method: SLOPE layer



The creation of an overlying strata layer (Figure 4.17) is based on combination of three maps: DIKTAS Map[113] Hydrogeological Map of Montenegro 1: 200,000[114] and the Soil Map for the territory of Montenegro (Pedological Map of Montenegro in scale 1:50.000, 1969/70).

[113] https://apps.geodan.nl/igrac/ggis-viewer/viewer/diktas/public/default) contains just six hydrogeological units as

[114] Radulović V., 1995: Hydrogeology Map of Montenegro, 1:200.000, Geological Survey of Montenegro, Podgorica.

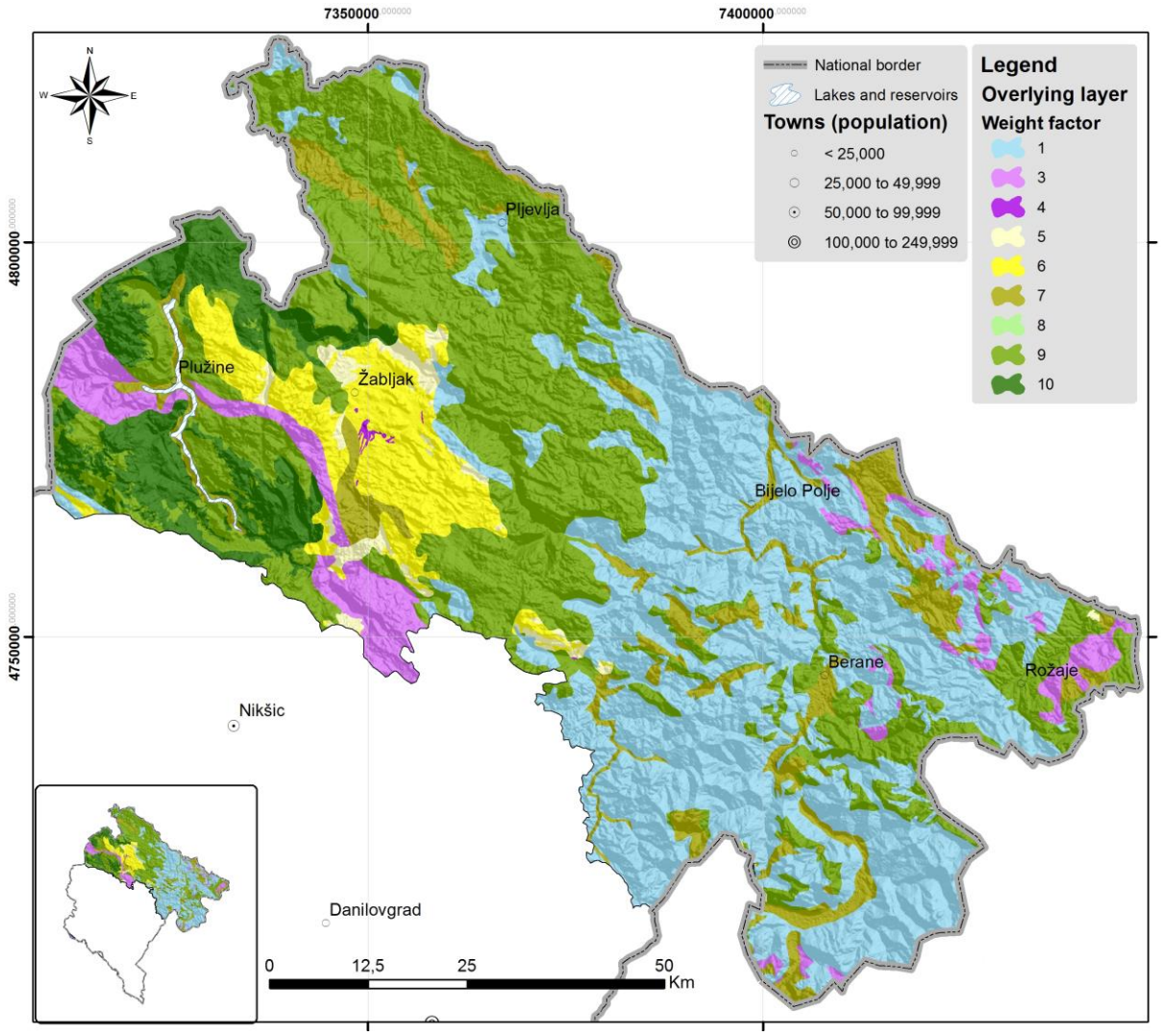
While the DIKTAS map contains just six members, as the following: AT (aquitards, with no or low groundwater content), FA (fissured aquifers), IA 1,2 (intergranular aquifers with various groundwater resources) and KA 1,2 (karstic aquifers with various groundwater resources), several other units are also delineated and included in the evaluation. For this reason, the DIKTAS Hydrogeological Map of Dinaric Region in scale 1:500,000 was compiled with 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 4.43 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 2. Neogene – clay and soil cover - AT	1. H > 10 m 2. H > 20 m	1-2
1. Fissured aquifer - FA 2. Alluvial, glacial, and terrace sediments with clay content and residual soil cover – IA2 3. Neogene – clay, sands IA2	1. H > 10 m 2. H = 8-12 m 3. H = 15-20 m	3-4
1. Karstic and karstic fissured aquifer with thick epikarst KA2 2. Alluvial, glacial, and terrace sediments of moderate permeability with soil cover IA2 3. Neogene – sands, gravel, clay with soil cover IA2	1. H = 5-10 m 2. H = 3-8 m 3. H = 10-15 m	5
1. Karstic and karstic fissured aquifer with thin epikarst KA2 2. Alluvial, glacial, and terrace sediments of moderate permeability with thin soil cover IA2	1. H = 2-5 m 2. H = 2-3 m	6
1. Karstic aquifer with thin epikarst KA1 2. Alluvial and fluvioglacial sediments of moderate to high permeability with thin soil cover IA1	1. H = 1-2 m 2. H = 1-2 m	7
1. Karstic aquifer well karstified with cavities KA1 2. Alluvial and fluvioglacial sediments of high permeability without soil cover IA1	1. H < 1 m 2. H < 1 m	8
1. Karstic aquifer highly karstified with large caverns KA1 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 4.17 Base layers created for Final Vulnerability Map of the Danube River Basin according the SODA method: OVERLYING layer



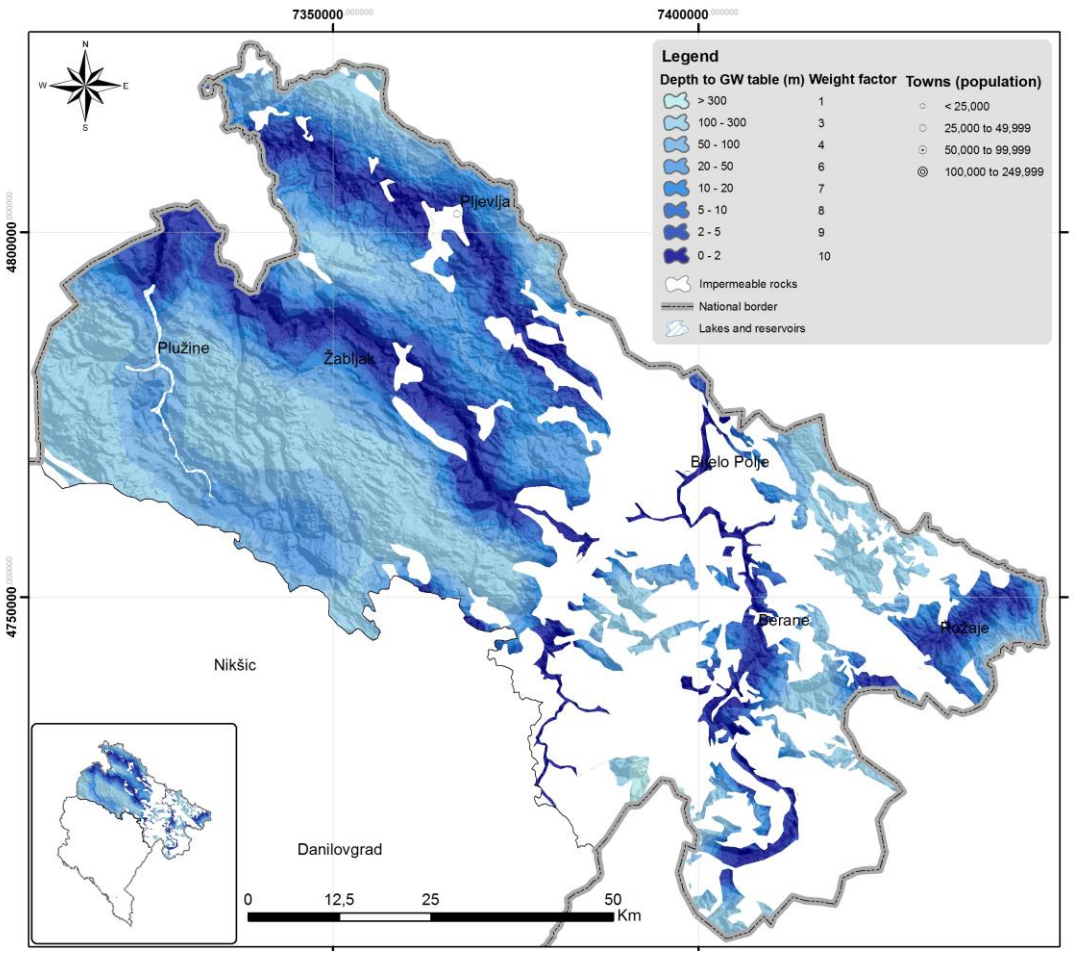
The parameter Depth to the groundwater table (Figure 4.18) is also problematic, because there are no sufficient data for the most of territory of Montenegro. In order to obtain some information for the terrains in the Danube River Basin, some approximation based on DEM, topographic maps in scale 1:25000 and Hydrogeological map in scale 1:200.000 has been made. The estimate is based on altitude of main springs and discharge points. The approach is analogical with that applied in case of the Sava River basin in Bosnia & Herzegovina[115]

[115] 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)

Table 4.44 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

Figure 4.18 Base layers created for Final Vulnerability Map of the Danube River Basin according the SODA method: DEPTH to groundwater table



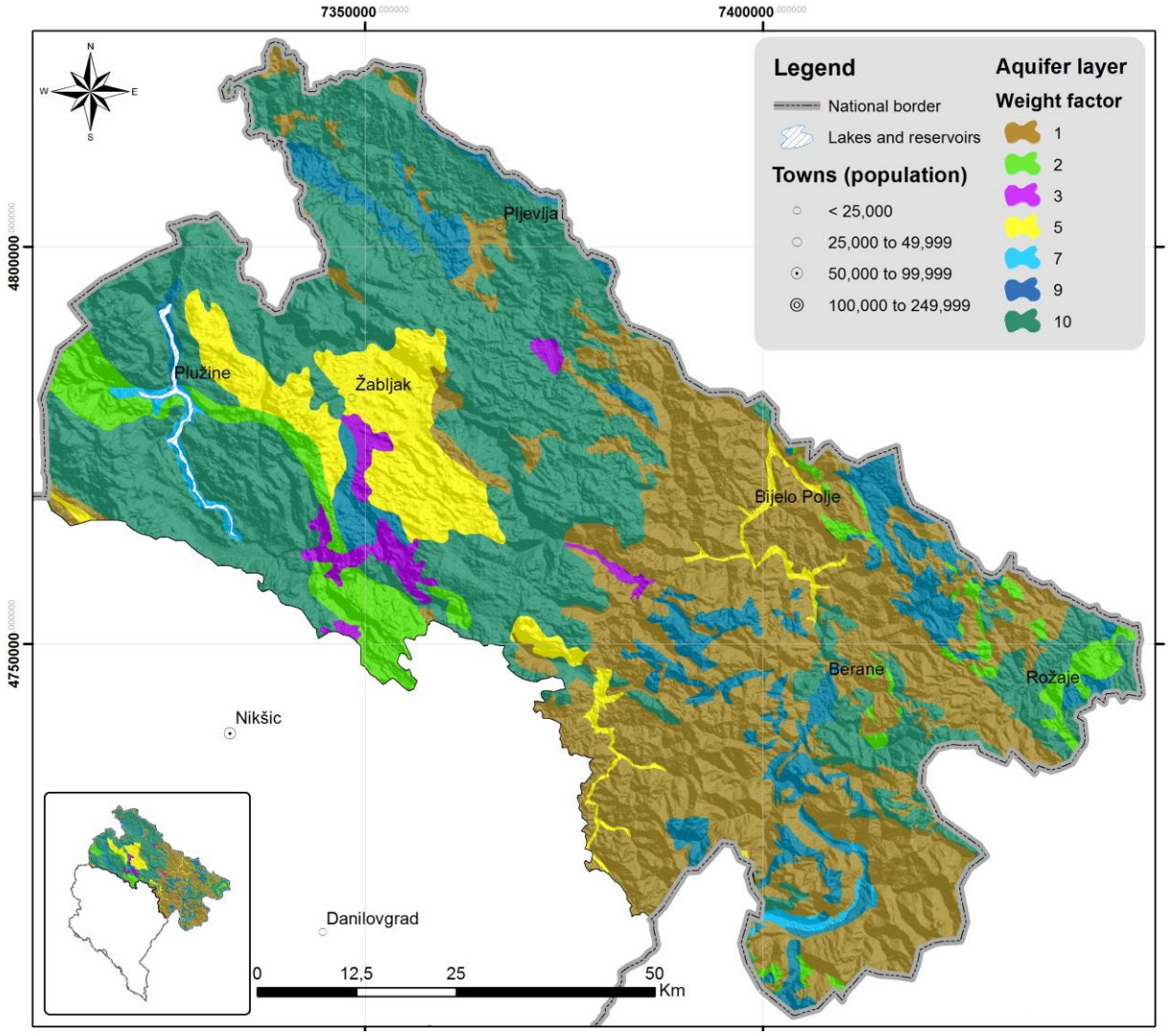
The parameter for aquifers type (Figure 4.19) is based on polygons obtained from DIKTAS map, Hydrogeological map of Montenegro in scale 1:200.000 and Basic Geological map of SFRY and is accordingly modified to include all distinguished 9 aquifer types shown in Table 4.45.

Table 4.45 Weight factor (A) – Aquifer types

Aquifers[116]	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 springs	10	10

[116] *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 4.19 Base layers created for Final Vulnerability Map of the Danube 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 4.20) is classified according to the given vulnerability classes given in Table 4.46.

Table 4.46 Categorization of intrinsic vulnerability of groundwater according to the SODA method

Vulnerability aquifer units	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**

4.14.4 Results of aquifer vulnerability assessment

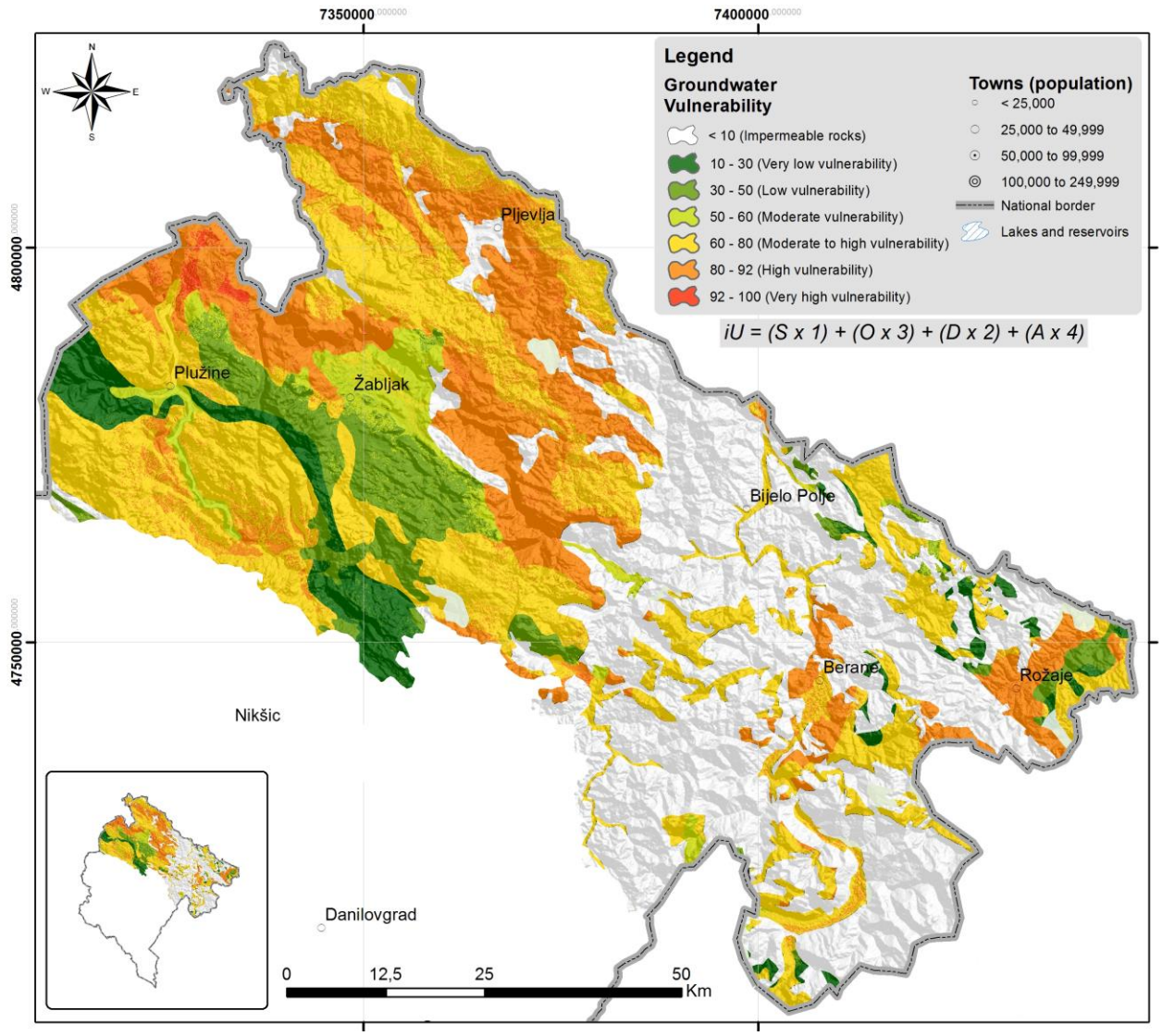
Using the SODA methodology for assessing the intrinsic vulnerability of groundwater, as presented in chapter above and the input parameters, vulnerability categories presented on the final map have been obtained. Fig. 3.20 shows final groundwater vulnerability map of the Danube River Basin. The vulnerability classes (in percentage) are also presented in Table 4.47.

The most widespread vulnerability category is ***Moderate to high vulnerability*** with 28.69% of total area belonging to the Danube 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 4.47 Vulnerability classes according the SODA method for groundwater vulnerability assessment

Danube River Basin - Vulnerability Classes			
	Class	**km²**	**%**
Terrains with no aquifers – impervious rocks	0 - 10	2,533.32	35.91
Very low vulnerability	10 - 30	314.72	4.46
Low vulnerability	30 - 50	490.65	6.96
Moderate vulnerability	50 - 60	254.89	3.61
Moderate to high vulnerability	60 - 80	2023,.2	28.69
Very high vulnerability	80 - 92	1,387.30	19.67
Extremely high vulnerability	92 - 100	49.00	0.69

Figure 4.20 Final groundwater vulnerability map of the Danube River Basin according the SODA method



4.14.5 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 28.69% of total area belonging to the Danube 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 Danube 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.

The groundwater hazard map of the Danube River Basin after diffuse pollution sources is derived from a CORINE 2012 land use map, created by European Environment Agency[117]. 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 4.48).

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[118] 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.

[117] https://www.eea.europa.eu/data-and-maps/data/clc-2012-raster

[118] https://www.ccware.eu/

Table 4.48 CORINE 2012 land use units and weight factors

Note: Only CORINE 2012 land use units located in Montenegro are colored in green

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
18	Pastures	0.233	**40**	Water courses	0.200
19	Annual crops associated with permanent crops	0.600	**41**	Water bodies	0.200

CORINE unit	Land Use (CORINE map 2012)	Load Coefficient	CORINE unit	Land Use (CORINE map 2012)	Load Coefficient
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 4.49).

Table 4.49. 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 4.50). 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 precide data on population equivalent (PE) load 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)[119] 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 4.50 Semi-Radius of circle based on PE load in creation of GW Hazard map for point pollutants in scale 1:850.000

PE load	Semi-Radius of circle (m)	PE load	Semi-Radius of circle (m)
0 – 1 000	2 000	6 000 – 7 000	5 000
1 000 – 2 000	2 500	7 000 – 8 000	5 500
2 000 – 3 000	3 000	8 000 – 9 000	6 000
3 000 – 4 000	3 500	9 000 – 10 000	6 500
4 000 – 5 000	4 000	10 000 – 11 000	7 000

[119] 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/

PE load	Semi-Radius of circle (m)	PE load	Semi-Radius of circle (m)
5 000 – 6 000	4 500	11 000 – 12 000	7 500
		> 12 000	8 000

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 semi-radius of the circle, which directly affects the degree of risk. The circles of different size are thus just visualizing relationship between more safe and endangered zones, while the methodology of risk assessment based on point pollution is explained in following text in more detail.

4.14.6 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 resolution. This methodology at the end, proposed risk classes after diffuse pollution sources, which are given in Table 4.51 below.

Table 4.51 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 Danube 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 4.52).

Table 4.52 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	Potentially at Risk
PE load /Vulnerability > 40	At Risk

4.14.7 Results of groundwater hazard and risk assessment

Hazard Assessment

The entire territory of the Danube River Basin was classified into 6 categories based on groundwater hazard assessment after diffuse pollutions (Table 4.53). 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 4.53 Groundwater hazard classes based on groundwater hazard assessment method

Montenegro - Hazard classes			
	Class	**km²**	**%**
No hazard – impervious rocks	0 – 0.1	2,533.32	35.91
Very Low Hazard	0.1 – 0.15	298.50	4.23
Low Hazard	0.15 – 0.35	3,552.85	50.37
Medium Hazard	0.35 – 0.55	626.78	8.89
High Hazard	0.55 – 0.75	38.73	0.55
Very High Hazard	0.75 – 1.0	3.78	0.05

Table 4.53 shows that the most extensive hazard class in the Danube River Basin is Low Hazard that covers 50.37% of total territory. That is the case mostly because large areas are not inhabited and belong to hilly-mountainous areas. 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 of diffuse pollution is only significant in most populated and developed municipality of Pljevlja, where the biggest industrial zones are also located (mines, thermal power plants, breweries, etc.). This situation is presented in Figure 4.21, which shows the groundwater hazard map of Danube River Basin for diffuse pollution sources.

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 4.22), which are also listed in the risk assessment for surface waters (Section 4.6.2).

The groundwater Hazard Map of the Danube River Basin for point source pollutants is shown in Figure 4.23.

Figure 4.21 Groundwater Hazard Map of the Danube River Basin for diffuse pollution

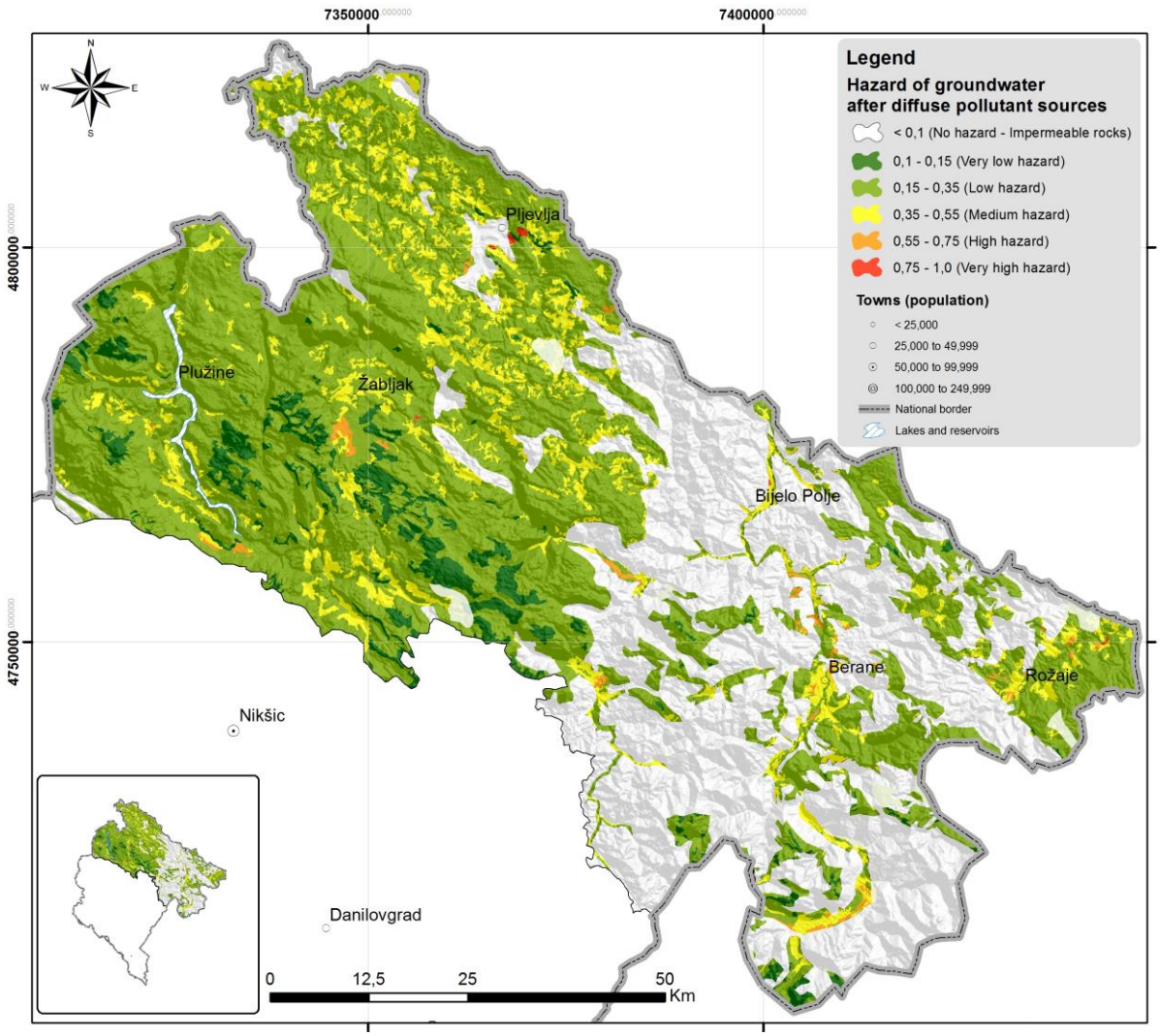


Figure 4.22 Locations of main industrial facilities in the Danube River Basin – potential water polluters

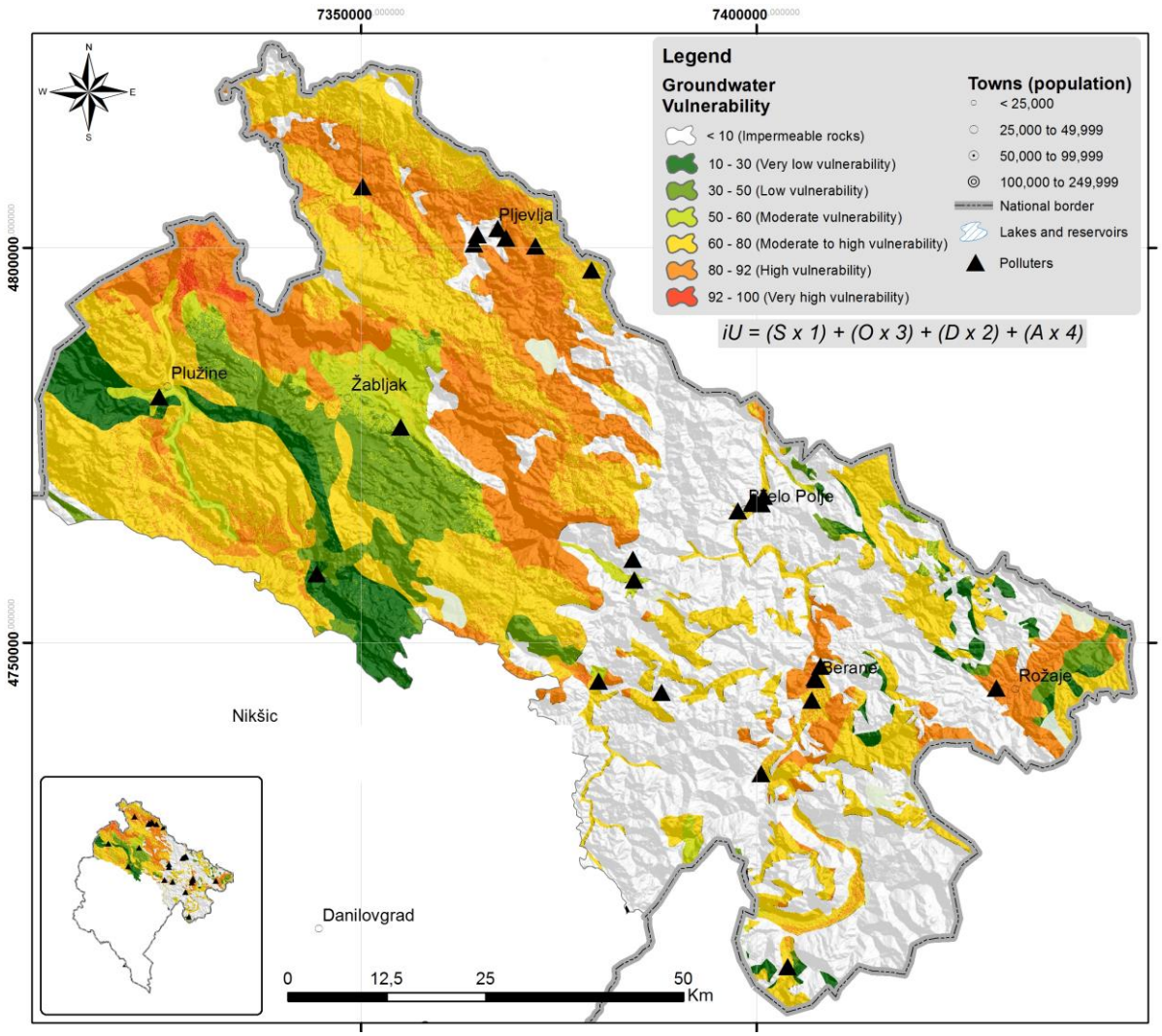
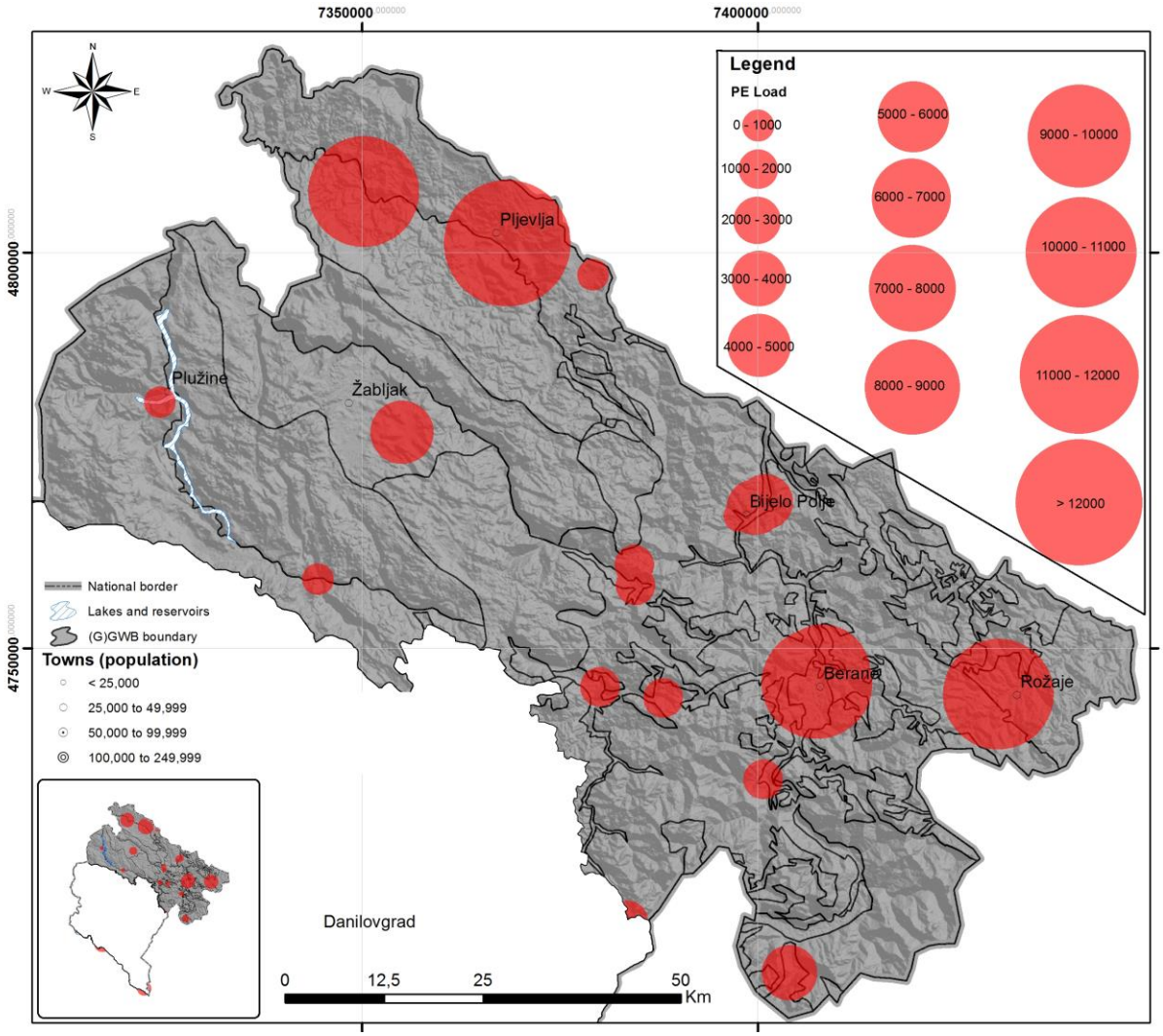


Figure 4.23 Groundwater Hazard Map of the Danube River Basin for point source pollutants



Risk Assessment

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 Danube River Basin. This risk category covers 43.71% of the total basin (Table 4.54).

The graphical presentation of groundwater risk for diffuse pollution is shown in Figure 4.24. The map also indicates so-called hotspots when it comes to the groundwater Risk – Berene, Pljevlja and Rožaje areas, and to a lesser extent Bijelo Polje, Vojno Selo and Dubrovsko. As it can be seen on the map (Figure 4.24), risk categories Medium, High and Very High risk are located in these areas. The associated groundwater bodies are: Brezna – Maglić, Gornji Ibar and Pljevlja Basin, which can be indicated as 'possibly at risk'.

Table 4.54 Groundwater risk assessment after diffuse pollution sources

Montenegro - Risk Classes			
	Class	**km²**	**%**
No Risk – impervious rocks	0 - 1	2,533.32	35.95
Very Low Risk	1 - 10	937.75	13.31
Low Risk	10 - 25	3,080.33	43.71
Medium Risk	25 40	470.64	6.68
High Risk	40 - 60	22.01	0.31
Very High Risk	60 - 100	2.77	0.04

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 4.47), a risk category for each of groundwater body has been calculated as shown in Table 4.55. This table shows that only one GGWB is under risk due to the impact of point pollution sources Plevlja Basin and three GGWBs is possibly at risk: Beranska Bistrica-Ljubovića, Gornji Ibar and Maoče. A graphical presentation of risk assessment for point pollution sources is shown in Fig. 3.25.

Table 4.55 Risk Assessment after comparison of PE load and vulnerability classes based on point pollution sources

No.	GWB Name	PE Load	Vulnerability	PE Load / Vulnerability	Risk Assessment
1	Brezna Maglić	150	1 311.39	0.11	No Risk
2	Pivska Mountain	150	1 092.93	0.14	No Risk
3	Sinjajevina	1 600	1 033.57	1.55	No Risk
4	Durmitor	4 024	1 024.07	3.93	No Risk
5	Kosanica	NO EBS LOAD	-	0	No Risk
6	Maoče	10 000	888.49	11.26	Potentially at Risk
7	Pljevlja Basin	173 652	951.22	182.56	At Risk

No.	GWB Name	PE Load	Vulnerability	PE Load / Vulnerability	Risk Assessment
8	Prokletije	3 717	1 126.90	3.29	No Risk
9	Komovi	1 435	824.23	1.74	No Risk
10	Beranska Bistrica	38 215	970.68	39.37	Potentially at Risk
11	Lješnica	NO EBS LOAD	-	0	No Risk
12	Pešter	NO EBS LOAD	-	0	No Risk
13	Gornji Ibar	10 000	1 070.43	10.27	Potentially at Risk

Figure 4.24 Groundwater risk map of the Danube River Basin for diffuse pollution

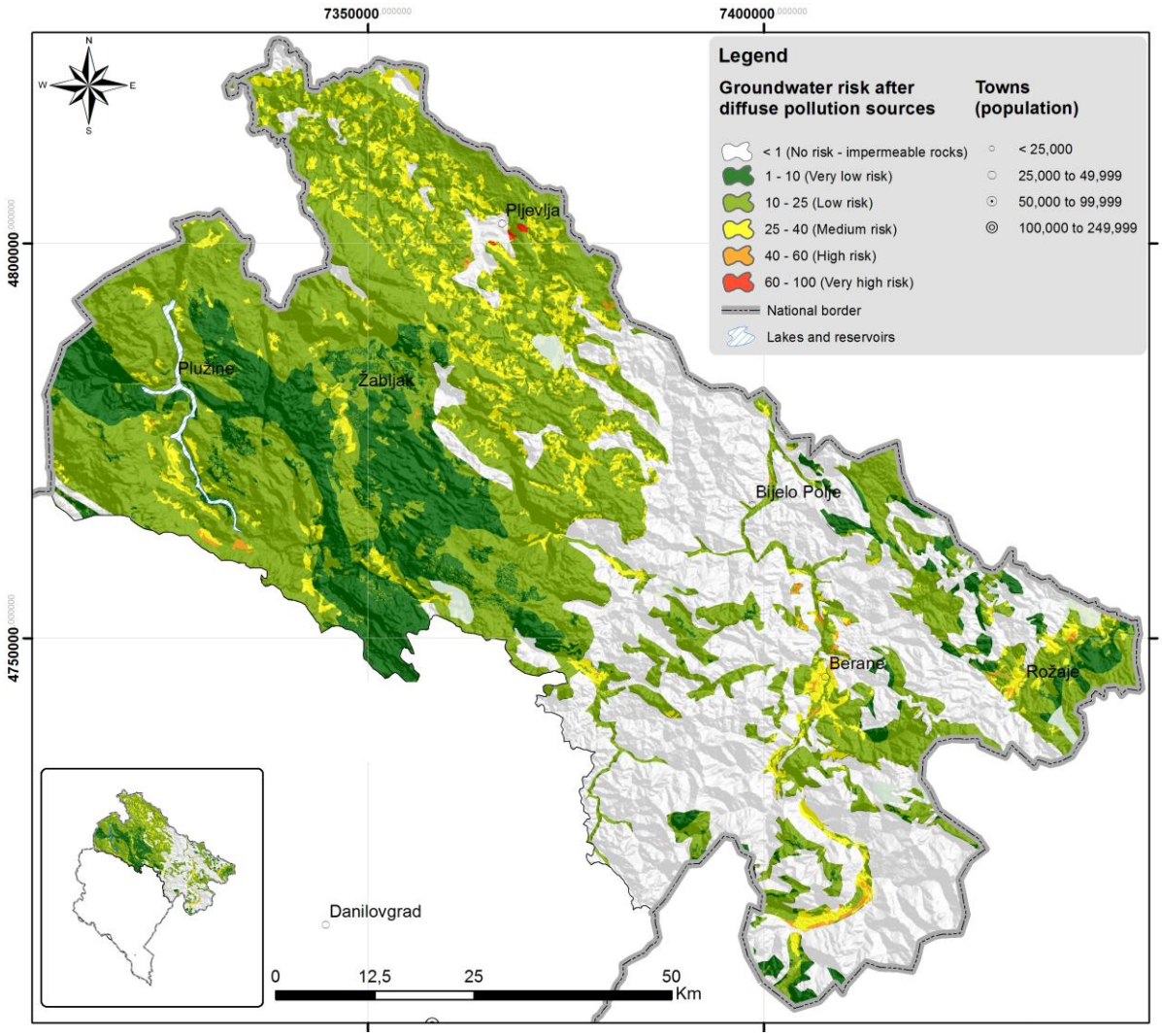
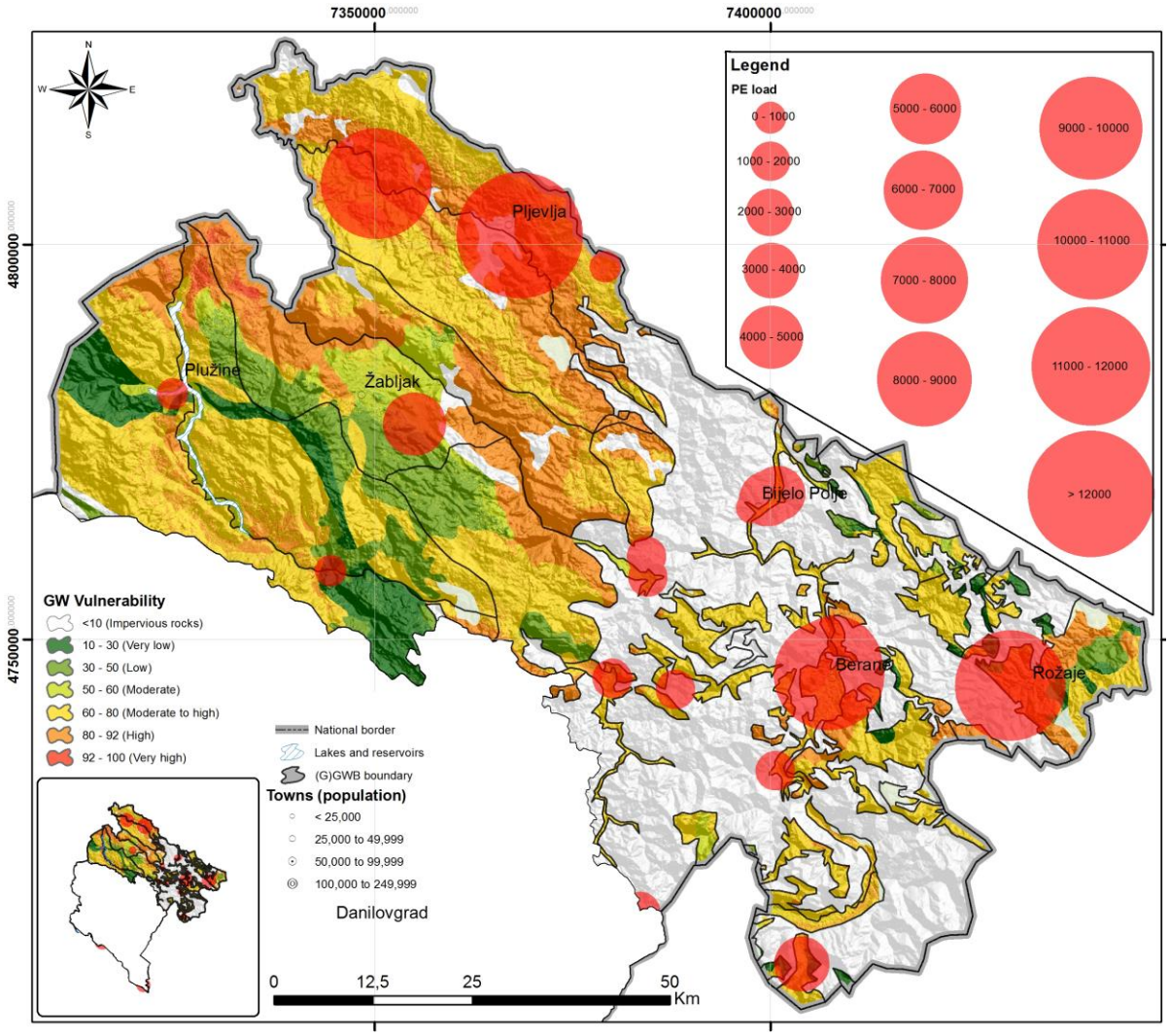


Figure 4.25 Groundwater Risk Map of the Danube River basin for point source pollutants



4.14.8 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 4.56. 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 4.56 Summary of Pressures and Status of Groundwater bodies in the Danube River Basin

No.	GWB Name	GW Code	Assessment of Pressure		Vulnerability & Assessment of Risk	GW status		Dependent ecosystems
			Point	Diffuse		Quality	Quantity	
1	Brezna - Maglić	ME_DB_GW_K_1	Factory of electrodes (Plužine); PE Load is estimated on 150, only	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Air pollution from thermal power plant "Gacko"; The main roads Nikšić-Šavnik and Nikšić-Plužine	65% of the GWB belongs to "Moderate to High" and "Very High" vulnerability classes Due to low population and activities ratio PE Load vs. Vulnerability is 0.11, means no risk	Good status	Good status	Piva Lake, Komarnica River, Bijela River, Trnovačko Lake
2	Pivska Mountain	ME_DB_GW_K_2	Fishpond (Šavnik), PE Load is small, 150	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; The main roads Šavnik-Žabljak and Plužine-Šćepan Polje	60% of the GWB belongs to "Moderate to High" (50%) and "Very High" (10%) vulnerability classes Due to low population and activities ratio PE Load vs. Vulnerability is 0.14, means no risk	Good status	Good status	Piva Lake, Komarnica River, Bukovica River and Tušina River
3	Sinjajevina	ME_DB_GW_K_3	Factory of weapon "Tara", wood industry, gravel extraction from riverbed, PE Load 1,600	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; The main road Kolašin-Djurdjevića Tara	62% of the GWB belongs to "Moderate to High" (36%) and "Very High" (26%) vulnerability classes PE Load vs. Vulnerability is 1.55, means no risk	Good status	Good status	Tara River, Savina Voda; Plašnica, Bistrica

No.	GWB Name	GW Code	Assessment of Pressure		Vulnerability & Assessment of Risk	GW status		Dependent ecosystems
			Point	Diffuse		Quality	Quantity	
4	Durmitor	ME_DB_GGW_K_4	PE Load estimated on 4,024	Wastewater of settlements and tourist houses which are not connected to sewage system; Local landfills; Agriculture; The main roads Šavnik-Žabljak-Djurdjevića Tara	42% of the GWB belongs to "Moderate to High" (8%) and "Very High" (34%) vulnerability classes PE Load vs. Vulnerability is 3.93, means no risk	Good status	Good status	Tara River, Crno Lake, Durmitor lakes
5	Kosanica	ME_DB_GW_K_5	No large point pollution sources, No EP Load	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; The main roads Djurdjevića Tara-Pljevlja and Mojkovac-Bijelo Polje	82% of the GWB belongs to "Moderate to High" (22%) and "Very High" (60%) vulnerability classes PE Load vs. Vulnerability is 0, means no risk	Good status	Good status	Tara River, Draga River
6	Maoče	ME_DB_GGW_C_1	Thermal power plant in Pljevlja, Landfill of thermal power plant "Maljevac", Mine of lead and zinc "Šuplja Stijena", Wood factory "Vektra Jakić", "Žitopromet" (Pljevlja); PE Load is estimated at 10,000	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network; Aero pollution from thermal power plant and heating on coal; Main road Djurdjevića Tara-Pljevlja	91% of the GWB belongs to "Moderate to High" (46%) and "Very High" (45%) vulnerability classes Still not at risk, but there are many threats. PE Load vs. Vulnerability is 11.26.	Potentially at risk	Good status	Ćehotina River, Maočnica River
7	Pljevlja basin	ME_DB_GGW_I_1	Coal Mine and TE Plant Pljevlja; farm "Razdolje" (Pljevlja); PE Load 173,652	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network; Aero pollution from thermal power plant and heating on coal; Main road Pljevlja-Jabuka	90% of the GWB belongs to "Moderate to High" (47%) and "Very High" (43%) vulnerability classes PE Load vs. Vulnerability is 182.56 (highest of all GWB in MNE)	Poor status – at risk	Good status	Ćehotina River
8	Prokletije	ME_DB_GGW_K_6	No large industrial objects, but certain number of local,	Wastewater of settlements which are not connected to	73% of the GWB belongs to "Moderate	Good status	Good status	Plavsko Lake, Vruja

No.	GWB Name	GW Code	Assessment of Pressure		Vulnerability & Assessment of Risk	GW status		Dependent ecosystems
			Point	Diffuse		Quality	Quantity	
			smaller pollutants, there are gravel extractions from riverbeds	sewage system; Local landfills; Local road network	to High" (63%) and "Very High" (10%) vulnerability classes PE Load vs. Vulnerability is 3.29, means no risk			River, Grnčar River, Ljuca River
9	Komovi	ME_DB_GGW_K_6	No large industrial objects, but certain number of local, smaller pollutants, there are gravel extractions from riverbeds	Wastewater of settlements which are not connected to sewage system; Local landfills; Local road network	87% of the GWB belongs to "Moderate to High" (77%) and "Very High" (10%) vulnerability classes PE Load vs. Vulnerability is 1.74, means no risk	Good status	Good status	Tara River, Lim River, Kutska River
10	Beranska Bistrica - Ljubovića	ME_DB_GGW_C_2	Polipak (Bijelo Polje), Meduza (Bijelo Polje), Meso promet (Bijelo Polje), Eko meso (Bijelo Polje), Kravica (Bijelo Polje), Farma Franca (Bijelo Polje), Rada (Bijelo Polje), Mont Opeka (Berane), Ribnjak (Berane), Poliex (Berane), Zora (Berane), Boj-commerc (Andrijevica), there are gravel extractions from riverbeds	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network	98% of the GWB belongs to "Moderate to High" (62%) and "Very High" (26%) vulnerability classes Potentially at risk, PE Load is 38215, while PE Load vs. Vulnerability is 39.37	Potentially under pressure and risk due to high load and presence of vulnerable aquifers	Currently in good status, but under low pressure due to unstable regime	Lim River, Beranska Bistrica, Ljubovića
11	Lješnica	ME_DB_GGW_K_8	No industrial objects, just some smaller pollutants, gravel extraction from riverbeds	Wastewater of settlements which are not connected to sewage system; Local landfills; Agriculture; Local road network	86% of the GWB belongs to "Moderate to High" (62%) and "Very High" (24%) vulnerability classes No PE Load, thus PE Load vs. Vulnerability is 0, means no risk	Good status	Good status	Lim River, Lješnica River

No.	GWB Name	GW Code	Assessment of Pressure		Vulnerability & Assessment of Risk	GW status		Dependent ecosystems
			Point	Diffuse		Quality	Quantity	
12	Pešter	ME_DB_GGW_K_9	None	Wastewater of small villages not connected to sewage system; Septic tanks; Local landfills; Agriculture; Local road network	73% of the GWB belongs to "Moderate to High" vulnerability class No PE Load, thus PE Load vs. Vulnerability is 0, means no risk	Good status	Good status	Bistrica River (Bijelo Polje)
13	Gornji Ibar	ME_DB_GGW_K_10	Factory of paper "Dekor" (Rožaje), a big municipal landfill at the right Ibar River bank	Wastewater of settlements which are not connected to sewage system; Local settlements landfills; Agriculture; Local road network	Still not at risk, but potentially could be; PE Load is 10,000, while PE Load vs. Vulnerability is 10.27	Potentially under pressure and risk due to high load and presence of highly vulnerable aquifers	Good status	Ibar River

4.14.9 Areas of special concern and protection of groundwaters

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 4.24 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 (Figures 5.6 and 5.7 and Tables 5.6 and 5.7). These areas require special attention and systematic monitoring of local groundwater.

5 PROTECTED AREAS

5.1 Overview of protected areas according to the WFD

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[120] 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), 15 of which are proposed in the Danube River Basin. According to the degree of harmonization, the EMERALD Network consists of the following areas in the Danube River Basin:

A. **Completely harmonized and accepted areas of importance for protection:** 9. Bioč, Maglić i Volujak, 10. Bjelasica, 11. Durmitor sa kanjonom Tare, 12. Komovi, 13. Hajla.

[120] 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.

B. **Areas of significance for protection that are harmonized in a high degree, but with the need for further harmonization**: 2. Sinjajevina, 3. Kanjon Pive, 4. Kanjon Mrtvice, 7. Golija, 8. Prokletije, 9. Visitor sa Zeletinom, 12. Kanjon Komarnice.

C. **Non-compliant areas, with the need for further harmonization:** 1. Ljubišnja, 2. Dolina Lima i 3. Dolina Ćehotine.

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 Danube 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.

In accordance with Article 53 of the Law on Waters and the by-law[121] 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 Danube 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 not located in the Danube River Basin.

Future safeguard Zones within each DrWPAs 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 of the studied GWBs and GGWBs in the Danube River Basin (tapped and non-tapped) and water protection zones where determined

No.	GW Body	Springs (Q_{min}/Q/Q_{max})	Protection Zones[122]
1	Brezna - Maglić	Čokova Springs (Q_{min}=1 m^3/s) Spring near Kruševo Mratinjski Spring Jakšino Vrelo and Vrioca Spring (Q_{min}=0.1 m^3/s) Pola Spring (Q_{min}=0.01 m^3/s) Borovnik Spring, Podvodje Spring Orašac Spring Sutulija Spring (Q_{min}=0.05 m^3/s; Q_{av}=1 m^3/s; Q_{max}=10 m^3/s) Sinjac Spring (Q_{min}=0.5 m^3/s; Q_{av}=20 m^3/s; Q_{max}=200 m^3/s) Rastioci (Q_{min}=0.1 m^3/s) Bukovik (Q_{min}=0.1 m^3/s) Dube Spring Duški springs (Q_{min}=0.2 m^3/s) Oko Bijele (Q_{min}=0.1 m^3/s) Gvozdenovića Spring	Delineated for water-source "Sutulija"
2	Pivska Mountain	Bukovička springs (Q_{min}=200 l/s) Šavnička Glava (Q_{min}=100 l/s) Dubravska Springs (Q_{min}=500 l/s) Bezujski Mlini Ilidža thermal spring (Q_{min}=0.1 l/s) Vrutak Spring (Q_{min}=100 l/s) Medjedjak Spring (Q_{min}=500 l/s)	Delineated for water-source "Šavnička Glava"

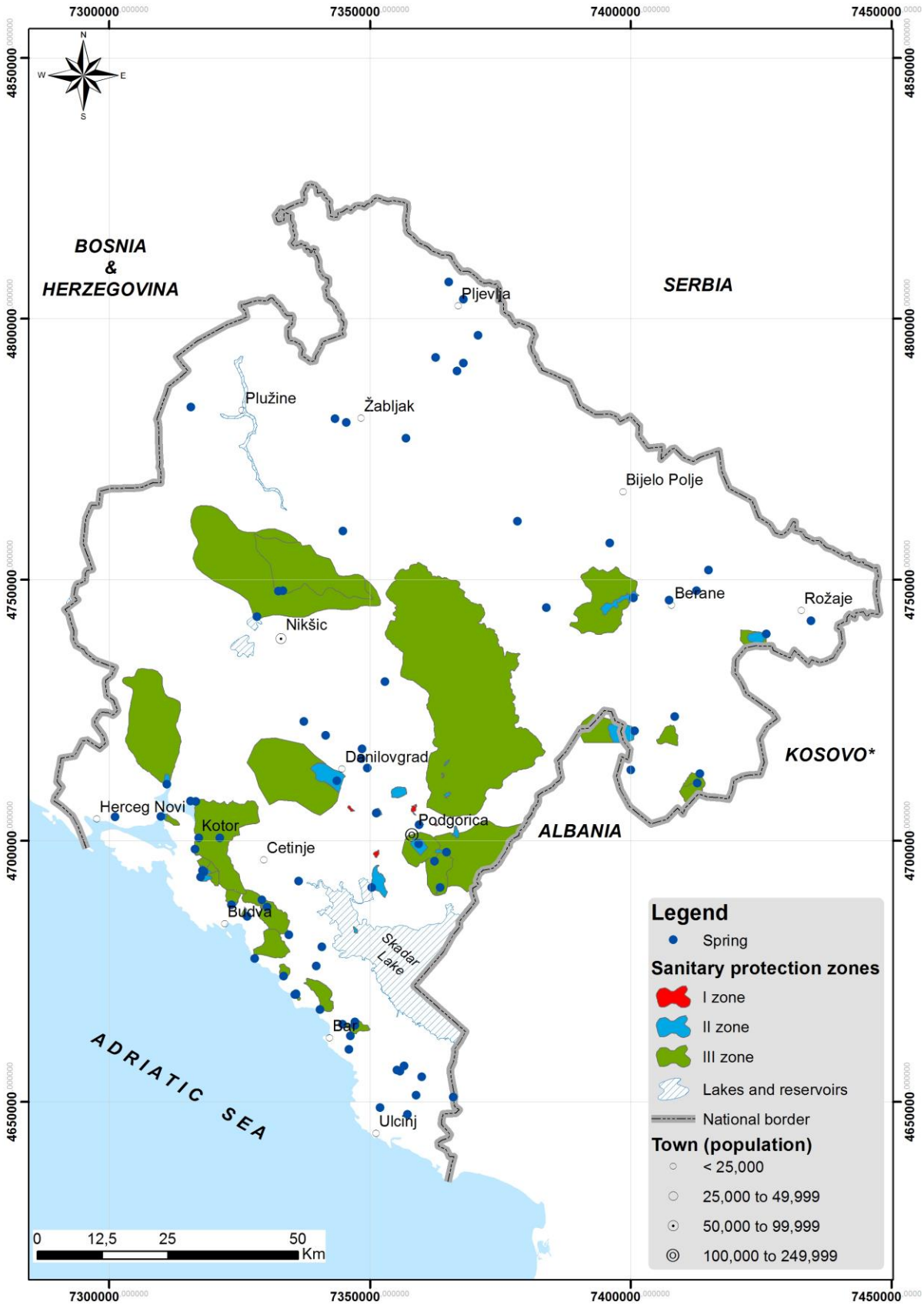
[121] Decision on Determination of Sources for Regional and Public Water Supply and Determination of their Boundaries ("Official Gazette of the Republic of Montenegro", No. 66/09),

[122] After Montenegrin regultions (Rulebook on determing and maintaining sanitary protection zones of water sources, Off. Gaz. 66/09) all potable water sources must have defined and delineated three protection zones

No.	GW Body	Springs (Q_{min}/Q/Q_{max})	Protection Zones[122]
		Nozdruć Spring (Q_{min}=500 l/s) Kaludjerovo Spring (Q_{min}=400 l/s; Q_{max}=1700 l/s)	
3	Sinjajevina	Milačko Vrelo Vrelo Bistrice (Pčinje) (Q_{min}=0.1 m^3/s) Vojkovića Spring (Plašnica) (Q_{min}=1 m^3/s) Migalovica Spring Ropušica Spring (Plašnica) Ravnjak Spring (Q_{min}=0.5 m^3/s) Ćorbudžak Spring Savina Voda Spring	Delineated for water sources "Ravnjak", "Gojakovića Spring" and "Ropušica"
4	Durmitor	Vukovića Vrelo Nozdruć Spring (Tara) Kaluđerovača Spring (Q_{min}=0.5 m^3/s) Sige (Q_{min}=0.1 m^3/s) Lazin Kamen Bijela Vrela Ljutica Spring (Q_{min}=1 m^3/s) Lijećevine Spring Spring in Polje Crkvičko Oko Spring	Delineated for water sources "Oko" and "Mlinski potok"
5	Kosanica	Mušova Vrela Vrela Spring Nikolića Luke Kućište (Q_{min}=1 m^3/s) Sokoline Sige (Q_{min}=0.1 m^3/s) Borovac Spring Bjelovac Spring (Q_{min}=0.5 m^3/s) Springs of Leverska River Djurdjevića Tara Springs	There are no potable water sources for municipal water supply
6	Maoče	Mandovac Spring (Q_{min}=0.01 m^3/s, Q_{av}=0.1 m3/s; Q_{max}=0.27 m^3/s) Zmajevac Spring (Q_{min}=0.045 m^3/s) Bezarska Vrela (Q_{min}=0.024 m^3/s) Džanova Česma Vodice Spring Vrelo Spring Gomilanovića Spring Manito Vrelo Rutovac Točak Spring of Rzavska River Ratkova Pećina Spring	Delineated for water sources water sources "Zmajevac", "Mandovac" and "Bezarska Vrela"
7	Pljevlja basin	Bezdan Spring (Breznica River, Pljevlja) (Q_{min}=0.05 m^3/s) Joguštica Spring (Q_{min}=0.005 m^3/s) Tvrdaš Spring	Delineated for water sources "Breznica" and "Jogušnica"

No.	GW Body	Springs (Q_{min}/Q/Q_{max})	Protection Zones[122]
8	Prokletije	Alipašini Springs (Q_{min}=2.5 m^3/s; Q_{max}=7 m^3/s) Bajrovića Springs (Q_{min}=0.02 m^3/s) Springs along Crna Dolja Springs along Skakavac Springs along Berički stream	Delineated for water source "Bajrovića Spring
9	Komovi	Krkori Spring (Q_{min}=0.1 m^3/s) Pipuran Spring (Murino) (Q_{min}=0.01 m^3/s; Q_{av}=0.04 m^3/s; Q_{max}=0.1 m^3/s)	Delineated for water sources "Krkori" and "Mateševo"
10	Beranska Bistrica - Ljubovića	Vrelo (Mušovića Rijeka) (Q_{min}=0.08 m^3/s) Vrelo Bistrice (Majstorovina, Ljubovića) (Q_{min}=0.5 m^3/s) Manastirski Spring (Q_{min}=0.1 m^3/s) Merića Vrelo (Q_{min}=0.2 m^3/s) Daspićko Vrelo (Q_{min}=0.045 m^3/s) Vinicka Spring (Q_{min}=0.03 m^3/s) Bjelezi Spring (Q_{min}=0.003 m^3/s) Trepča Spring (Q_{min}=0.03 m^3/s) Komčar Spring (Q_{min}=0.0025 m^3/s)	Delineated for municipal water sources
11	Lješnica	Popča Sping (Q_{min}=0.07 m^3/s) Pusta Vrata Spring (Q_{min}=0.027 m^3/s) Soca Spring (Q_{min}=0.01 m^3/s) Bijela Vrela (Andrijevica) (Q_{min}=0.1 m^3/s) Pjaninica Spring (No. 2267/07) (Q_{min}=0.1 m^3/s) Navotila Spring (Q_{min}=0.01 m^3/s)	Delineated for water sources "Popča", "Pusta Vrata" and "Jasenica"
12	Pešter	Glava Bistrice (Q_{min}=0.2 m^3/s; Q_{max}=3 m^3/s) Juriška Springs (Qmin=1 m^3/s) Springs in Stube	There are no municipal water sources
13	Gornji Ibar	Vrelo Ibra (Q_{min}=0.1 m^3/s) Plunačko Vrelo (Q_{min}=0.01 m^3/s) Grlja Spring (Q_{min}=0.005 m^3/s) Grahovska Vrela Topljik Spring	Delineated for water sources "Vrelo Ibra" and "Grlja Spring

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[123] 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.

5.4 Bodies of Water Designated as Recreational and Bathing Waters

The main recreational use of water in the Danube River Basin is rafting. However, there are no bodies of water currently classified for the status of bathing/recreation within the Danube River Basin.

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 Danube River Basins ("Official Gazette of Montenegro", No. 46/17) has been made. In accordance with Article 2, the sensitive areas are the following:

"Sensitive areas in the Danube and Adriatic catchment areas are areas that are eutrophic or susceptible to eutrophication, areas intended for abstraction of drinking water and other protected areas.

The river basin district of the Danube basin is, as a whole, a sensitive area of the Danube basin.

Montenegro has planned to identify nitrate vulnerable zones (NVZ) in the Danube River Basin between 2020 and 2021[124].

[123] Order on fishing restrictions, restrictions and measures for the protection of fish stock, No.325-48/15-6 , April 15, 2015.

[124] EU Project 'Support to implementation and monitoring of water management'. EuropeAid/139429/IH/SER/ME

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 Danube 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, 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

Apart from strategic framework, two major legal acts govern the proclamation and management of Protected Areas in the Danube River Basin:

- The Law on Nature Protection
- The Law on National Parks

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[125], 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 Danube 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;

[125] Law on Nature Protection ("Official Gazette of Montenegro", No. 54/16)

- 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 area 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;
- 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.[126] 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.

[126] http://prirodainfo.me

The Danube River Basin has one UNESCO site, Durmitor National Park, which has been on the World Natural Heritage list since 1980.

The national efforts for conservation of biodiversity and natural assets resulted in the designation of several Protected Areas under successive nature protection laws. The national network of protected natural areas currently covers 124,964 ha or more than 9% of the land area of Montenegro. The Danube River Basin has three national parks Durmitor, Biogradska gora and Prokletije. The other protected areas, 8, fall under the categories of regional parks/nature parks and natural monuments.

Table 5.3 provides a summary of all the register of Protected Areas relevant from the aspect of habitat and species conservation in the Danube River Basin.

Table 5.3 The register of Protected Areas relevant from the aspect of habitat and species conservation in the Danube River Basin[127]

No.	Cat.	Name	National code	Act of Proclamation	Approval Date	Region	Surf (ha)	Central coordin. X	Central coordin. y	Elev. m	MP/ SP[128]	UNESCO Heritage	EMERALD Network	RAMSAR	IPA[129]
2. National Park (NP)															
1	II	Durmitor	MNE022008 19522	Official Gaz. NRCG, 16-17/1952	20/08/ 1952	Municipalities of Žabljak, Mojkovac, Pljevlja Šavnik and Plužine	32519.00	43.148863	19.033147	530 - 2525	Yes[130]	Yes 32100.00 ha	Yes 32100.00 ha		
2	II	Biogradska gora	MNE022008 19523	Official Gaz. NRCG 16-17/1952	20/08/ 1952	Municipalities of Kolašin, Mojkovac, Berane, Andrijevica and Bijelo Polje	5650.00	42.880416	19.628148	832 - 2139	Yes[131]		Yes 5743.00 ha		Yes 5733.00 ha
3	II	Prokletije	MNE021408 20091063	Official Gaz. MNE 56/2009	14/08/ 2009	Municipalities Plav and Gusinje	16038.00	42.529406	19.884535		Yes[132]		Yes Visitor i Zeletin (13655.00 ha) Prokletije (15729.00 ha)		Yes Grebaje (1112.00 ha) Visitor (1779.00 ha)

[127] The numbers associated with the register of protected areas do not include #1 strict nature reserves, or #3, special nature reserves.

[128] Management Plan or Study of protection

[129] IPA - Important plant area

[130] Management Plan of Durmitor National Park from 2016 to 2020.

[131] Management Plan of NP Biogradska Gora from 2016 to 2020.

[132] Management Plan of NP Prokletije 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[128]	UNESCO Heritage	EMERALD Network	RAMSAR	IPA[129]
4. Regional Park and Nature Park															
1	V	Komovi	MNE042002 201561	Official Gaz. MNE municipal regulations 6/15	20/02/ 2015	Municipalities Andrijevica and Podgorica	15692.00	42.689103	19.667353		Yes[133]		Yes 6125.00 ha		Yes 3332.00 ha
2	V	Piva	MNE042204 201563	Official Gaz. MNE municipal regulations 15/15	22/04/ 2015	Municipality of Plužine	32477.90	43.223013	18.813722	433-2397	Yes[134]	Yes Basin of river Tare 182889.0 0 ha	Yes Malglić, Volujak i Bioč 7241.00 ha		Yes 7344.00 ha
3	V	Dragišnica i Komarnica	MNE042011 201765	Official Gaz. MNE municipal regulations Šavnik 49/17	29/11/ 2017	Municipality of Šavnik	2994.00	43.004788	19.059713		Yes[135]				
4		Orjen[136]	MNE 042404200 91066	-	-	Municipality of Herceg Novi	0								
5. Natural Monument															
1	III	Botanical garden	MNE050206 1994211	Decision 01-78, Official Gaz. RMNE 20/94	02/06/ 1994	Municipality of Kolašin - Dulovina	0.64	42.8192659	19.5254624	1018	No				
2	III	Canyon of River Piva and Komarnica	MNE052706 196942	Decision 01-582	27/06/ 1969	Municipalities Plužine and Šavnik	10260.00	42.9802984	19.0406638	1200	No	Yes Tara river basin 182889.0 0 ha	Yes Malglić, Volujak Bioč I Canyon of River		Yes Canyon of River Piva 7344.00 ha

[133] Study of protection Regional Park of Komovi

[134] Study of protection Regional Park of Piva

[135] Study of protection Regional Park of Dragišnica i Komarnica

[136] Revision required

No.	Cat.	Name	National code	Act of Proclamation	Approval Date	Region	Surf (ha)	Central coordin. X	Central coordin. y	Elev. m	MP/ SP[128]	UNESCO Heritage	EMERALD Network	RAMSAR	IPA[129]
													Komarnice 10141.00 ha		
3	III	Đalovića gorge	MNE052812196844	Decision 01-959 Official Gaz. SRCG 30/68	28/12/ 1968	Municipality of Bijelo Polje	1600.00	43.0734335	19.9209595	820	No		Yes 191.00 ha		
4	III	Novakovića cave	MNE052812196851	Decision 01-959 Official Gaz. SRCG 30/68	28/12/ 1968	Municipality of Bijelo Polje -Tomasevo	0	43.06053	19.36361		No				

5.6.1 Surface Waters in Protected Areas

Figures 5.2 and 5.3 illustrate the registered protected areas and the proposed EMERALD[137] network in the Danube 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 3 out of 48 surface water bodies are present in the protected areas.

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 28 (58% of all SWBs). **It should be borne in mind that the designation of the EMERALD network to encompass the whole of the Ćehotina and Lim Rivers will result in need for surface water bodies to reach a 'high' level status, which is obviously not possible without incurring excessive and disproportionate costs.**

[137] 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 Danube River Basin

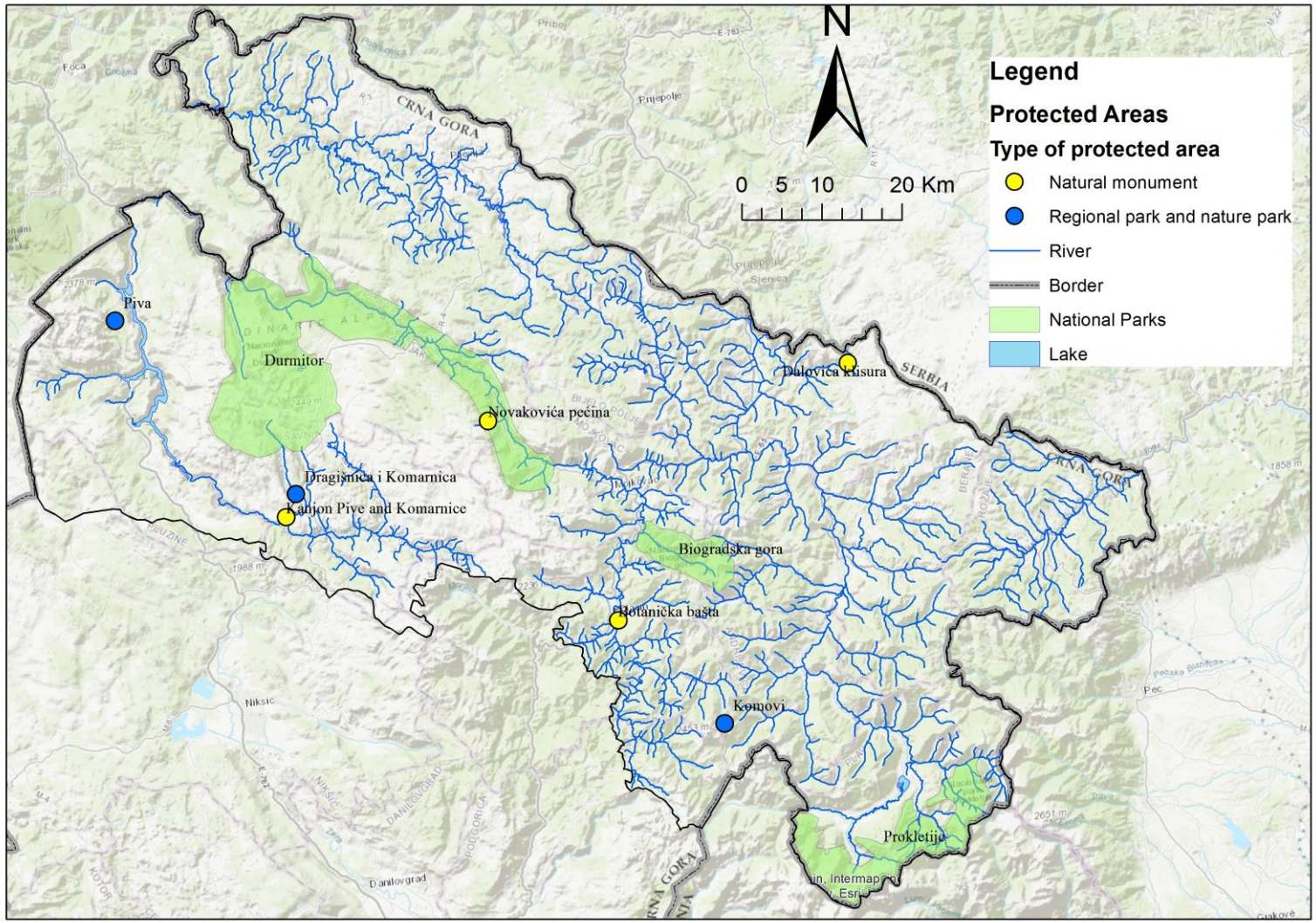


Figure 5.3 Proposed EMERALD Network and in the Danube River Basin

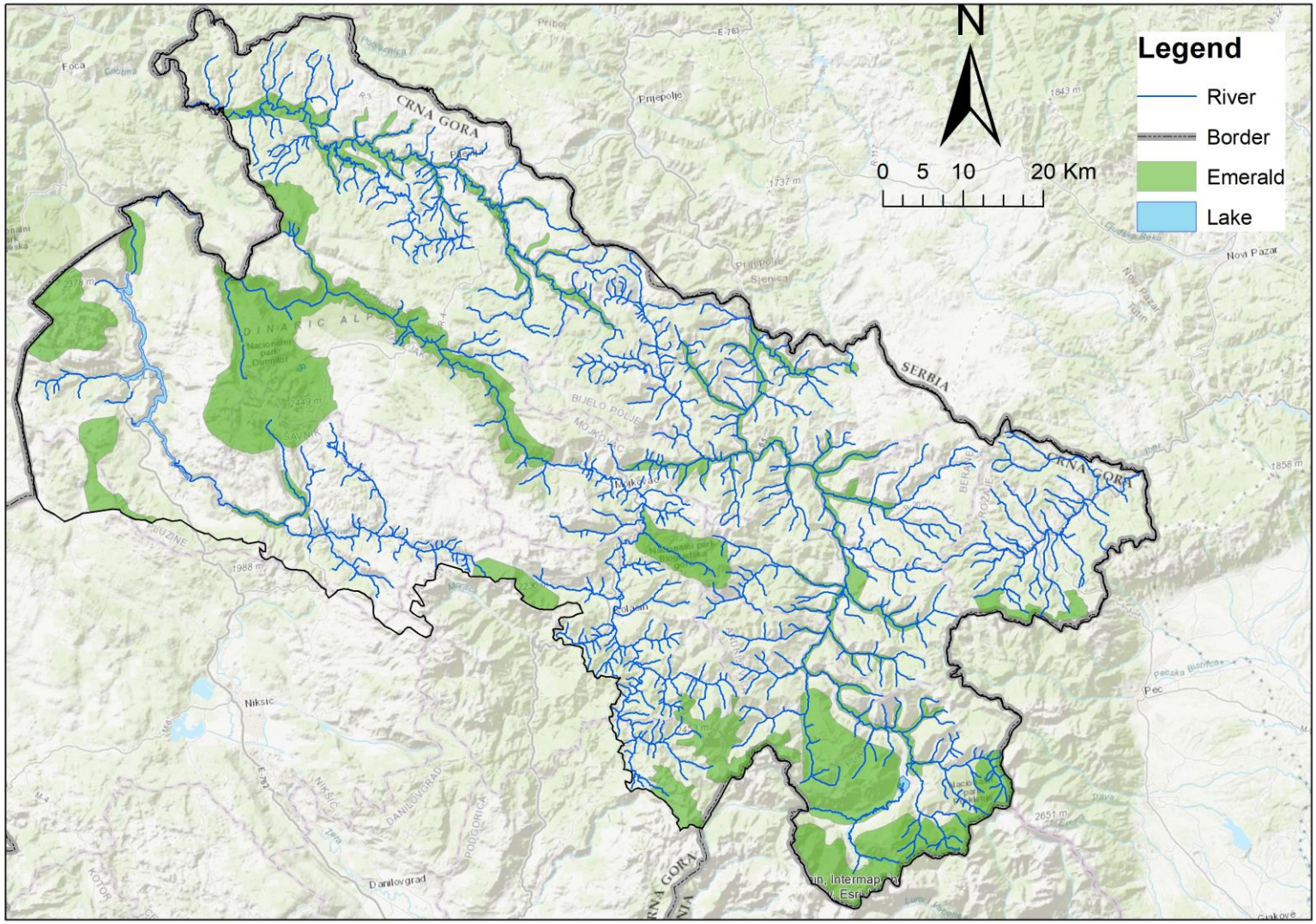


Figure 5.4 The relationship between the surface water bodies and the registered protected areas in the Danube River Basin

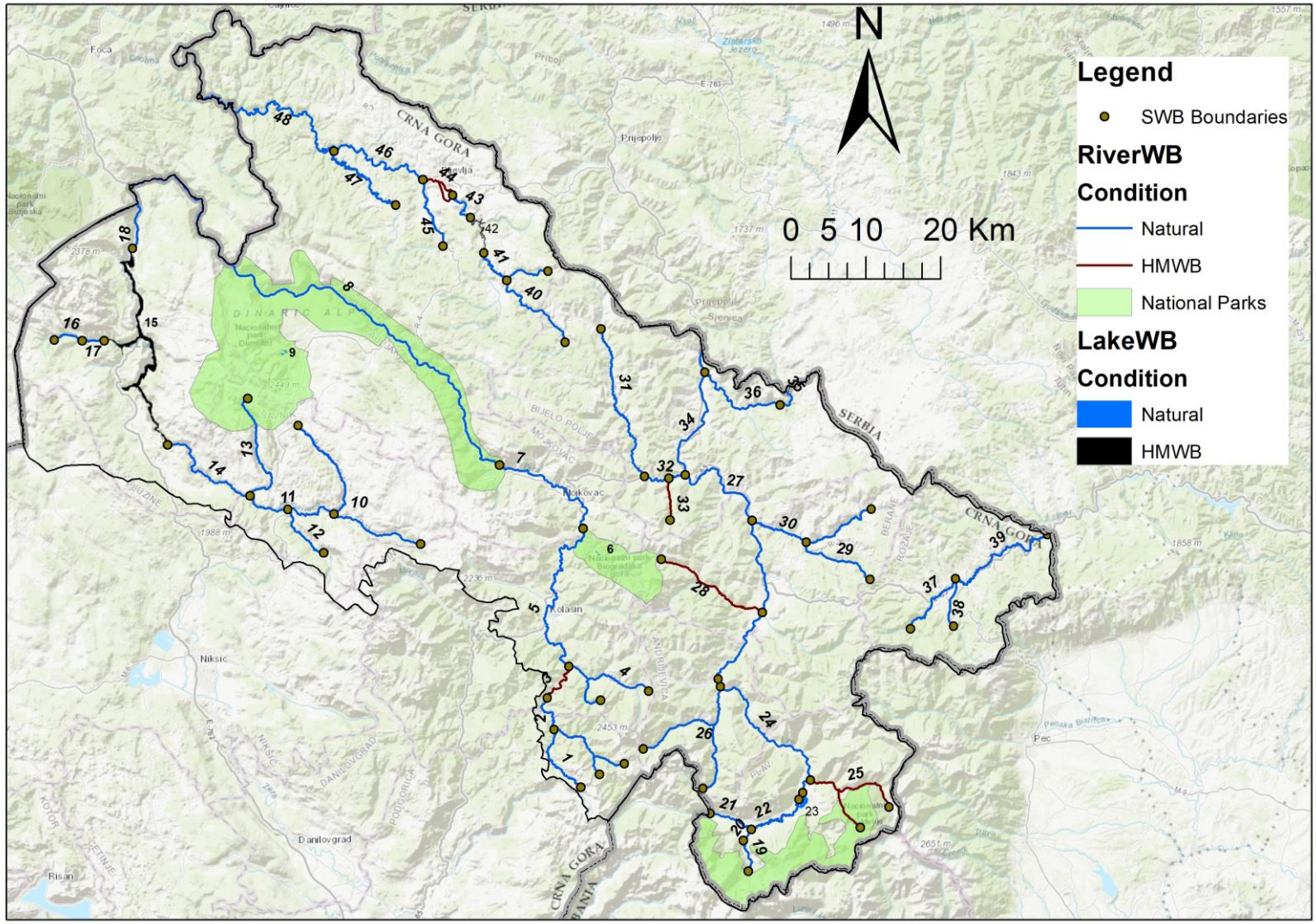


Figure 5.5 The relationship between the surface water bodies and the proposed EMERALD Network in the Danube River Basin

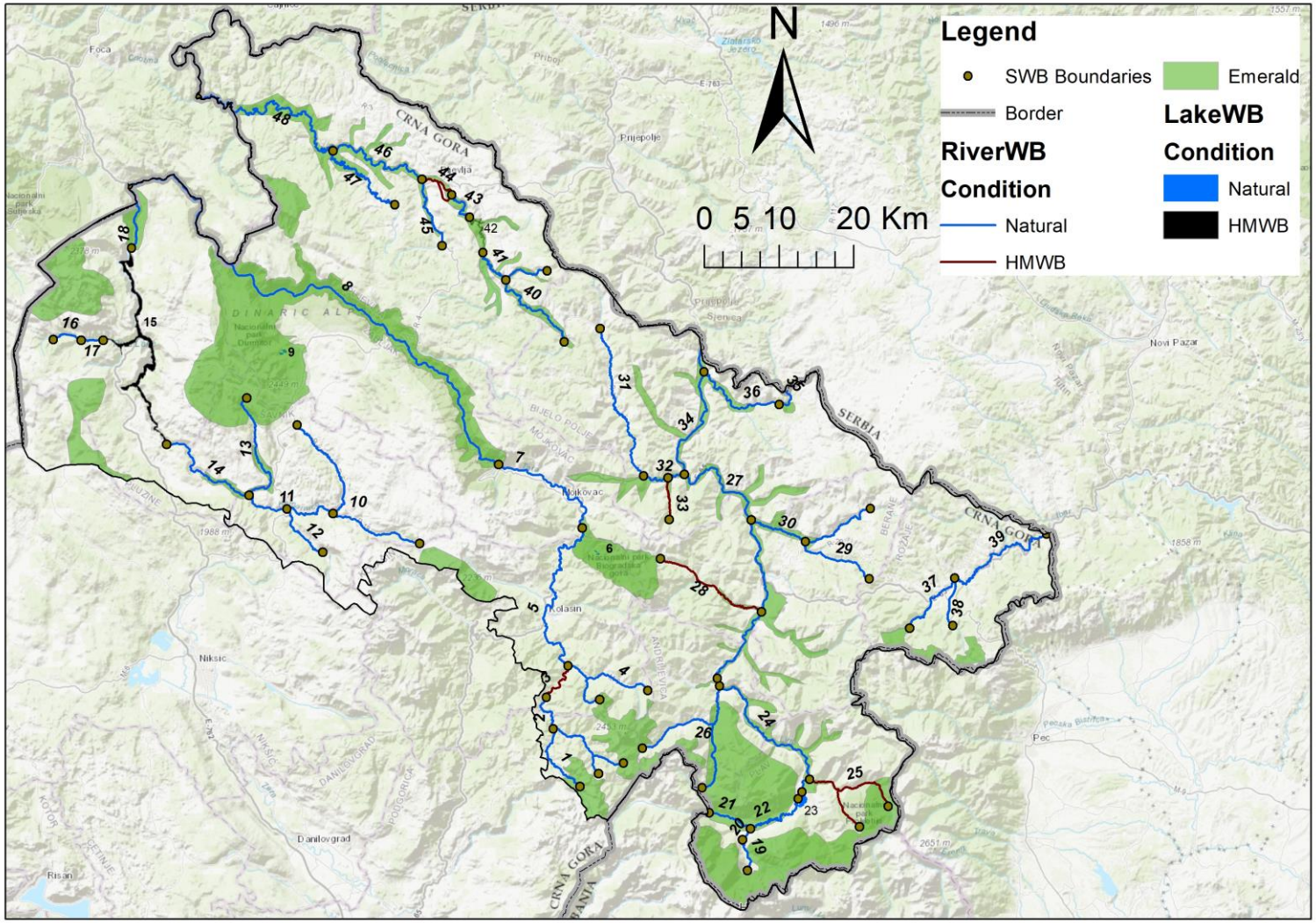


Table 5.4 Surface water bodies that are within the protected areas in the Danube River Basin

Municipality	SWB No.	Surface Water Bodies In Registered Protected Areas	Judged to be at Risk[138]
Mojkovac, Žabljak, Pljevlja, Plužine	8	Tara_5	**No**
Šavnik	13	Komarnica_1	**No**
Plav	25	Komarača	**At risk**

Table 5.5 Surface water bodies that are within the protected areas and the proposed EMERALD network in the Danube River Basin

Municipality	SWB No.	Surface Water Bodies In Proposed EMERALD network	Judged to be at Risk[139]
Podgorica[140]	1	Opasanica / Verušica	**Possibly at risk**
Kolašin, Mojkovac	6	Biogradsko Lake	**No**
Mojkovac, Žabljak, Pljevlja, Plužine	8	Tara_5	**No**
Žabljak	9	Crno Lake	**No**
Šavnik	13	Komarnica_1	**No**
	14	Komarnica_2	**No**
Plužine	18	Piva	**Possibly at risk**
Gusinje	21	Grnčar	**No**
Gusinje, Plav	22	Ljuča	**No**
Plav	24	Lim_1	**Possibly at risk**
	25	Komarača	**At risk**
Andrijevica	26	Kutska/Mojanska/Zlorečica	**No**
Andrijevica, Berane, Bijelo Polje	27	Lim_2	**Possibly at risk**
Berane	30	Lješnica	**No**
Bijelo Polje	32	Ljubovića_2	**No**
	33	Bistirca (Lj)	**At risk**
	34	Lim_3	**At risk**

[138] See Section 7 for the full assessment of surface water bodies in terms of risk

[139] See Section 7 for the full assessment of surface water bodies in terms of risk

[140] Podgorica Municipality is mostly in the Adriatic River Basin but 12% extends into the Danube River Basin

Municipality	SWB No.	Surface Water Bodies In Proposed EMERALD network	Judged to be at Risk[139]
	35	Bistrica (L)_1	**No**
	36	Bistrica (L)_2	**Possibly at risk**
Bijelo Polje, Pljevlja	40	Ćehotina_1 /Kozička rijeka	**No**
Pljevlja	41	Ćehotina_2	**No**
	42	Otilovići Reservoir	**No**
	43	Ćehotina_3	**No**
	44	Ćehotina_4	**At risk**
	45	Vezišnica	**At risk**
	46	Ćehotina_5	**At risk**
	47	Voloder	**No**
	48	Ćehotina_6	**At 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.

Figure 5.6 The relationship between the karstic springs and the registered protected areas in the Danube River Basin

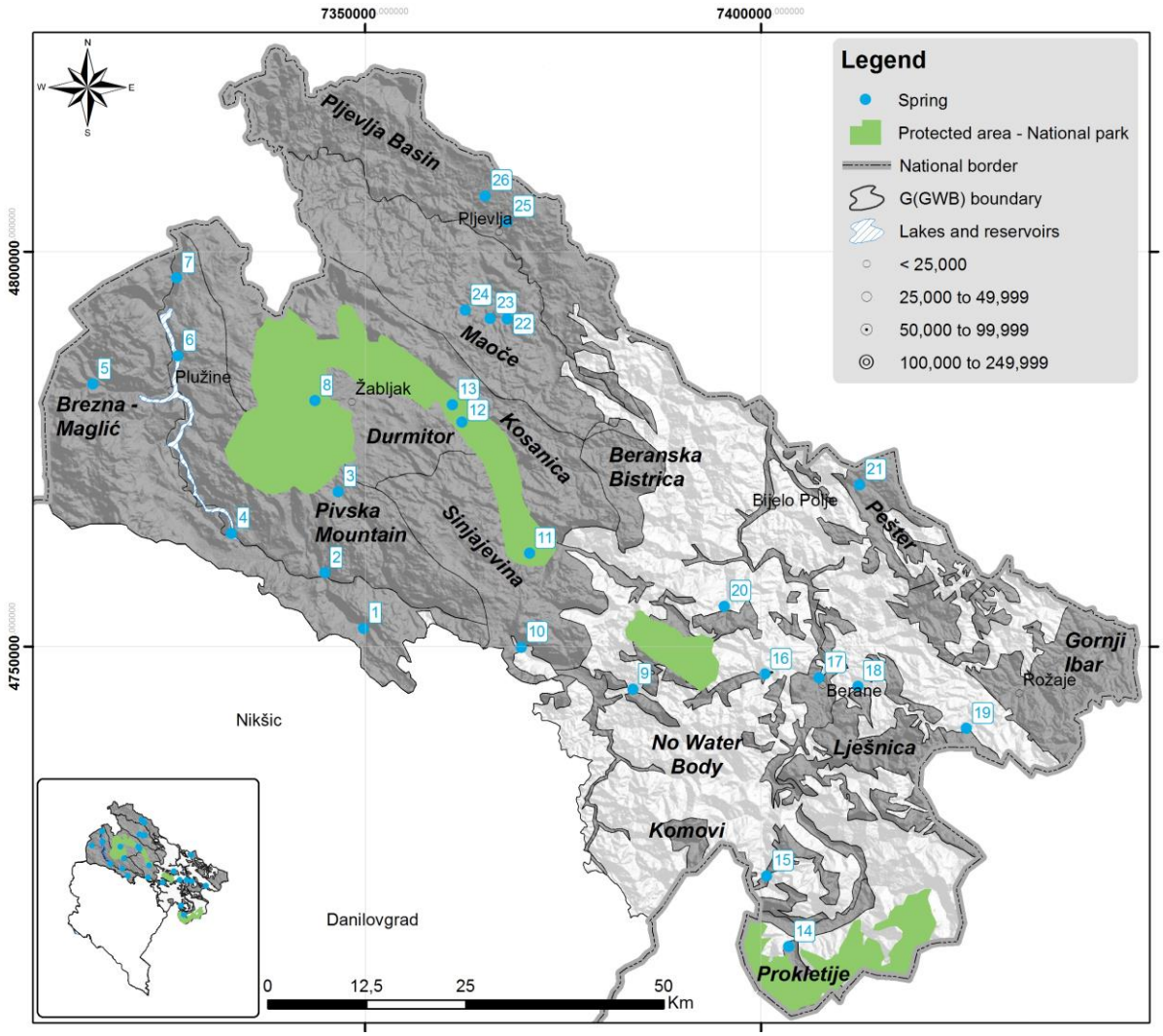


Figure 5.7 The relationship between the karstic springs and the proposed EMERALD Network in the Danube River Basin

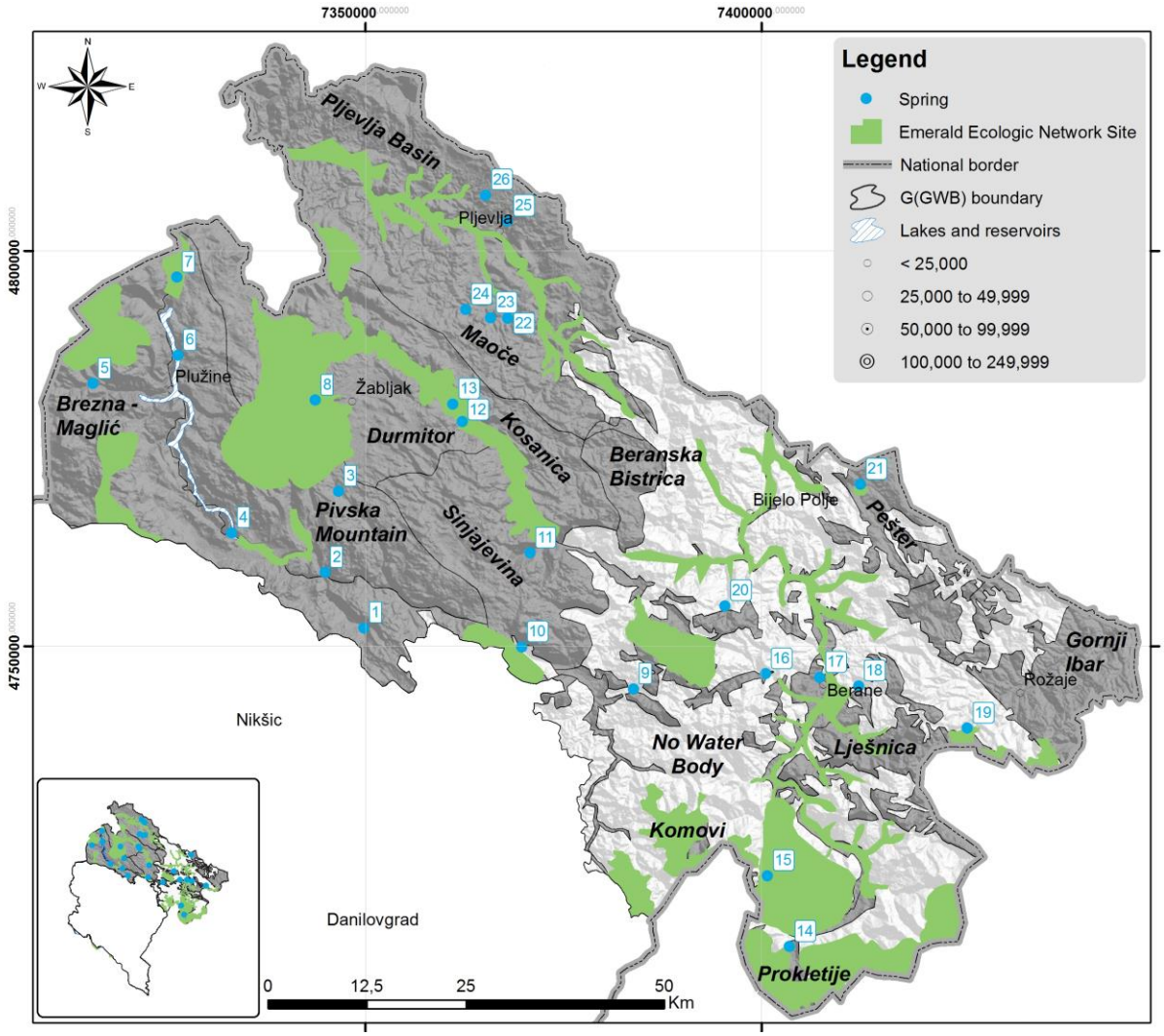


Table 5.6. shows the names of 4 Karstic springs inside of the registered protected areas. Table 5.7 provides the names of 8 karstic springs that are located inside the proposed EMERALD network.

Table 5.6 Karstic springs within the designated protected areas and in the Danube River Basin

No.	Karstic Springs	Groundwater Body
8	Oko (Zminje Lake)	Durmitor
11	Ravnjak	Sinjajevina
12	Ljutica	Durmitor
13	Bijela Vrela	Durmitor

Table 5.7 Karstic springs within the proposed EMERALD network in the Danube River Basin

No.	Karstic Springs	Groundwater Body
7	Kaludjerovo Vrelo	Pivska Mountain
8	Oko (Zminje Lake)	Durmitor
12	Ljutica	Durmitor
13	Bijela Vrela	Durmitor
14	Alipašini vgt springs	Prokletije
15	Krkor	Komovi
19	Vrelo Ibra	Gornji Ibar
21	Djalovića Cave	Pešter

5.6.3 Small hydropower plants in Protected Areas

Figure 5.8 highlights the fact that no SHPPs in operation, in construction or in the planning phase are located in the registered protected areas of the Danube 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 2 of the SHPPs under construction and 2 others in the stage of planning would be located inside of the boundaries of the proposed EMERALD network.

Figure 5.8 The relationship between the constructed, in construction and planned SHPPs and the registered protected areas in the Danube River Basin

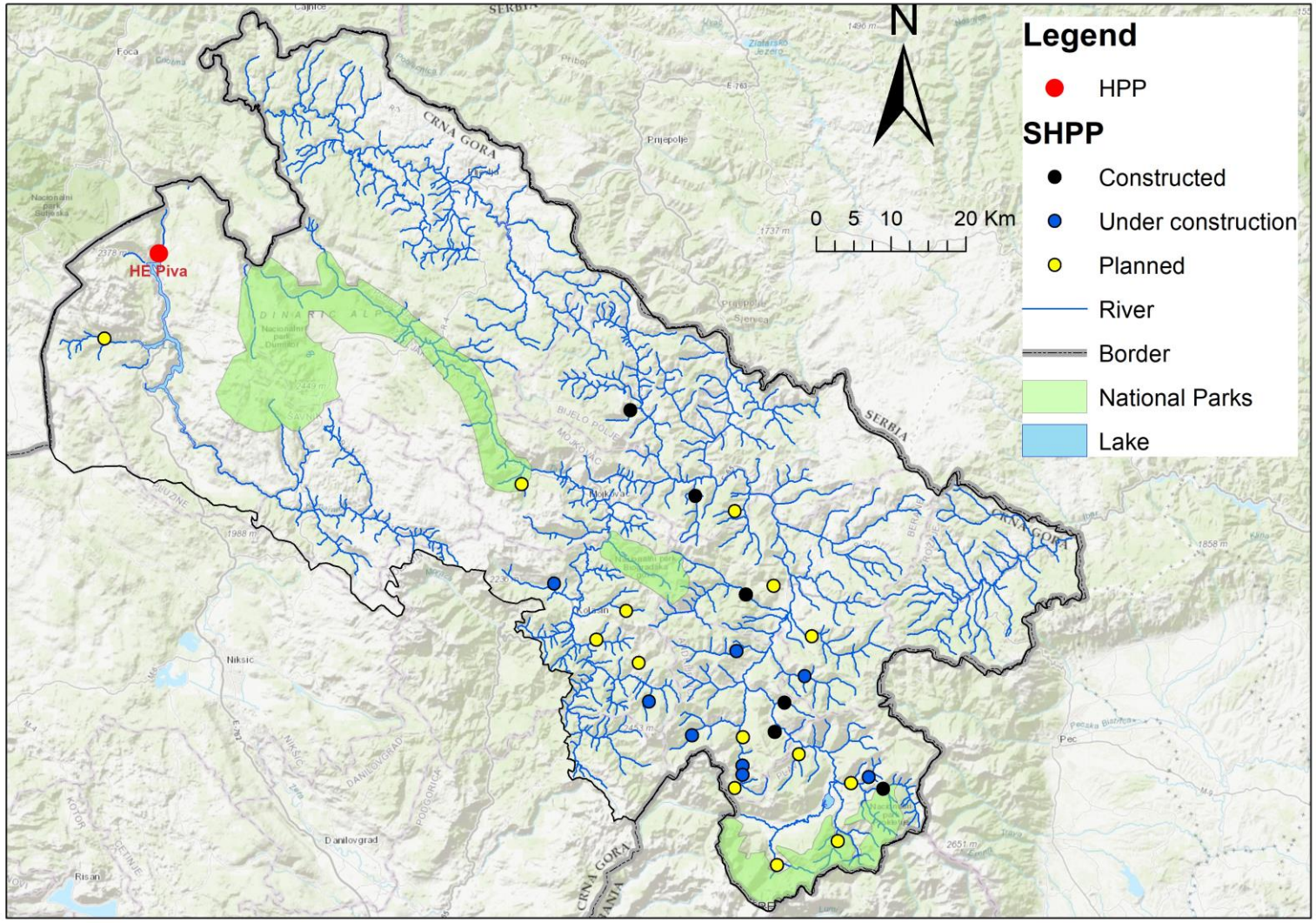
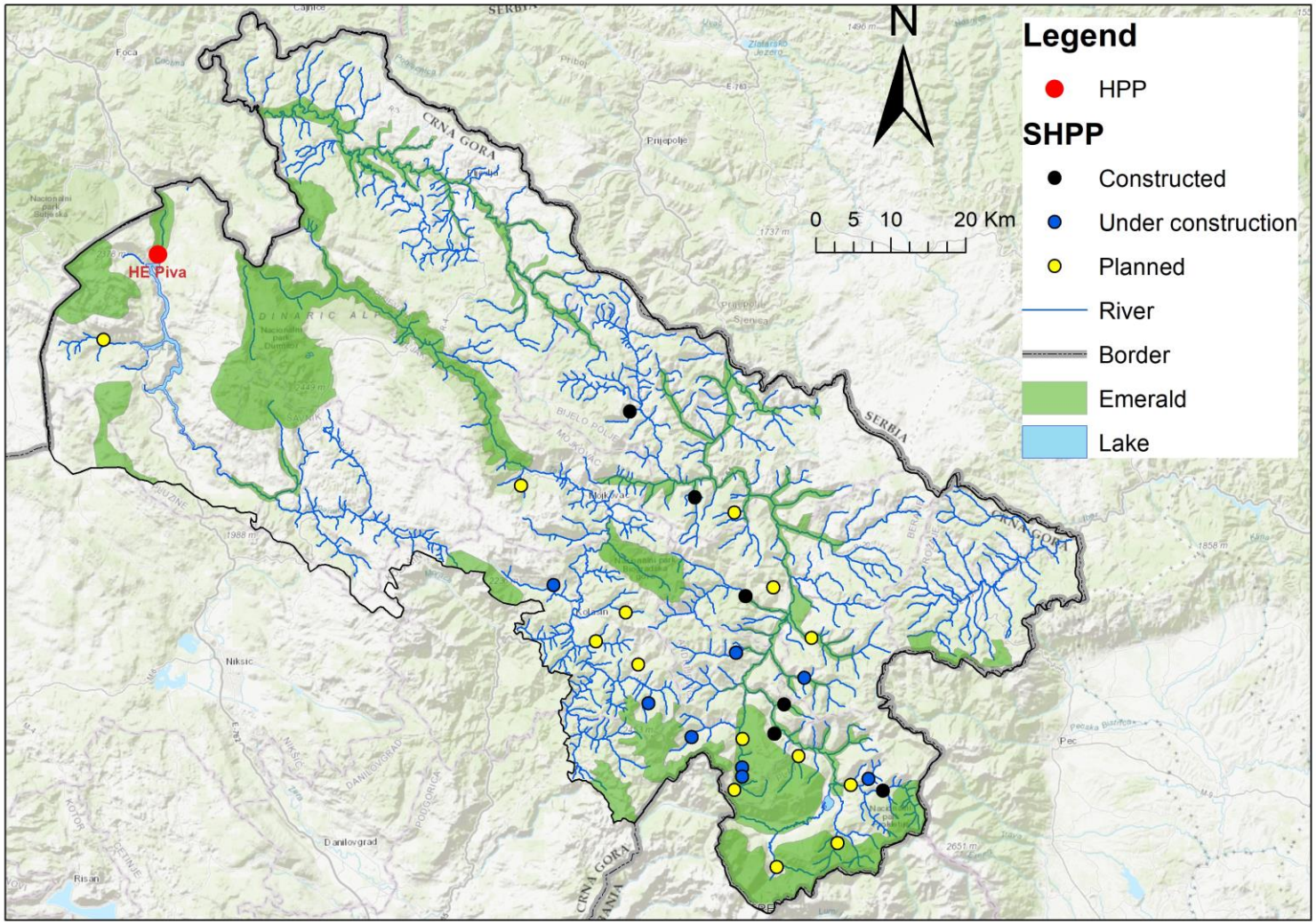


Figure 5.9 The relationship between the constructed, in construction and planned SHPPs and the proposed EMERALD Network in the Danube River Basin



6 MONITORING PROGRAMMES

6.1 Surface Water Monitoring Requirements under the WFD

The Water Framework Directive covers all waters of the Danube River Basin, which includes both surface water and groundwater[141].

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[142].

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)[143]. 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[144]. 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[145].

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[146]. A brief description of the three types of monitoring is provided below.

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[141] Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Guidance Document No 7, Monitoring under the Water Framework Directive, European Communities 2003

[142] Directive 2000/60/EC, Annex V

[143] Directive 2000/60/EC

[144] Directive 2000/60/EC, Annex V

[145] Directive 2000/60/EC, Annex V/1.2

[146] 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[147]. **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**[148]. The monitoring includes characteristics that are indicative of the pressures to which the bodies are subject[149]. 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[150]:

- 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[151].

[147] European Community 2003, Guidance Document No 7

[148] European Community 2003, Guidance Document No 7

[149] European Community 2003, Guidance Document No 7

[150] European Community 2003, Guidance Document No 7

[151] 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[152], 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.

[152] 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[153]

Monitoring elements (parameters) for surface water bodies			Surface water bodies	
			Rivers	Lakes
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	√	y
		Structure and substrate of the bed	√	y
		Structure of the riparian zone	√	Structure of lake shore
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	√	√

[153] Directive 2000/60/EC, Annex V

Table 6.2 Monitoring frequency of quality elements in surface water bodies according to WFD[154]

Quality Elements	Surface Water Bodies	
	Rivers	Lakes
Biological quality elements		
Phytoplankton	6 months	6 months
Other aquatic flora	3 years	3 years
Macro invertebrates	3 years	3 years
Fish	3 years	3 years
Hydromorphological elements		
Continuity	6 years	
Hydrology	continuous	1 month
Morphology	6 years	6 years
Physico-chemical elements		
Thermal conditions	3 months	3 months
Oxygenation	3 months	3 months
Salinity	3 months	3 months
Nutrient status	3 months	3 months
Acidification status/pH	3 months	3 months
Other pollutants	3 months	3 months
Priority substances	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[155]. 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[156].

EQS are specifically required for the main pollutants included in the indicative list provided in Annex VIII of the WFD[157], 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 endocrine-related functions in or via the aquatic environment, persistent hydrocarbons and persistent

[154] Source: WFD, Annex 5/1.3.4

[155] Directive 2000/60/EC, Article 2

[156] Directive 2000/60/EC, Annex V, 1.2.6

[157] Directive 2000/60/EC, Annex VIII

and bioaccumulable organic toxic substances, cyanides, metals and their compounds, arsenic and its compounds, and biocides and plant protection products[158].

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[159]. 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[160] are required to establish reference conditions based on existing high-status water bodies where they still exist[161]. 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[162].

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[163]. 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.

[158] Directive 2000/60/EC, Annex VIII

[159] European Community 2003, Guidance Document No 7, 2.12.2

[160] European Community 2003, Guidance Document No 7

[161] European Community 2003, Guidance Document No 7

[162] Directive 2000/60/EC, Annex II

[163] 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[164]. 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[165].

6.2 WFD compliant surface water monitoring program for the Danube River Basin

This section describes the approach in monitoring programme for the Danube River Basin (DRB) 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 Danube 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

[164] Directive 2000/60/EC, Annex V

[165] 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 Danube 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 Danube 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 and
- 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 obligatory biological quality elements for water body type groups is presented in the proposed ecological status assessment system in Annex 1.

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 **11 sites, which are identified as sites of high priority** (Table 6.3, sites that cover both, surveillance and operational monitoring) 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 Danube 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 1. 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 Danube River Basin in Montenegro.

The proposed WFD compliant monitoring programme for the Danube River Basin in Montenegro is detailed in Table 6.3 and illustrated in Figure 6.1.

The WFD compliant monitoring network for the Danube River Basin covers 44 sites. A total of 27 sites are identified for surveillance monitoring, 25 for operational, while 12 sites are proposed for investigative monitoring. 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 surveillance monitoring network has been designed in order to provide data on general status of water bodies within the Danube 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. Thus, Table 6.3 also contain information if the chosen site is part of the existing monitoring network.

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 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 1), 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 progamme 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.

Sites that are identified as relevant for both, surveillance and operational monitoring are considered as **high priority sites – first order sites – 11 sites**. 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) and Transnational Monitoring Network (TNMN – water quality monitoring network established to support the implementation of the Danube River Protection Convention). High priority sites should also provide the data for identification of Montenegro River Basin Specific Pollutants, as identified for the Danube River Basin (RBSPs; WFD 2000/60/EC).

The network identified for investigative monitoring includes mainly the sites that are under minor anthropogenic influence (reference or “near natural” sites). 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 Danube River Basin

No.	Monitoring Stations – WFD compliant	Station type	Monitoring Parameters	Risk	SWB No.	Type No.	Surface Water Body	Priority	Sub-Basin	Grouping of SWBs	Comments
1	Downstream Opasanica	O	MZB	Possibly at risk	1	R1	Opasanica/ Verušica		Tara	N	
2	Tara, Uvač	S, I	PH, HYMO B, C	Likely not at risk	2	R1	Tara_1		Tara	2, 4 (R1)	
3	Tara, Jabuka	S, O	PH, HYMO B, C	At risk	3	R1	Tara_2	High	Tara	N	HMWB
4	Mateševo	I	B, PH	Likely not at risk	4	R1	Drcka		Tara	2, 4 (R1)	
5	Crne Pode	O	PH, selected C	At risk	5	R4	Tara_3		Tara	N	E
6	Kolašin	O	PH, selected C	At risk	5	R4	Tara_3		Tara	N	E
7	Trebaljevo (Rovačko)	S, O	PH, HYMO B, C	At risk	5	R4	Tara_3	High	Tara	N	E
8	Bogradsk lake	S	PH, HYMO B, C	Likely not at risk	6	L2	Biogradsko Lake		Tara	N	
9	Mojkovac	S, O	PH, HYMO B, C	Possibly at risk	7	R5	Tara_4	High	Tara	N	E
10	Đurdjevića Tara	S	PH, HYMO B, C	Likely not at risk	8	R7	Tara_5		Tara	N	E
11	Crno jezero	S	PH, HYMO B, C	Likely not at risk	9	L1	Crno Lake		Tara	N	

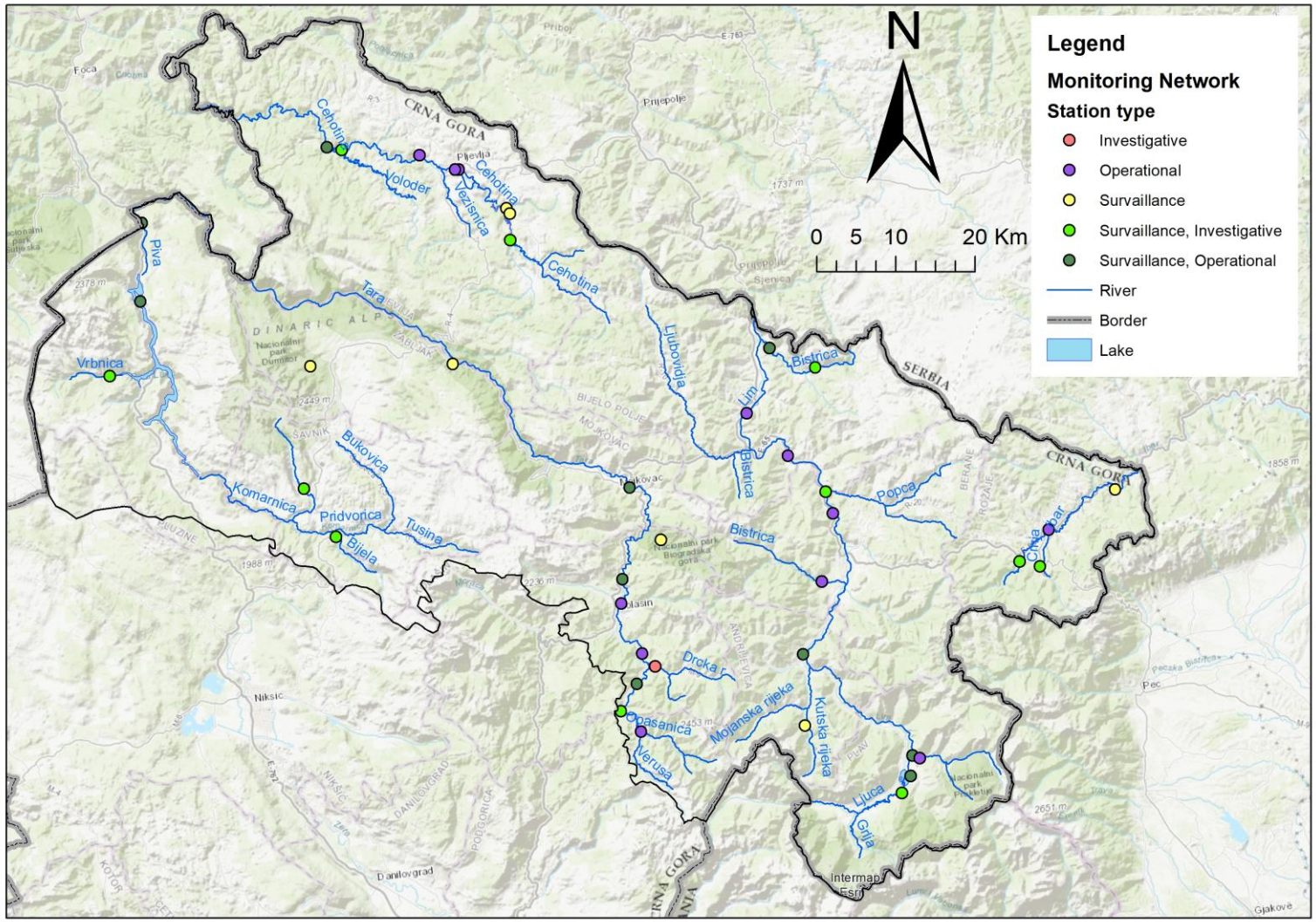
No.	Monitoring Stations – WFD compliant	Station type	Monitoring Parameters	Risk	SWB No.	Type No.	Surface Water Body	Priority	Sub-Basin	Grouping of SWBs	Comments
12	Bijela, Šavnik	S, I	PH, HYMO B, C	Likely not at risk	12	R1	Bijela		Piva	10, 11, 12 (R1, R4)	
13	Komarnica, upstream Nevidio	S, I	PH, HYMO B, C	Likely not at risk	13	R1	Komarnica_1		Piva	13,14 (R1, R5)	
14	Piva Reservoir	S, O	PH, HYMO B, C	Likely not at risk	15	R7	Piva Reservoir	High	Piva		HMWB
15	Vrbnica, kamp	S, I	PH, HYMO B, C	Likely not at risk	17	R2	Vrbnica_2		Piva	16, 17 (R1, R2)	
16	Sćepan polje	S, O	PH, HYMO B, C	Possibly at risk	18	R7	Piva	High	Piva		E
17	Gusinje, Ljuča	S, I	PH, HYMO B, C	Likely not at risk	22	R4	Ljuča		Lim	19, 20, 21, 22 (R1 and R4)	E
18	Plav	S, O	PH, HYMO B, C	Possibly at risk	23	L3	Plavsko lake	High	Lim	N	E
19	Lim, downstream Plav	S, O	PH, HYMO B, C	Possibly at risk	24	R1	Lim_1	High	Lim	N	
20	Komarača	O	MZB	At risk	25	R1	Komarača		Lim	N	HMWB
21	Obzovik	S	PH, HYMO B, C	Likely not at risk	26	R1	Kutska/Mojanska /Zlorečica		Lim	N	E; Modified position of site
22	Andrijevica	S, O	PH, HYMO B, C	Possibly at risk	27	R4	Lim_2	High	Lim	N	E
23	Skakavac	O	PH, selected C	Possibly at risk	27	R4	Lim_2		Lim	N	E

No.	Monitoring Stations – WFD compliant	Station type	Monitoring Parameters	Risk	SWB No.	Type No.	Surface Water Body	Priority	Sub-Basin	Grouping of SWBs	Comments
24	Bistrica, upstream Buče	O	MZB	At risk	28	R2	Bistrica		Lim	N	
25	Lješnica, Bioča	S, I	PH, HYMO B, C	Likely not at risk	30	R2	Lješnica		Lim	29, 30 (R1, R2)	
26	Zaton	O	PH, selected C	At risk	34	R7	Lim_3		Lim	N	E
27	Bijelo Polje	O	PH, selected C	At risk	34	R7	Lim_3		Lim	N	E
28	Dobrakovo	S, O	PH, HYMO B, C	At risk	34	R7	Lim_3	High	Lim	N	E
29	Bistrica, upper, upstream Savino Polje	S, I	PH, HYMO B, C	Likely not at risk	35	R1	Bistrica (L)_1		Lim	31, 32, 35 (R1, R2, R5)	
30	Bistrica, Gubavač	S, O	PH, HYMO B, C	Possibly at risk	36	R2	Bistrica (L)_2	High	Lim	36, 33 (R2)	HMWB
31	Ibar, upstream Suho Polje	S, I	PH, HYMO B, C	Likely not at risk	37	R1	Ibar_1		Ibar	N	
32	Crnja River, Downstream Daciće (Rožaje)	S, I	PH, HYMO B, C	Likely not at risk	38	R1	Crnja		Ibar	N	
33	Rožaje	O	PH, selected C	At risk	39	R4	Ibar_2		Ibar	N	E; Modified position of site
34	Bać	S	PH, HYMO B, C	At risk	39	R4	Ibar_2		Ibar	N	E

No.	Monitoring Stations – WFD compliant	Station type	Monitoring Parameters	Risk	SWB No.	Type No.	Surface Water Body	Priority	Sub-Basin	Grouping of SWBs	Comments
35	Kozačka reka/ Ćehotina	I	B	Likely not at risk	40	R1	Ćehotina_1 /Kozička rijeka		Ćehotina	40, 41 (R1, R4)	
36	Ćehotina, upstream	S, I	PH, HYMO B, C	Likely not at risk	41	R4	Ćehotina_2		Ćehotina	40, 41 (R1, R4)	
37	Zekavice	S	PH, HYMO B, C	Likely not at risk	42	R5	Otilovići Reservoir		Ćehotina	N	HMWB
38	Rabitlja	S	PH, HYMO B, C	Likely not at risk	43	R5	Ćehotina_3		Ćehotina	N	E
39	Pljevlja	O	MZB	At risk	44	R5	Ćehotina_4		Ćehotina	N	E; HMWB
40	Ispod usća Vezišnice	O	MZB	At risk	44	R5	Ćehotina_4		Ćehotina	N	E; HMWB
41	Vezišnica	O	MZB, PH, selected C	At risk	45	R1	Vezišnica		Ćehotina	N	E
42	Brvenica	O	PH, HYMO B, C	At risk	46	R5	Ćehotina_5		Ćehotina	N	
43	Voloder, ušće	S, I	PH, HYMO B, C	Likely not at risk	47	R1	Voloder		Ćehotina	N	
44	Gradac	S, O	PH, HYMO B, C	At risk	48	R5	Ćehortina _6	High	Ćehotina	46, 48 (R5)	E

Priority monitoring sites marked in green. E: This designates locations that were previously involved in routine water quality monitoring in Montenegro in the previous period. Abbreviations: S – surveillance monitoring; O- Operational monitoring; I – Investigative monitoring; PH – Physico-chemical monitoring; MZB – Macroinvertebrate monitoring; HYMO – Hydromorphological monitoring; B – Biological monitoring (5 Biological quality elements); C – Monitoring of priority chemicals; HMWB – Heavily Modified Water Body

Figure 6.1 Proposed monitoring network for the WFD compliant monitoring programme of the Danube 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[166].

(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 I line with the requirements of the Floods Directive (2007/60/EC).

Hydrological monitoring and measurements are conducted by the hydro-meteorological service (IHMS). There are currently 32 hydrological stations in operation in the Danube River Basin: 18 stations provide flow data, 19 provide level data and 8 stations do not have any recorded data as yet. There are also two new stations planned for installation in 2019-2020 in the Ibar sub-basin at Bac and Rožaje, and one further station on the Vezišnica River in the Ćehotina sub-basin (Tables 6.4 and Figure 6.2).

Upgrading of the existing stations has been initiated thought the World Bank and EU IPA projects in 2016 and 2018, respectively.

Table 6.4 Operational and planned hydrological Stations in the Danube River Basin[167]

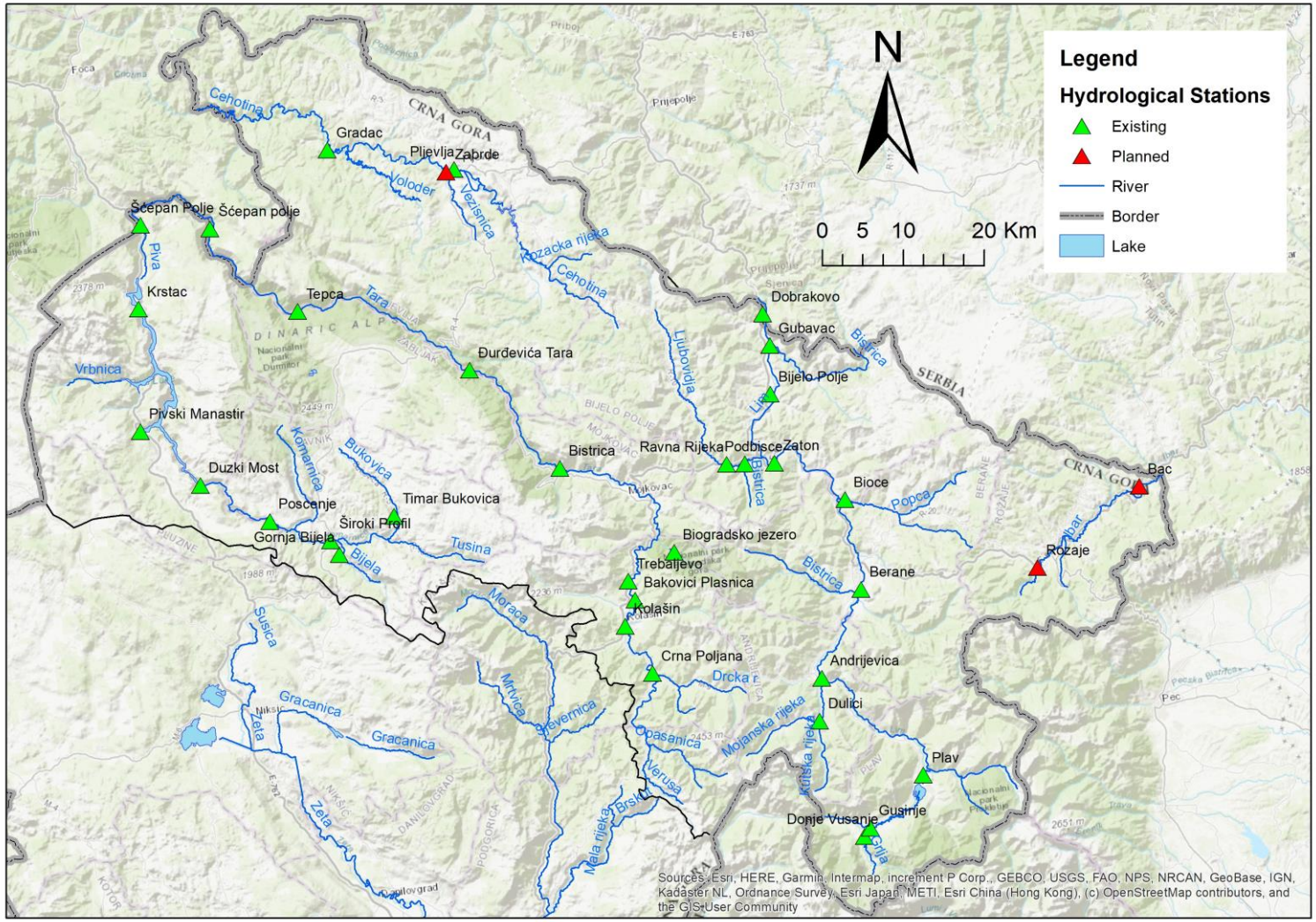
No.	Station Name	Flow (Q)	Level (H)	River	Sub-Basin	Surface Water Body (SWB)	SWB No.
Operational							
1	Trebaljevo	+	-	Tara	Tara	Tara_3	5
2	Kolašin	-	-	Tara	Tara	Tara_3	5
3	Crna Poljana	-	-	Tara	Tara	Tara_3	5
4	Bakovici	+	+	Plasnica	Tara	Tara_3	5
5	Biogradsko jezero	-	+	Biogradsko jerzero	Tara	Tara_3	5
6	Scapan Polje	-	-	Tara	Tara	Tara_5	8
7	Tepca	+	-	Tara	Tara	Tara_5	8
8	Durdevica Tara	-	-	Tara	Tara	Tara_5	8
9	Bistrica	-	+	Tara	Tara	Tara_5	8
10	Timar	+	+	Bukovica	Piva	Pridvorica	11
11	Siroki Profil	-	-	Pridvorica	Piva	Pridvorica	11
12	Gornja Bijela	-	-	Bijela	Piva	Bijela	12
13	Poscenje	+	+	Komarnica	Piva	Komarnica_2	14
14	Duzki Most	-	-	Komarnica	Piva	Komarnica_2	14

[166] http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

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

No.	Station Name	Flow (Q)	Level (H)	River	Sub-Basin	Surface Water Body (SWB)	SWB No.
15	Pivski Manastir	-	+	Sinjac	Piva	Piva Reservoir	15
16	Krstac	+	+	Piva	Piva	Piva Reservoir	15
17	Šćepan Polje	+	+	Piva	Piva	Piva	18
18	Donje Vasanje	-	+	Grlja	Lim	Grlja_2	20
19	Gusinje	-	+	Grncar	Lim	Grnčar	21
20	Plav	+	+	Lim	Lim	Lim_1	24
21	Andrijevica	+	+	Lim	Lim	Lim_1	24
22	Dulici	-	-	Zlorecica	Lim	Kutska/Mojanska/ Zlorečica	26
23	Berane	+	+	Lim	Lim	Lim_2	27
24	Zaton	+	+	Lim	Lim	Lim_2	27
25	Bioce	+	+	Lješnica	Lim	Lješnica	30
26	Ravna Rijeka	+	+	Ljubovida	Lim	Ljubovića_2	32
27	Dobrakovo	+	+	Lim	Lim	Lim_3	34
28	Bijelo Polje	+	+	Lim	Lim	Lim_3	34
29	Gubavac	+	+	Bjelopoljska Bistrica	Lim	Lim_3	34
30	Podbisce	+	+	Stitarica	Lim	Bistirca (Lj)	33
31	Pljevja	+	+	Ćehotina	Ćehotina	Ćehotina_3	43
32	Gradac	+	+	Ćehotina	Ćehotina	Ćehotina_6	48
Planned							
33	Bac	+	+	Ibar	Ibar	Ibar_2	39
34	Rožaje	+	+	Ibar	Ibar	Ibar_1	37
35	Zabrde	+	+	Vezisnica	Ćehotina	Vezišnica	45

Figure 6.2 Location of hydrological Stations in the Danube 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 Danube 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 13 groundwater bodies and groups of groundwater bodies in the Danube 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.[168]

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[169].

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

[168] 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

[169] 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 Danube 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 Danube 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 Danube 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

		Aquifer Flow Type				
		Confined	**Unconfined**			
			Intergranular flow significant		Fracture flow only	Karst flow**
			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.[170]

Table 6.6 Proposed minimum monitoring frequencies for operational monitoring

		Aquifer Flow Type				
		Confined	**Unconfined**			
			Intergranular flow significant		Fracture flow only	Karst flow**
			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
Trend assessments		Annual	Twice per year	Twice per year	Twice per year	

[170] 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

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 Danube River Basin is presented in Table 6.7. For some GWBs operational monitoring is proposed despite lack of some considerable pressures in their catchments in this stage. The reason is very dynamic karstic water regime and variations of chemical and bacteriological quality, which is strongly dependent on rainfall and river flow, if hydraulic connection with the latter exists.

Table 6.7 Proposed monitoring of quality and quantity of groundwater bodies in the Danube River Basin

No.	GW Body	Groundwater Monitoring			
		Quality		Quantity	
		Existing	Proposed	Existing	Proposed
1	Brezna - Maglić	Continual for water source "Sutulija"	Surveillance monitoring	Continual for water source "Sutulija"	Surveillance monitoring
2	Pivska Mountain	Continual for water source "Šavnička Glava"	Operational monitoring	Continual for water source "Šavnička Glava"	Surveillance monitoring
3	Sinjajevina	Continual for water sources "Ravnjak", "Gojakovića Spring" and "Ropušica"	Operational monitoring	Continual for water sources source "Ravnjak", "Gojakovića Spring" and "Ropušica"	Surveillance monitoring
4	Durmitor	Continual for water sources "Oko" and "Mlinski potok"	Operational monitoring	Continual for water sources "Oko" and "Mlinski potok"	Surveillance monitoring
5	Kosanica	There are no existing monitoring points	Surveillance monitoring	There are no existing monitoring points	Surveillance monitoring
6	Maoče	Continual for water sources "Zmajevac",	Operational monitoring	Continual for water sources "Zmajevac",	Surveillance monitoring

No.	GW Body	Groundwater Monitoring			
		Quality		Quantity	
		Existing	Proposed	Existing	Proposed
		"Mandovac" and "Bezarska Vrela"		"Mandovac" and "Bezarska Vrela"	
7	Pljevlja basin	Continual for water sources "Breznica" and "Jogušnica"	Operational monitoring	Continual for water sources "Breznica" and "Jogušnica"	Surveillance monitoring
8	Prokletije	Continual for water source "Bajrovića Spring"	Operational monitoring	Continual for water source "Bajrovića Spring"	Surveillance monitoring
9	Komovi	Continual for water source "Krkori Spring"	Operational monitoring	Continual for water source "Krkori Spring"	Surveillance monitoring
10	Beranska Bistrica - Ljubovića	Continual for water sources: Vrelo (Mušovića Rijeka; Vrelo Bistrice (Majstorovina, Ljubovića), Manastirski Spring; Merića Vrelo; Daspićko Vrelo; Vinicka Spring, Bjelezi Spring, Trepča Spring, Komčar Spring	Operational monitoring	Continual for water sources: Vrelo (Mušovića Rijeka; Vrelo Bistrice (Majstorovina, Ljubovića), Manastirski Spring; Merića Vrelo; Daspićko Vrelo; Vinicka Spring, Bjelezi Spring, Trepča Spring, Komčar Spring	Operational monitoring
11	Lješnica	Continual for water sources "Popča", "Pusta Vrata" and "Jasenica"	Operational monitoring	Continual for water sources "Popča", "Pusta Vrata" and "Jasenica"	Surveillance monitoring
12	Pešter	There are no existing monitoring points	Surveillance monitoring	There are no existing monitoring points	Surveillance monitoring
13	Gornji Ibar	Continual for water sources "Vrelo Ibra" and "Grlja Spring"	Operational monitoring	Continual for water sources "Vrelo Ibra" and "Grlja Spring"	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 Danube River Basin is illustrated in Figure 6.3.

For the selection of observation points the two important factors are considered:

- Areas which should be prioritized for systematic monitoring, and
- Equipment and funds availability.

The following areas are selected:

- Areas of intensive land use (industry, mining, agriculture, urbanized zones), and zones with contaminated or potentially contaminated soil (and water):
- Transboundary aquifers:
- Remote areas, mainly in karst, with unsolved 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 of this kind.

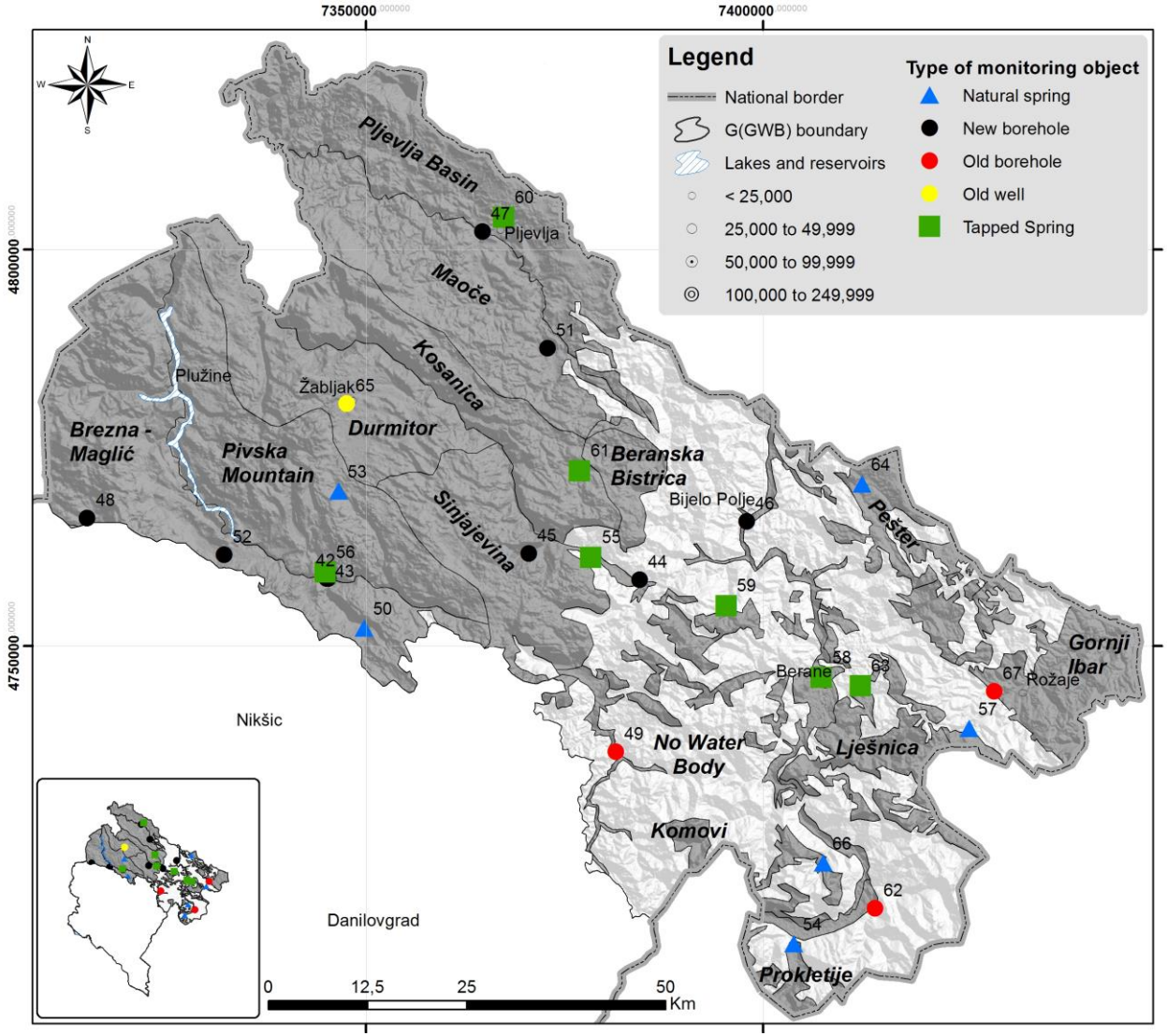
Table 6.8 Groundwater monitoring locations in the Danube River Basin

MNE No.[171]	Name	Type	Code of GWB/GGWB
42	Šavnik (near school)	New borehole[172]	ME_DB_GW_K_1
43	Šavnik (alluvium)	New borehole	ME_DB_GW_K_1
44	Mojkovac	New borehole	ME_DB_GW_K_3
45	Ravnjak	New borehole	ME_DB_GW_K_3
46	Bijelo Polje	New borehole	ME_DB_GGW_C_2
47	Pljevlja	New borehole	ME_DB_GGW_I_1
48	Zaljutnica	New borehole	ME_DB_GW_K_1
49	Mateševo	Old borehole	ME_DB_GGW_K_7
50	Oko Bijele Spring	Natural Spring	ME_DB_GW_K_1
51	Maoče	New borehole	ME_DB_GGW_C_1
52	Brezna	New borehole	ME_DB_GW_K_1
53	Bukovica Spring	Natural Spring	ME_DB_GW_K_2
54	Alipaša Spring	Natural Spring	ME_DB_GGW_K_6
55	Gojakovića Spring	Tapped Spring	ME_DB_GW_K_3
56	Šavnička Glava Spring	Tapped Spring	ME_DB_GW_K_2
57	Ibar Spring	Natural Spring	ME_DB_GGW_K_10
58	Manastirsko Spring	Tapped Spring	ME_DB_GGW_C_2
59	Bitrica Spring	Tapped Spring	ME_DB_GGW_C_2
60	Breznica Spring	Tapped Spring	ME_DB_GGW_I_1
61	Zmajevac Spring	Tapped Spring	ME_DB_GW_K_5
62	Djurička River (alluvium)	Old borehole	ME_DB_GGW_K_6
63	Dapsića Vrelo	Tapped spring	ME_DB_GGW_K_8
64	Djalovića Cave	Natural spring	ME_DB_GGW_K_9
65	Žabljak (Crno Lake)	Old well	ME_DB_GGW_K_4
66	Murinski springs	Natural spring	ME_DB_GGW_K_7
67	Rožaje (Županica)	Old borehole	ME_DB_GGW_K_10

[171] Number reference is or Montenegro as a whole, i.e. including the Adriatic River Basin where there are 41 monitoring locations.

[172] All new boreholes are drilled under frame of this RBMP during the year of 2018.

Figure 6.3 Location of groundwater monitoring in the Danube 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 Sites for chemical analysis of priority substances (2018)

No.	Water body	Name of site	Coordinates
1	Ćehotina	Upstream Pljevlja, Rabitlja	N 43.311624; E 19.385532
2	Ćehotina	Downstream Pljevlja	N 43.363442; E 19.298902
3	Lim	Andrijevica	N 42.750276; E 19.793501
4	Lim	Downstream Bijelo polje (Dobrakovo)	N 43.134953; E 19.775594
5	Tara	Trebaljevo	N 42.861815; E 19.525816

The following results could be underlined:

- Four WFD PS metals have been measured in water – arsenic (As), barium (Ba), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and vanadium (V) the values larger than EQS were not detected in samples - EU Directive (EQSD 2013/39/EU). In respect to other pollutants, high concentration of Mn in compare with other sites was detected at site Ćehotina, Rabitlja - 218 ug/l.
- Measurement of 30 selected pesticides listed in the original EQS Directive (2008/105/EC) as well as new PSs that were added to the EQSD at its last revision did not confirmed presence of those compounds.
- The group of industrial pollutants comprised of 6 WFD PS and DEHP (ubiquitous plasticiser) was determined in all samples and exceeded its AA-EQS (1.3 ug/l) at 2 sites – Ćehotina, Rabitlja

and Tara - Trebaljevo (highest value of 2.75 ug/l). PAHs (13 PAHs measured) and tributyltin compounds did not exceed EQSs.

- In respect to measurement of mercury concentration in biota, analyses of tissue of two species (*Oncorhynchus mykiss* and *Cottus gobio*) was analysed at site Ćehotina, Gradac showed values that exceed EQS for both taxa, which indicate that it is of high importance to monitor mercury in biota in consequent period.

In order to obtain an overview on the candidate chemicals for the Danube River Basin RBSPs, non-target screening was performed at site Ćehotina-Downstream Pljevlja. 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).

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 1. 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.

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.

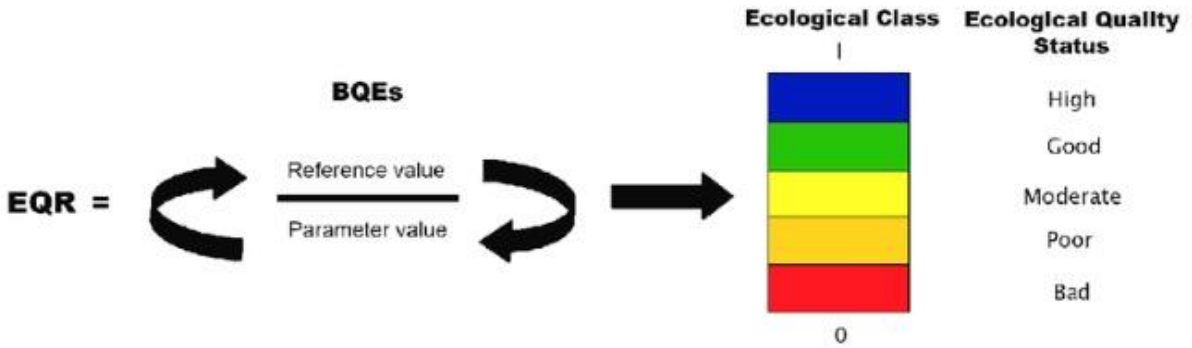
For high status - There are no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The values of the biological quality 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.

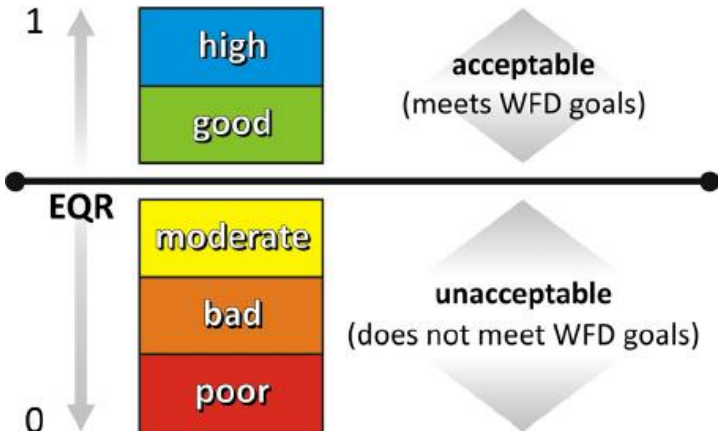
For good status - The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.

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 1.

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 1.

Biological Parameters

The information of indicative BQEs for identified SWBs in the Danube River Basin is presented in Annex 1, 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 2018 for SWBs in the Danube River Basin and could be considered as low to medium confidence assessment.

Out of 48 total surface water bodies delineated in the Danube River Basin, 26 are considered to be without significant hydromorphological pressures. For 14 surface water bodies, hydromorphological degradation is assessed as moderate to high. Seven 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.

7.1.4 Surface water body (SWB) status – an overview

An assessment of surface water quality status has been made for all 48 delineated surface water bodies. 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 7.3 shows the analysis of the pressures on all 48 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 48 assessed SWBs, a total of 18 SWBs (37.5%) are judged to have failed to achieve good status and mitigation measures have to be identified and applied (Section 10).

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 is evaluated to be of medium confidence, which is 10.42% of total length of assessed WBs. Thus, for complete design of mitigation measures, more information is required.

Table 7.2 Description of Confidence Levels

Confidence level	Description
HIGH	All of the following criteria apply: **Biology**: • WFD-compliant monitoring data; • Biological monitoring complies fully with preconditions for sampling/analysis; • WFD compliant methods included in intercalibration process; • Biological monitoring results are supported by: • Results of hydromorphological quality elements (for structural degradation); • Results of physico-chemical quality elements (for nutrient/organic poll.); • Aggregation (grouping procedure) of water bodies in compliance with WFD shows plausible results. **Chemistry:** • 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: **Biology**: • WFD compliant methods not included in intercalibration process; • WFD compliant monitoring data, but: • biological results not in agreement with supportive quality elements or • only few biological data available (possibly showing different results); • Medium confidence in grouping of water bodies; • Biological monitoring does not comply completely with preconditions for sampling and analysis (e.g. use of incorrect sampling period). **Chemistry:** • National EQS available but insufficient data available (according to WFD); Medium confidence in grouping of water bodies.
LOW	One or more of the following criteria apply: **Biology**: • No WFD-compliant methods and/or monitoring data available; • Evaluation from risk assessment to EQ (updated risk assessment is mandatory). **Chemistry:** • No national EQS available for specific pollutants, but limited data available (pollution is detectable).

Table 7.3 Assessment of surface water quality status in the Danube River Basin

Key:

High Status | Good Status | Moderate Status | Poor Status | Bad Status

Sub-Basin	Map No.[173]	Surface Water Body	Type	Condition	Length or Area	Overall Status	HYMO[174]	Risk[175]	Confidence Level[176]
Tara	1	Opasanica / Verušica	R1	Natural	27.04 km			Possibly at risk	Low
Tara	2	Tara_1	R1	Natural	6.03 km			Likely not at risk	Low
Tara	3	Tara_2	R1	HMWB	6.97 km		HMWB	At risk	Low
Tara	4	Drcka	R1	Natural	18.87 km			Likely not at risk	Low
Tara	5	Tara_3	R4	Natural	29.96 km			At risk	Low
Tara	6	Biogradsko Lake	L2	Natural	0.23 km^2			Likely not at risk	Low
Tara	7	Tara_4	R5	Natural	19.35 km			Possibly at risk	Low
Tara	8	Tara_5	R7	Natural	79.77 km			Likely not at risk	Low
Tara	9	Crno Lake	L1	Natural	0.52 km^2			Likely not at risk	Low
Piva	10	Tušina/Bukovica	R1	Natural	30.93 km			Likely not at risk	Low
Piva	11	Pridvorica	R4	Natural	14.89 km			Likely not at risk	Low
Piva	12	Bijela	R1	Natural	9.00 km			Likely not at risk	Low
Piva	13	Komarnica_1	R1	Natural	18.13 km			Likely not at risk	Low
Piva	14	Komarnica_2	R5	Natural	17.07 km			Likely not at risk	Low
Piva	15	Piva Reservoir	R7	HMWB	12.5 km^2		HMWB	Likely not at risk	Low
Piva	16	Vrbnica_1	R1	Natural	4.39 km			Likely not at risk	Low
Piva	17	Vrbnica_2	R2	Natural	3.22 km			Likely not at risk	Low
Piva	18	Piva	R7	Natural	9.72 km			Possibly at risk	Low

[173] Map numbers refer to the position of the surface water bodies shown in Section 3

[174] HYMO: hydromorphological monitoring

[175] The actual pressures on the surface water bodies are clarified in Section 4

[176] A description of the confidence levels is provided in Table 7.2

Sub-Basin	Map No.[173]	Surface Water Body	Type	Condition	Length or Area	Overall Status	HYMO[174]	Risk[175]	Confidence Level[176]
Lim	19	Grlja_1	R1	Natural	5.61 km			Likely not at risk	Low
Lim	20	Grlja_2	R4	Natural	2.08 km			Likely not at risk	Low
Lim	21	Grnčar	R1	Natural	6.71 km			Likely not at risk	Low
Lim	22	Ljuča	R4	Natural	12.76 km			Likely not at risk	Medium
Lim	23	Plavsko Lake	L3	Natural	1.99 km^2			Possibly at risk	Low
Lim	24	Lim_1	R4	Natural	26.02 km			Possibly at risk	Low
Lim	25	Komarača	R1	HMWB	20.49 km		HMWB	At risk	Medium
Lim	26	Kutska/Mojanska/Zlorečica	R1	Natural	28.02 km			Likely not at risk	Low
LIm	27	Lim_2	R7	Natural	44.14 km			Possibly at risk	Low
LIm	28	Bistrica	R2	HMWB	17.29 km		HMWB	At risk	Low
Lim	29	Popča / Vrbička rijeka	R1	Natural	24.18 km			Likely not at risk	Low
Lim	30	Lješnica	R2	Natural	9.31 km			Likely not at risk	Low
Lim	31	Ljubovića_1	R2	Natural	25.30 km			Likely not at risk	Low
Lim	32	Ljubovića_2	R5	Natural	7.11 km			Likely not at risk	Low
Lim	33	Bistirca (Lj)	R1	HMWB	5.89 km		HMWB	Possibly at risk	Low
Lim	34	Lim_3	R7	Natural	23.84 km			At risk	Low
Lim	35	Bistrica (L)_1	R1	Natural	5.21 km			Likely not at risk	Low
Lim	36	Bistrica (L)_2	R2	Natural	14.83 km			Possibly at risk	Low
Ibar	37	Ibar_1	R1	Natural	11.21 km			Likely not at risk	Low
Ibar	38	Crnja	R1	Natural	7.33 km			Likely not at risk	Low
Ibar	39	Ibar_2	R4	Natural	21.48 km			At risk	Low
Ćehotina	40	Ćehotina_1 /Kozička rijeka	R1	Natural	21.49 km			Likely not at risk	Low
Ćehotina	41	Ćehotina_2	R4	Natural	7.58 km			Likely not at risk	Low
Ćehotina	42	Otilovići Reservoir	R5	HMWB	7.58 km		HMWB	Likely not at risk	Medium
Ćehotina	43	Ćehotina_3	R5	Natural	6.80 km			Likely not at risk	Low
Ćehotina	44	Ćehotina_4	R5	HMWB	10.13 km		HMWB	At risk	Low
Ćehotina	45	Vezišnica	R1	Natural	11.33 km			At risk	Low
Ćehotina	46	Ćehotina_5	R5	Natural	19.32 km			Possibly at risk	Low
Ćehotina	47	Voloder	R1	Natural	21.23 km			Likely not at risk	Low
Ćehotina	48	Ćehotina_6	R5	Natural	38.43 km			At risk	Medium

7.2 Groundwater status

7.2.1 Groundwater body No. 1 "Brezna - Maglić"

The groundwater body "Brezna - Maglić" (ME_DB_GW_K_1) abstraction amounts around 10 l/s, only. The single water source used for potable water supply in this GWB is "Sutulija Spring". The assessed groundwater resources are over 20,000 l/s. Considering actual groundwater extraction, only about 0.05% 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. 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.

There are four ecosystems which depend of water from this GWB: Piva Lake, Komarnica River, Bijela River and Trnovačko Lake.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 65% of GWB area. There are no point sources of pollution within the area of this GWB which belongs to Montenegro except of the factory of electrodes close to Plužine (according to the map of industrial polluters). Some pollutants from Gacko area (in Bosnia & Herzegovina, B&H) such as coal mine and thermopower plant can also have some indirect impact on air and soil/water quality but this should be studied more. 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-Plužine and Nikšić-Šavnik are potential sources of pollution because the wastewater from roads are not collected and treated. Taking into account the present sources of pollution, PE Load, which is estimated at 150 only, and assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability 0.11), the risk of aquifer contamination 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 GWB, the surveillance for quantity and surveillance monitoring of groundwater for quality, should be established. Furthermore, the study of potential impact of Gacko (B&H) on groundwater quality should be undertaken and possibly launch need for operational monitoring of groundwater quality. The current monitoring network is very poor (parameters are periodically measured just on water source "Sutulija"). 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.

7.2.2 Groundwater body No. 2 "Pivska Mountain"

The groundwater body "Pivska Mountain" (ME_DB_GW_K_2) abstraction amounts around 50 l/s. The single potable water source in the area of this GWB is water source „Šavnička Glava" tapped for Šavnik settlement. The assessed groundwater resources are around 20,000 l/s. Considering actual groundwater extraction of 50 l/s, only about 0.25% 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. 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. There is one thermal spring Ilidža with different physical and chemical characteristics of water (temperature around 29°C; increased content of SO_4^{2-} ion). Protection zones are delineated only for the water source "Šavnička Glava".

There are four ecosystems which depend of water from this GWB: Piva Lake, Komarnica River, Bukovica River and Tušina River.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 60% of GWB area. There are no point sources of pollution within the area of GWB except of the fishpond in Šavnik. 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 Šavnik-Žabljak and Plužine-Šćepan Polje are potential sources of pollution because the wastewater from roads are not collected and treated. Taking into account the present sources of pollution, PE Load which is estimated at 150 only (ratio PE Load vs. Vulnerability 0.14), and assessed natural vulnerability of terrain, the risk of aquifer contamination 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 GWB, the surveillance for quantity, and operational monitoring of groundwater for quality, should be established in initial stage. The current monitoring network is very poor (parameters are periodically measured just on water source "Šavnička Glava"). 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 "Sinjajevina"

The groundwater body "Sinjajevina" (ME_DB_GW_K_3) abstraction amounts around 61 l/s. There are three potable water sources in the area of this GWB: „Ravnjak", „Ropušica" and "Gojakovića Spring". The assessed groundwater resources are around 14,000 l/s. Considering actual groundwater extraction of 61 l/s, only about 0.5% 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. 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 the water sources „Ravnjak", „Ropušica" and „Gojakovića Spring".

There are three ecosystems which depend of water from this GWB: Tara River, Plašnica and Bistrica River (Kolašin).

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 62% of GWB area, i.e. 36% and 26%, recpectively. According to the map of industrial polluters there are no point sources of polution within the area of GWB except of factory of weapon 'Tara' close to Mojkovac. PE Load is

estimated on 1600. 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 Kolašin – Djurdjević Tara is a potential source of pollution because the wastewater from roads are not collected and treated. Taking into account the present sources of pollution, the PE load estimated at 1,600 and assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability 1.55), the risk of aquifer contamination 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 GWB, 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 "Ravnjak", "Ropušica" and "Gojakovića 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.

7.2.4 Groundwater body No. 4 "Durmitor"

The group of groundwater bodies "Durmitor" (ME_DB_GGW_K_4) abstraction amounts around 57 l/s. There are two official water sources in the area of this GGWB: "Oko" and "Mlinski potok". The assessed groundwater resources are around 10,000 l/s. Considering actual groundwater extraction of 57 l/s, only about 0.6% 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 delineated for the water sources "Oko" and "Mlinski potok".

There are few ecosystems which depend of water from this GGWB: Tara River, Crno Lake and other smaller glacial lakes in wider Durmitor Mt. area.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 42% of GWB area, i.e. 8% and 34%, recpectively. There are no large 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 including tourist houses which are not connected to sewage system. Also, the main road Šavnik-Žabljak-Djurdjevića Tara is a potential source of pollution because the wastewater from roads are not collected and treated. Taking into account the present sources of pollution, PE Load which is estimated at c.4000, and assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability 3.93), the risk of aquifer contamination 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 in initial stage, should be established. The current monitoring network is very poor (parameters are periodically measured just on water sources "Oko" and "Mlinski potok"). 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.

7.2.5 Groundwater body No. 5 “Kosanica”

The groundwater body “Kosanica” (ME_DB_GW_K_5) does not have any abstraction from this groundwater body. The assessed groundwater resources are around 10,000 l/s. Since that there are no groundwater abstraction it can be concluded that **the GWB 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 tapped water sources.

There are two ecosystems which depend of water from this GWB: Tara River and Draga River. The extraction of gravel is registered at certain locations, some time out of control.

According to the Vulnerability map, the classes “Moderate to High“ and “Very High“ vulnerability occupy around 82% of GWB area, i.e. 22% and 60%, recpectively. According to the map of industrial polluters there are no point sources of polution within the area of GWB. 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 Djurdjević Tara – Pljevlja is a potential source of pollution because the wastewater from roads are not collected and treated. Taking into account the lack of point sources of pollution, PE Load is estimated at 0, as well as assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability is thus 0), the risk of aquifer contamination 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 GWB, the surveillance for quantity and for groundwater quality, should be established. There are no observation points within area of this GWB. 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 “Maoče”

The group of groundwater bodies “Maoče” (ME_DB_GGW_C_1) abstraction amounts around 45 l/s. There are three potable water sources used for local water supply in the area of this GGWB, that are: Zmajevac, Mandovac and Bezarska Vrela (with total abstraction of 45 l/s). The assessed groundwater resources are around 6,000 l/s. Considering actual groundwater extraction of 45 l/s, only about 0.75% 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. Certain groundwater protection zones are delineated. 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 the mentioned water sources.

There are several ecosystems which depend of water from this GGWB: Ćehotina River, Maočnica, Voloder, Vežišnica, Sjevernica River and reservoir "Otilovići".

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 91% of GWB area, i.e. 46% and 45%, recpectively. According to the map of industrial polluters there are few potential point sources of pollution within the area of this GGWB such as: thermal power plant in Pljevlja, landfill of thermal power plant "Maljevac", Mine of lead and zinc "Šuplja Stijena", Wood factory "Vektra Jakić" and factory „Žitopromet" in Pljevlja. 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 Đurđevića Tara-Pljevlja is a potential source of pollution because the wastewater from road are not collected and treated. Taking into account the present sources of pollution, PE Load which is estimated at 10000, and assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability 11.26), there is a potential risk of aquifer contamination. According to this assessment, it can be concluded that **the GWB 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 the mentioned water sources). 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.

7.2.7 Groundwater body No. 7 "Pljevlja Basin"

The group of groundwater bodies "Pljevlja basin" (ME_DB_GGW_I_1) abstraction amounts around 55 l/s. There are two tapped water sources in this GGWB: „Breznica" (Q=50 l/s) and „Jogušnica" (Q=5 l/s). The assessed groundwater resources are around 7,000 l/s. Considering actual groundwater extraction of 55 l/s, only about 0.8% 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 of the two exisiting karstic sources is generally good, but of variable character. 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 the water sources "Breznica" and "Jogušnica", but data on groundwater quality of other sources, as well as water pumped out from the open coal pit mine in the center of the basin is missing

There is one ecosystem which depends of water from this GGWB, that is Ćehotina River.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 90% of GWB area, i.e. 47% and 43%, recpectively. According to the map of industrial polluters there are two potential point sources of pollution within the area of this GGWB such as: Coal Mine Pljevlja, TE Plant and farm "Razdolje" (Pljevlja). 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 Pljevlja-Jabuka (Serbia) is a potential source of pollution because the wastewater from road are not collected and treated. Taking into account the present large sources of pollution, PE Load is estimated at 173652, which is the largest in entire

Montenegro. By this value and assessed natural vulnerability of terrain ratio PE Load vs. Vulnerability is reaching 182.56, become the largest in the country. Therefore, the risk of groundwater contamination is very high. According to expert judgment and assessment based on hazard and risk maps, it can be concluded that **the GWB is under the qualitative pressure and 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 "Breznica" and "Jogušnica"). 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 "Prokletije"

The group of transboundary groundwater bodies "Prokletije" (ME_DB_GGW_K_6) abstraction amounts around 30 l/s. There is just one water source in the area of this GGWB, the water source "Bajrovića Spring" used for municipal water supply. The assessed groundwater resources are around 5,000 l/s. Considering actual groundwater extraction of 30 l/s, only about 0.6% 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 delineated just for the water source "Bajrovića Spring".

There are four ecosystems which depend of water from this GGWB: Plavsko Lake, Vruja River, Grnčar River and Ljuca River.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 73% of GGWB area, i.e. 63% and 10%, respectively. According to the map of industrial polluters there are no point sources of polution within the area of GGWB. The diffuse sources of pollution are many and 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, PE Load which is estimated at 3717, and assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability 3.29), the risk of aquifer contamination is still relatively 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 in initial stage, should be established. The current monitoring network is very poor (parameters are periodically measured just on water source "Bajrovića 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.

7.2.9 Groundwater body No. 9 “Komovi”

The group of transboundary groundwater bodies “Komovi” (ME_DB_GGW_K_7) abstraction amounts around 180 l/s. There is just one municipal water source in the area of this GGWB, the water source “Krkori“ (Q=100 l/s), but new water intake for the purposes of water supply of highway is under construction („Mateševo“; Q=80 l/s). The assessed groundwater resources are around 3,500 l/s. Considering the groundwater extraction of 180 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. 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 just for the water sources “Krkori” and “Mateševo”.

There are three ecosystems which depend of water from this GGWB: Tara River, Lim River and Kutska River.

According to the Vulnerability map, the classes “Moderate to High“ and “Very High“ vulnerability occupy around 87% of GGWB area, i.e. 77% and 10%, respectively. According to the map of industrial polluters 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. Taking into account the present sources of pollution, PE Load which is estimated at 1435, and assessed natural vulnerability of terrain (ratio PE Load vs. Vulnerability 1.74), the risk of aquifer contamination is still relatively 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 in initial stage, should be established. The current monitoring network is very poor (parameters are periodically measured just on water source “Krkori”). 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.

7.2.10 Groundwater body No. 10 “Beranska Bistrica-Ljubovidja”

The group of complex and relatively dispersed groundwater bodies “Bistrica-Ljubovića” (ME_DB_GGW_C_2) abstraction amounts around 908 l/s. There are five municipal water sources in the area of this GGWB: “Manastirsko Vrelo” (Q=85 l/s), “Merića Vrelo” (Q=200 l/s), “Daspićko Vrelo” (Q=45 l/s), “Vrelo Bistrice” (Q=500 l/s) and “Mušovića River” (Q=78 l/s). The assessed groundwater resources are around 8,000 l/s. Considering that groundwater extraction of 908 l/s is about 11% of renewable resources it can be concluded that **the GGWB is still in good status, not under the quantitative pressure and not at risk,** but careful extraction followed by systematic monitoring is necessary**.**

The groundwater quality is relatively good despite presence of many potential pollutants. After extreme rainfall events there is regularly an 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 the mentioned municipal water sources.

There are three ecosystems which depend of water from this GGWB: Lim River, Beranska Bistrica River and Ljubovića River.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 98% of GGWB area, i.e. 62% and 26%, respectively. According to the map of industrial polluters there several potential point sources of polution within the area of GGWB such as: Polipak (Bijelo Polje), Meduza (Bijelo Polje), Meso promet (Bijelo Polje), Eko meso (Bijelo Polje), Kravica (Bijelo Polje), Farma Franca (Bijelo Polje), Rada (Bijelo Polje), Mont Opeka (Berane), Ribnjak (Berane), Poliex (Berane), Zora (Berane), and Boj-commerc (Andrijevica). 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 high natural vulnerability of terrain (88%), the risk of aquifer contamination is potentially high. PE Load is estimated at 38,215, and ratio PE Load vs. Vulnerability is 39.37. According to this assessment, it can be concluded that **the GWB is potentially under the qualitative pressure and at risk** and operational monitoring is obligatory.

Bearing in mind the significance of this GGWB, the operational monitoring for both, quantity and quality, should be established. The current monitoring network is very poor (parameters are periodically measured just on mentioned water sources). The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken in timely and efficient manner.

7.2.11 Groundwater body No. 11 "Lješnica"

The group of transboundary groundwater bodies "Lješnica" (ME_DB_GGW_K_8) abstraction amounts around 141 l/s. There are three water sources in the area of this GGWB used for municipal water supply: "Popča" (Q=70 l/s), "Pusta Vrata" (Q=27 l/s) and "Jasenica" (Q=44 l/s). The assessed groundwater resources are around 4,000 l/s. Considering the groundwater extraction of 141 l/s, just about 3.5% 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. 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 the mentioned water sources.

There are two ecosystems which depend of water from this GGWB: Lim River and Lješnica River.

According to the Vulnerability map, the classes "Moderate to High" and "Very High" vulnerability occupy around 86% of GGWB area, i.e. 62% and 24%, respectively. According to the map of industrial objects there are no potential 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. Taking into account the present sources of pollution, PE Load estimated at 0, and accordingly assessed ratio PE Load vs. Vulnerability of 0, the risk of aquifer contamination is low. According to this assessment, it can be concluded that **the GWB is not under the qualitative pressure and not at risk.**

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 municipal water sources). 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 "Pešter"

The group of transboundary groundwater bodies "Pešter" (ME_DB_GGW_K_9) does not have any groundwater abstraction. The assessed groundwater resources are around 3,000 l/s. Since that there are no groundwater abstraction it can be concluded that **the GWB 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 tapped water sources for centralized water supply.

There is one ecosystem which depends of water from this GGWB, that is Bistrica River (Bijelo Polje).

According to the Vulnerability map, the "Moderate to High" vulnerability occupies around 73% of GGWB area. 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. Taking into account the present sources of pollution, 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.**

The surveillance monitoring for both, quantity and quality, should be established. There are no observation points within area of this GWB. The proposed monitoring will provide parameters for qualitative and quantitative status, so all precautionary protection measures necessary for sustainable groundwater development can be taken in timely manner.

7.2.13 Groundwater body No. 13 "Gornji Ibar"

The group of groundwater bodies "Gornji Ibar" (ME_DB_GGW_K_10) abstraction amounts around 105 l/s. There are two tapped water sources in the area of this GGWB: "Vrelo Ibra" (Q=100 l/s) and „Grlja Spring" (Q=5 l/s). The assessed groundwater resources are around 3,500 l/s. Considering actual groundwater extraction of 105 l/s, only about 3% 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 of controlled tapped springs 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 the water sources “Vrelo Ibra” and “Grlja Spring“.

There is Ibar River as the main ecosystem which depends of water from this GGWB.

According to the Vulnerability map, the classes “Moderate to High“ and “Very High“ vulnerability occupy around 655% of GGWB area, i.e. 25% and 40%, respectively According to the map of industrial activities there are no point sources of polution within the area of GGWB except of factory of paper “Dekor” in Rožaje plus the municipal landfill of Rožaje, directly located at right river bank downstream of the city. The diffuse sources of pollution are represented by agricultural areas, local villages landfills, local road network and settlements which are not connected to sewage system. Taking into account the present sources of pollution and assessed high natural vulnerability of terrain (65%), out of which 40% is in class “Very high”, the risk of aquifer contamination is potentially moderate to high. PE Load is estimated at 10000, and ratio PE Load vs. Vulnerability is 10.27. According to this assessment, it can be concluded that **the GWB is under the qualitative pressure and potentially at risk but .**

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 “Vrelo Ibra” and “Grlja 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.

7.3 Summary of pressures on surface and groundwaters

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 the Danube River Basin and also indicates the main pressures involved.

The key types of mitigation measures for surface waters and groundwaters that are judged to be ‘at risk’ or ‘possibly at risk’ are idenified and elaborated in Section 10.

Table 7.4 Groundwater and surface water bodies at risk or potentially at risk in the Danube River Basin

No.	GWB or SWB	Risk Assessment	Main Pressure(s) Based on Risk Assessment[177]
Groundwater Bodies			
6.	ME_DB_GGW_C_1 (Maoče)	Possibly at risk	• Point source pollution • Diffuse source pollution
7.	ME_DB_GGW_I_1 (Pljevlja Basin)	At risk	• Point source pollution • Diffuse source pollution
10.	ME_DB_GGW_C_2 (Beranska Bistrica – Ljubovića)	Possibly at risk	• Point source pollution • Diffuse source pollution
13	ME_DB_GGW_K_10 (Gornji Ibar)	Possibly at risk	• Point source pollution • Diffuse source pollution
Surface Water Bodies			
1.	Opasanica / Verušica	Possibly at risk	• Point source pollution • Physical
3.	Tara_2	At risk	• Physical
5.	Tara_3	At risk	• Point source pollution • Diffuse source pollution
7.	Tara_4	Possibly at risk	• Diffuse source pollution
18.	Piva	Possibly at risk	• Point source pollution • Physical
23.	Plavsko Lake	Possibly at risk	• Point source pollution • Diffuse source pollution
24.	Lim_1	Possibly at risk	• Point source pollution • Diffuse source pollution
25.	Komarača	At risk	• Point source pollution
27.	Lim_2	Possibly at risk	• Point source pollution • Diffuse source pollution • Abstraction
28.	Bistrica	At risk	• Point source pollution • Abstraction
33.	Bistirca (Lj)	At risk	• Point source pollution
34.	Lim_3	At risk	• Point source pollution • Diffuse source pollution

[177] The specific pressures are outlined in Section 4, Table 4.36 (for surface waters) and Table 4.56 (for groundwaters)

No.	GWB or SWB	Risk Assessment	Main Pressure(s) Based on Risk Assessment[177]
			• Abstraction
36.	Bistrica (L)_2	Possibly at risk	• Point source pollution • Diffuse source pollution
39.	Ibar_2	At risk	• Point source pollution • Diffuse source pollution • Abstraction
44.	Ćehotina_4	At risk	• Point source pollution • Diffuse source pollution • Abstraction • Physical
45.	Vezišnica	At risk	• Point source pollution • Diffuse source pollution
46.	Ćehotina_5	At risk	• Point source pollution • Diffuse source pollution
48.	Ćehotina_6	At risk	• Point source pollution • Diffuse source pollution

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 Danube River 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 Danube River 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 Danube River Basin will lead to the identification of a program of measures and the development of the River Basin Management Plan. The main economic elements which will be 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 services, whereby Member States shall take account of the principle of recovery of the costs of water 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 River 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 river 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 river 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 River Basin District, where “costs” include the expenditures for the provision of water 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 supply 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 supply services (e.g. number of persons connected/using the service);
- Costs of water supply 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 - 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 since the volume of water they exploit is transferred back into the system through gravity. Water use in the Danube River Basin falls then into the following categories:

- Agricultural consumption
- Domestic consumption
- Industrial consumption
- Irrigation
- Fish farms, and

- Hydropower

8.2 Abstractions

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.

8.2.1 Agricultural use of water

The Consultant used the most recent statistical yearbook for 2014 from MONSTAT to retrieve relevant information. However, in order to obtain the municipal-level agricultural data for the Danube River 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 Danube River Basin, 2011[178]

Municipality	Total Agriculture Holdings	Total available agricultural land (Ha)	Total used agriculture land (ha)
Andrijevica	1,417	10,257	**8,710**
Berane + Petnjica	4,509	25,475	**21,870**
Bijelo Polje	6,407	36,387	**29,011**
Žabljak	623	9,610	**7,480**
Kolašin	1,575	14,242	**8,629**
Mojkovac	1,214	10,144	**7,873**
Plav + Gusinje	2,479	14,122	**10,749**
Plužine	859	26,336	**23,186**
Pljevlja	4,001	29,364	**22,901**
Rožaje	2,089	No Data	**11,985**
Šavnik	800	9,901	**6,506**
Total	**25,973**	**185,843**	**158,903**

As we can see from Table 8.1 above, Bijelo Polje municipality has the most agricultural land followed by Pljevlja, Plužine, and Berane. The municipalities of the Danube River Basin have more than 97% of the land in permanent meadows and pastures; indicating the limitations that exist in terms of good soils for crop production. Around 1% of the utilized agricultural land is used for arable farming. There are no vineyards in

[178] MONSTAT: Structure of agricultural holdings, Typology of Agricultural Holdings, Agricultural Census 2010

the Basin and very limited holding of orchards and nurseries, the majority being located in Bijelo Polje and Berane.

Around 21% of the agricultural land in most of the municipalities, representing the Danube River Basin is classified as un-utilized. However, this varies between municipalities - with Kolašin having almost 40% unutilized agricultural land, whilst Plužine has 12%, followed by Berane and Andrijevica with 14% and 15% respectively. This appears to be quite a substantial amount, but it must be remembered that some land in karst areas may be very difficult to gain access, for example Kolašin municipality has large amounts of karst and this could be one of the reasons for such high rate of un-utilization.

Irrigation of arable land is less than 0.5% of the used agricultural land available, as shown in Table 8.2. In terms of water consumption, the municipalities making up the Danube River Basin have consumed about 4.6 million m^3 of water for irrigation throughout a year, (this estimation are based on the data recorded upon the period from Jun 2009 to May 2010). Bijelo Polje municipality consumes the most nearly 1.9 million m^3 of water per year. Berane consumes 1.5 million m^3 per year and Pljevlja 1.1 million m^3 per year. The municipalities of Šavnik, Plužine and Žabljak have no irrigation activity.

Table 8.2 Irrigation water use in the Danube River Basin, 2011[179]

Municipality	Agriculture land (ha)	Irrigated area (ha)	Irrigation water volume (m^3/ year)
Andrijevica	8,710	42.70	31,736
Berane + Petnjica	21,870	147.00	1,512,032
Bijelo Polje	29,011	220.60	1,883,598
Kolašin	8,629	22.50	22,152
Mojkovac	7,873	29.60	26,606
Plav + Gusinje	10,749	132.90	1,059,633
Pljevlja	22,901	71.50	68,349
Plužine	23,186	0.10	310
Rožaje	11,985	NA	NA
Šavnik	6,506	0.00	0
Žabljak	7,480	3.30	1,612
Total	**158,904**	**670.2**	**4,606,028**

According to the Agricultural Census, the largest number of irrigation points are from surface water, especially from rivers (67%). Groundwater sources account for 10% of the irrigation points. This is totally the reverse of other reference sources which suggest 97% of irrigated water is from groundwater (UNECE 2015). 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. Irrigation methods, which use substantially less amounts of water

[179] MONSTAT: Structure of agricultural holdings, Typology of Agricultural Holdings, Agricultural Census 2010

are very few and are still not widely used in the area, primarily due to the cost of installation. Plav has the largest number of surface water irrigations points; this is presumably partly due to the presence of Lake Plav, a large surface water store. Bijelo Polje has the largest number of groundwater irrigation points with more than 57% of the total[180]. The Lim sub basin accounts for 93% of the irrigated water use in the Danube River Basin.

The volume of water used for livestock was estimated by 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 calculated and shown in Table 8.4 below.

The agricultural use of water is obtained by combining the water consumed for arable land irrigation and for livestock purpose. The total agricultural use of water is 7,026,180 m^3/ year, of which 4,606,028 m^3/year is used for irrigation purposes while the remaining 2,420,152 m^3/year is used for livestock (Table 8.5).

[180] World Bank Group: Support to water resources management in the Drina River Basin: Montenegro – IWRM study and plan –background paper -volume 1 – Main report- 2016

Table 8.4 Animal farm water use in the Danube River Basin by animal, 2011[181]

Animal	No. (000 heads)	L/day	Total m^3/day	Water use (m^3/ year)
Cattle	54.29	60	3,257.28	1,188,907
Cows	34.003	40	1,360.12	496,443.8
Sheep	157.44	5	787.22	287,333.5
Milked sheep	89.25	10	892.51	325,766.2
Goats	10.85	5	54.25	19,801.25
Milked goats	6.15	10	61.5	22,447.5
Pigs	16.27	5	81.36	29,696.4
Equidae	2.78	35	97.4	35,552.83
Poultry	155.66	0.25	38.91	14,203.61
TOTAL	**526,693**		**6,630.55**	**2,420,152**

Table 8.5 Total water use for livestock in the Danube River Basin by animal, 2011

Municipality	Cattle/ Bovine	Cows	Sheep	Milked sheep	Goats	Milked goats	Pigs	Equidae	Poultry	Total m3/year
Andrijevica	1759	1143	4901	3035	334	188	1475	282	14703	84,164
Berane + Petnjica	6651	4469	18480	11575	2238	1396	3761	520	34404	312,705
Bijelo Polje	13666	8515	32061	19081	1948	1169	4850	619	41060	580,089
Žabljak	1990	1040	6027	3170	133	69	160	63	2566	83,160
Kolašin	2129	1437	8416	5355	1110	671	669	184	12050	111,656
Mojkovac	2443	1480	4572	2571	421	216	1304	188	4207	99,560
Plav + Gusinje	3757	2206	11726	8200	985	528	925	319	9076	176,132
Plužine	3263	1673	16072	7770	1118	499	491	151	5941	160,806
Pljevlja	10606	7162	31596	15114	1171	602	1902	291	19787	462,994
Rožaje	5648	3548	8705	5776	689	427	163	58	7809	217,028
Šavnik	2376	1330	14887	7604	703	385	572	108	4053	131,857
TOTAL HEAD	54288	34003	157443	89251	10850	6150	16272	2783	155656	
m^3/day/head	3257	2040	9447	5355	651	369	976	167	9339	

[181] MONSTAT: Structure of agricultural holdings, Livestock Resources, Agricultural Census 2010

Total m³/year	1188907	744666	3448002	1954597	237615	134685	356357	60948	3408866	**2,420,152**

Table 8.6 below summarizes the agricultural use of water in the Danube River Basin, by municipality.

Table 8.6 Total agricultural use of water in Danube River Basin

Municipality	Irrigation water volume (m³/ year)	Livestock (m³/ year)	Total (m³/ year)
Andrijevica	31,736	84,164	115,900
Berane + Petnjica	1,512,032	312,705	1,824,737
Bijelo Polje	1,883,598	580,089	2,463,687
Kolašin	22,152	111,656	133,808
Mojkovac	26,606	99,560	126,166
Plav + Gusinje	1,059,633	176,132	1,235,765
Pljevlja	68,349	462,994	531,343
Plužine	310	160,806	161,116
Rožaje	No Data	217,028	217,028
Šavnik	No Data	131,857	131,857
Žabljak	1,612	83,160	84,772
Total	**4,606,028**	**2,420,152**	**7,026,180**

8.2.2 Industrial use of water

The water used in the industrial/ commercial/ institutional (ICI) sector is used 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 the self-service basis.

There are very limited data available to estimate the economic impact of this aspect of water use in terms of annual turnover, income and employment of the ICI sector. Hence, our methodological approach consisted of 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 Danube River Basin, 2014[182]

Municipality	Farmers	Companies (Commercial users / legal entities)
Andrijevica	1417	80
Berane + Petnjica	4509	681
Bijelo Polje	6407	793
Žabljak	623	175
Kolašin	1575	238
Mojkovac	1214	240
Plav + Gusinje	2479	714
Plužine	859	45
Pljevlja	4001	330
Rožaje	2089	30
Šavnik	800	122

Industrial water consumption has fallen considerably in Montenegro since 2012 due to closure of KAP and reduced operations at Nikšić steel factory. The main industrial consumers in the Danube River Basin are the Pljevlja TPP and the accompanying coalmines as well as a nearby lead and zinc mine.

There are six bottled water plants in the Danube River Basin located in Kolašin, Šavnik and Bijelo Polje. A further four concessions have recently been granted[183]. Bottled water has become an important product in the basin in recent years as the northern region's rivers are characterized by their pureness and high quality. Until 2009, six factories for natural spring water (still water) were operational for commercial purposes. However, only one of them was used for mineral water - the water from the springs at Bijelo Polje. However, the 2010 Concession Law inspired more interest in the field of bottled water production and concessions have been granted at four locations. Despite this, the overall consumptive use of bottled water plants is relatively low in the basin (Table 8.8).

[182] MONSTAT: Annual Yearbook for Montenegro 2014

[183] Support to water resources management in the Drina River Basin: Montenegro – IWRM study and plan –background paper -volume 1 – Main report- 2016

Table 8.8 Bottled water companies in operation and concessions granted, 2016[184]

OPERATING COMPANIES			
Municipality	**Type of Water**	**Factory and Company**	**Capacity (m^3/year)**
Bijelo Polje	Mineral	Rada	30,000
Kolašin	Still	Aqua Bianca, Aqua Bianca doo	31,536
Kolašin	Still	Aqua Monta, Fin Invest doo	50,000
Kolašin	Still	Suza, water Group doo	63,072
Kolašin	Still	Gorska voda, Gorska doo	157,680
Šavnik	Still	Gorska voda, Gorska doo	3,208
RECENTLY GRANTED CONCESSIONS			
Municipality	**Type of Water**	**Concession**	**Abstraction amount agreed (l/s)**
Andrijevica	NA	Bradavac	5
Mojkovac	NA	Vrelo	1
Kolašin	NA	Drijenak	5
Kolašin	NA	Sjerogoste	10

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 (Dwellings are either for industrial use only or a combination of housing and industry combined). Some 417 dwellings were associated with industrial use, around 1% of the total number of dwellings located within the Danube River Basin. Industrial water use amount (Table 8.9) has been assumed to 3.43 Mm^3/year within the Danube River Basin for this this report[185], with the largest consumer being Bijelo Polje and Pljevlja municipality (associated with the TPP).

[184] Support to water resources management in the Drina River Basin: Montenegro – IWRM study and plan –background paper -volume 1 – Main report- 2016

Table 8.9 Annual industrial water consumption in the Danube River Basin, 2014[186]

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/Year)
Andrijevica	2,463	1	9	10	52,814
Berane + Petnjica	12,438	4	38	42	748,968
Bijelo Polje	16,458	20	119	139	809,072
Kolašin	3,455	13	35	48	181,010
Mojkovac	3,458	8	21	29	72,391
Plav + Gusinje	4,933	1	27	28	309,259
Pljevlja	12,855	5	61	66	759,497
Plužine	1,555	1	2	3	173,591
Šavnik	1,294	2	6	8	30,000
Žabljak	1,666	13	31	44	120,772
Rožaje	6,190	2	25	27	173,843
Total	**66,765**	**70**	**374**	**444**	**3,430,587**

The volume of industrial, commercial and institutional (ICI) water was estimated considering the data provided by the local/regional water utilities and thus excluded 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. It is, however, 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 35% of the gross figure supplied to the ICI sector. We will discuss the proportion of the NRW in the relevant sub-section below.

8.2.3 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 217 l/c/d which corresponds to the figures indicated by the Montenegro Water Management Strategy. However, these are rather high values compared to many European countries and reflect the level of water losses in the water systems of the country. The current Strategy lists the range of losses encountered in the system to be between 24% and 85%, while the Annual report on Water Management reports that losses are precisely 60.8% for the

[186] 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

entire territory of Montenegro. It must, however, be noted that specific consumption was overestimated by the amount of technical losses as the quality of available data did not allow for elimination of those.

Population estimates for the people living in the Danube River Basin were taken from the 2011 census, which is available at municipal level.

The 2014 Census data showing population levels for the main cities in the river basin and water supplied to the households are shown in Table 8.10.

Table 8.10 Domestic water use in Danube River Basin, 2014[187]

Municipality	Population[188] (Number of Inhabitants)	Number of households	Water supplied to the households, by Municipality (m^3/year)
Andrijevica	5071	1700	120,862
Berane + Petnjica	33,970	9990	4,707,944
Bijelo Polje	46,051	13200	3,017,728
Žabljak	3569	1270	75,031
Kolašin	8380	2850	649,152
Mojkovac	8622	2820	513,165
Plav + Gusinje	13,108	3740	595,209
Plužine	3246	1140	27,250
Pljevlja	30,786	10790	2,955,873
Rožaje	22,964	5680	1,429,565
Šavnik	2070	700	15,000
Total	**177,837**	**53,880**	**14,106,779**

The calculated domestic total water production from centralized resources in the Danube River Basin is thus 14.1 Mm^3/year. When considering typical European principles for domestic water consumption, these are extremely high values and reveal the major issues on water loss that are present in Montenegro. Indeed, average NRW in Montenegro are at 58%, 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.

[187] MONSTAT: Statistical Yearbook for Montenegro 2014 Annual Report on the Water sector from 2016

[188] Population data referes to 2011 which is the latest year when official census was performed in Montenegro.

Table 8.11 Total Domestic Water consumption in Danube River Basin[189]

Municipality	Number of households	Domestic Water Supply (m^3/year)	Connected to Water Supply (%)	Self-service (%)	Self-Service Water Consumption (m^3/year)	Total Domestic Water Consumption (m^3/year)
Andrijevica	1700	120,862	75	25	30,215	151,077
Berane + Petnjica	9990	4,707,944	89	11	517,873	5,225,817
Bijelo Polje	13200	3,017,727	81	19	573,368	3,591,095
Žabljak	1270	75,031	79	21	15,756	90,787
Kolašin	2850	649,152	78	22	142,813	791,965
Mojkovac	2820	513,165	85	15	76,974	590,140
Plav + Gusinje	3740	595,208	91	9	53,568	648,777
Plužine	1140	27,250	59	41	11,172	38,422
Pljevlja	10790	2,955,873	82	18	532,057	3,487,930
Rožaje	5680	1,429,564	91	9	128,660	1,558,225
Šavnik	700	15,000	49	51	7,650	22,650
Total	**53,880**	**14,106,779**	**83**	**17**	**2,090,112**	**16,196,891**

Table 8.11 shows that the total estimated quantity of water taken by the domestic sector amounts to 16.2 million m^3 per year of which 14.1 million is supplied by Public Utility Companies while the remaining 2.1 million m^3 is from self-serviced resources.

Combined water supply (piped and through pump or other means) connection rates vary from 49% for Šavnik to 91% for Plav. Many of the smaller municipalities, Šavnik for example, are more remotely located implying more challenges in connecting household services.

8.3 Non-abstractive use of water

8.3.1 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:

[189] Support to water resources management in the Drina River Basin: Montenegro – IWRM study and plan –background paper -volume 1 – main report - 2016

- 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[190], 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)[191].

A single power plant is located in the Danube River Basin, with a generation capacity of 342 MW. Its annual energy production is 800 GWh (million kWh). It is located on the Piva River. The very high dam defines a large reservoir, which allows the generation of peak power. The power plant is located in the immediate vicinity of the dam. In the existing conditions, utilization of the hydropower potential is one of the most important ways of using water resources of the Drina River and its tributaries.

In addition to the Piva HPP, there are 15 small HPPs with total estimated annual production of close to 80 GWh. The largest amongst them is the SHPP “Bistrica” located in Berane Municipality with a total of 30.65 GWh annual production from a series of 8 SHPPs.

[190] 1 GWh = 1 million kWh; TPP = thermal power plant; HPP = hydropower plant; SHPP = small hydropower plant

[191] 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.

Table 8.12 Hydropower plants in the Danube River Basin[192,193]

Name	Installed power (MW)	Expected Annual Production (GWh)	River/Stream	Municipality
Piva HPP	342	800	Piva	Plužine
mHE "Vrelo"	0.59	2.76	Vrelo	Bijelo Polje
mHE "Rijeka"	2.97	3.82	Bradavac	Andrijevica
mHE "Piševska rijeka"	0.95	2.91	Piševska rijeka	Andrijevica
mHE "Babiono-poljska"	7.09 (2 SHPPs)	21.41	Babino-poljska rijeka	Šavnik
mHE "Bistrica - Majstorovina"	3.50	11.30	Bistrica (Majstorivina)	Bijelo Polje
mHE "Šeremet potok"	0.80	3.46	Šermetski potok	Andrijevica
mHE "Bistrica"	8.20 (8 SHPPs)	30.65	Bistrica (Beranska)	Berane
Total	**368.10**	**876.31**		

Pre-feasibility studies toward a Piva HPP capacity increase were completed in 2011; the preliminary design was be finished in 2015, followed by the preparation of Tender Documents for rehabilitation of the generating units. Some of the electrical equipment has been rehabilitated in 2014.

8.3.2 Fish farming

Most of large operations in the fishing sector are marine based or concentrated outside the Danube River Basin - either along the coast, or on the Skadar Lake or Krupac Lake. There are 11 fish farms in the Danube River Basin, primarily rearing rainbow trout. Given the ecology of the trout as a species, all the fish farms are located near or on water bodies providing a clear, cold, abundant and constant supply of water (Table 8.13).

The trout farms are all generally situated in the central and northern parts of the country (the latter region predominantly the location of the Danube River Basin), on rivers or on the lakes, but there is no precise data on the surface areas that they occupy.

Substantial amounts of free-flowing water are required which are diverted from rivers and streams, but then returned to the system. The Consultant has assumed there are no water losses in the Danube River Basin from fish farming. The largest fish farm in the Danube River Basin is on Lake Piva where cages are used. 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 DRB) that produce 40–130 tones per year, ran by private companies.

[192] Strategija upravljanja vodama crne gore - 2017

[193] Support to water resources management in the Drina River Basin: Montenegro – iwrm study and plan –background paper -volume 1 – main report - 2016

Table 8.13 The main fisheries in the Danube River Basin, 2011[194]

Name of farm	Location	Area (m^2)	Production (tonnes/year)		Water Requirement (m^3/24h)
			Capacity Actual	Capacity Actual	
Rabrenović	Andrijevica	NA	NA	NA	NA
Buče	Berane	6,000	200	40	NA
Bistrica	Bijelo Polje	550	20	15	NA
Bistrica	Bijelo Polje	500	30	15	NA
Trebaljevo	Kolašin	600	NA	10	NA
Radenko	Mojkovac	NA	NA	NA	NA
Novaković	Mojkovac	NA	NA	NA	NA
Rabrenović	Mojkovac	NA	NA	NA	NA
Vukojičić	Pljevlja	NA	NA	NA	NA
Aqua d'Or	Plužine	1,000 (22 cages)	250	130	168,000
Šavnik	Šavnik	1,100	10	NA	18,500
Marić	Žabljak	NA	NA	NA	NA

[194] Sustainable Management of Marine Fishery; Ref. No: Europe Aid/128947/C/SER/ME; Report 34 Fishery Sector Study for the IPARD Program; October 2011

8.3.3 Water use - summary

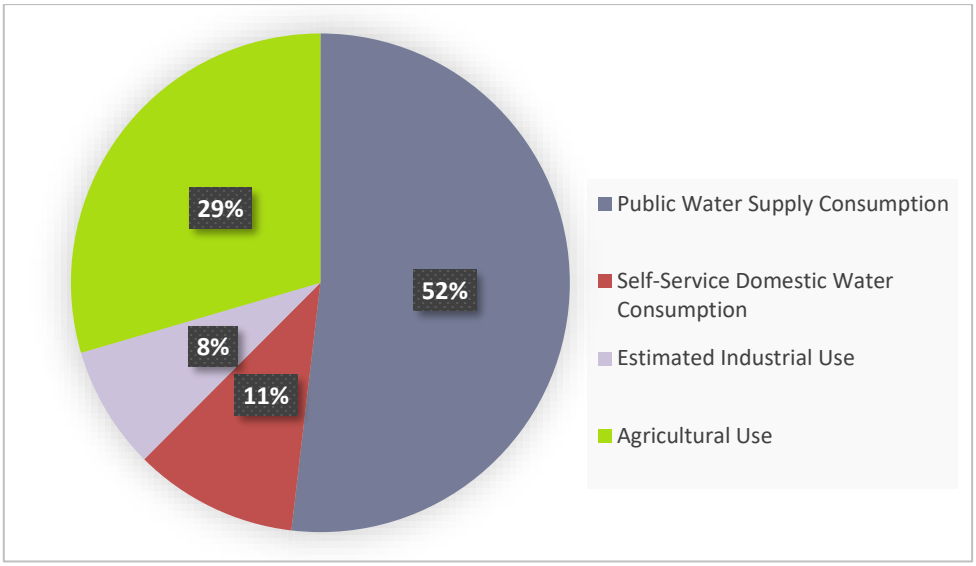
A summary of the water use from the different sectors in the municipalities making up the Danube River Basin is presented in Table 8.14. Our estimates are that about 26.6 Mm^3/year of water is necessary to cover consumption needs for the domestic, industrial and agricultural sectors making up the municipalities in the DRB.

Table 8.14 Summary of water use in Danube River 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
Andrijevica	5071	151,077	52,814	115,900	In river flow	In river flow	319,791
Berane + Petnjica	33,970	5,225,817	748,968	1,824,737	In river flow	In river flow	7,799,522
Bijelo Polje	46,051	3,591,095	809,072	2,463,687	In river flow	In river flow	6,863,854
Žabljak	3569	90,787	181,010	133,808	In river flow	In river flow	405,605
Kolašin	8380	791,965	72,391	126,166	In river flow	In river flow	990,522
Mojkovac	8622	590,140	309,259	1,235,765	In river flow	In river flow	2,135,164
Plav + Gusinje	13,108	648,777	759,497	531,343	In river flow	In river flow	1,939,617
Plužine	3246	38,422.00	173,591	161,116	In river flow	In river flow	373,129
Pljevlja	30,786	3,487,930	30,000	217,028	In river flow	In river flow	3,734,958
Rožaje	22,964	1,558,225	120,772	131,857	In river flow	In river flow	1,810,854
Šavnik	2070	22,650	173,843	84,772	In river flow	In river flow	281,265
Total	**177,837**	**16,196,891**	**3,430,587**	**7,026,180**			**26,654,281**

The structure of the domestic (Public WS + Self-service), agricultural and ICI uses of water can be represented as shown in Figure 8.1. Due to the low industrial/ commercial activity in the river basin, the ICI water consumption is much smaller than the domestic consumption. This fact reduces the economic impact of the water in the region.

Figure 8.1 The Structure of water use (m^3/year) in the Danube River Basin



8.4 Non-Revenue Water

Each water utility in the river 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 68.1% 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 as shown in Table 8.15.

Table 8.15 Supplied versus invoiced water use in Danube River 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
Andrijevica	173,046	50.0%	60,431	26,092	86,523
Berane + Petnjica	5,456,912	75.0%	1,176,986	187,242	1,364,228
Bijelo Polje	3,826,800	71.0%	875,141	234,631	1,109,772
Žabljak	195,803	No data	75,031	120,772	195,803
Kolašin	830,162	59.9%	260,310	72,585	332,895
Mojkovac	585,557	54.0%	236,056	33,300	269,356
Plav + Gusinje	904,467	54.0%	273,796	142,259	416,055
Plužine	200,841	56.0%	11,990	76,380	88,370
Pljevlja	3,715,370	70.0%	886,762	227,849	1,114,611
Rožaje	1,603,408	64.1%	512,642	62,340	574,982
Šavnik	45,000	20.0%	12,000	24,000	36,000
Total	**17,537,366**	**68.1%**	**4,381,145**	**1,207,450**	**5,588,595**

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 Danube River 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 8.16 The value of water for domestic use in the Danube River Basin, 2014[195]

Municipality	Public Water Supply Consumption (m^3/year)	Water invoiced (m^3)	Tariff (Euro/m^3), excluding VAT	Domestic water value (Euro/year)
Andrijevica	120,862	60,431	0.14	8,460
Berane + Petnjica	4,707,944	1,176,986	0.24	282,477
Bijelo Polje	3,017,728	875,141	0.39	341,305
Žabljak	75,031	75,031	0.41	30,763
Kolašin	649,152	260,310	0.52	135,361
Mojkovac	513,165	236,056	0.37	87,341
Plav + Gusinje	595,209	273,796	0.22	60,235
Plužine	27,250	11,990	0.26	3,117
Pljevlja	2,955,873	886,762	0.34	301,499
Rožaje	1,429,565	512,642	0.21	107,655
Šavnik	15,000	12,000	0.12	1,440
Total	**14,106,779**	**4,381,146**		**1,359,653**

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 River Basin. Self-service water value is not included as no reliable data were available on this matter.

[195] Annual report on water use in Montenegro, 2016

Table 8.17 The annual value of water for Legal Entities (ICIs) in the Danube River Basin, 2014[196]

Municipality	Water invoiced (m^3)	Tariff (€/m^3)	Legal Entities water value (Euro/year)
Andrijevica	26,092	0.41	10,698
Berane + Petnjica	187,242	0.92	172,263
Bijelo Polje	234,631	1.35	316,752
Žabljak	120,772	1.67	201,689
Kolašin	72,585	1.57	113,958
Mojkovac	33,300	1.34	44,622
Plav + Gusinje	142,259	0.75	106,694
Plužine	76,380	1.13	86,309
Pljevlja	227,849	1.22	277,976
Rožaje	62,340	0.83	51,742
Šavnik	24,000	0.5	12,000
Total	**1,207,450**		**1,394,704**

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. Considering the prices above, the value of irrigation can be assessed as shown in Table 8.18.

The 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.[197]

[196] Annual report on water use in Montenegro, 2016

[197] 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 8.18 The value of water for agricultural use in the Danube River Basin[198]

Municipality	Agriculture land (ha)	Irrigated area (ha)	Irrigation water volume (m^3/year)	Irrigation water value (€/year)
Andrijevica	8,710.3	42.70	31,736	1,269.4
Berane + Petnjica	21,870.4	147.00	1,512,032	6,048.13
Bijelo Polje	29,011.2	220.60	1,883,598	7,534.39
Kolašin	8,629	22.50	22,152	886.1
Mojkovac	7873.3	29.60	26,606	1,064.2
Plav + Gusinje	10,749	132.90	1,059,633	4,238.53
Pljevlja	22,901.4	71.50	68,349	2,733.96
Plužine	23,186.5	0.10	310	12.4
Rožaje	11,985.8	NA	NA	NA
Šavnik	6,506.5	0.00	0	0
Žabljak	7,480.5	3.30	1,612	6.448
Total	**158,904**	**670.20**	**4,606,028**	**30,992**

There is a lack of data regarding value of the water used for agricultural activities related to cattle farming. Regarding the very small amount of value of water obtained for irrigation activities and the relatively small amount of water consumed through livestock activities (2.4Mm^3), we will not consider water used by cattle farming in the following sections.

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 (Table 8.19) . 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.

[198] MONSTAT : Agricultural Census, 2010

Table 8.19 The annual income from hydropower plants in the Danube River Basin[199,200]

Municipality	Name	Installed power (MW)	Expected Annual Production (GWh)	Average Annual Income from Energy (Euro/year)
Plužine	Piva HPP	342	800	1,760,000
Bijelo Polje	mHE "Vrelo"	0.59	2.76	6,072
Andrijevica	mHE "Rijeka"	2.97	3.82	8,404
Andrijevica	mHE "Piševska rijeka"	0.95	2.91	6,402
Šavnik	mHE "Babino-poljska"	7.09 (2 SHPPs)	21.41	47,102
Bijelo Polje	mHE "Bistrica - Majstorovina"	3.50	11.30	24,860
Andrijevica	mHE "Šeremet potok"	0.80	3.46	7,612
Berane	mHE "Bistrica"	8.20 (8 SHPPs)	30.65	67,430
	Total	**368.10**	**876.31**	**1,927,882**

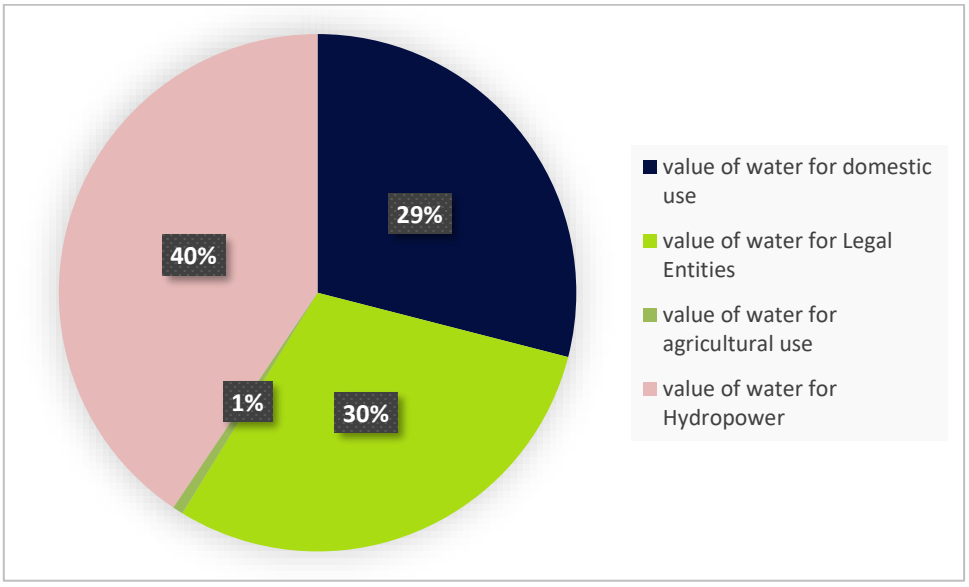
[199] Strategija upravljanja vodama crne gore - 2017

[200] World Bank: Support to water resources management in the drina river basin: montenegro – IWRM study and plan – background paper -volume 1 – main report - 2016

8.6 The value of water – summary

Taking the above data into consideration (i.e. domestic, legal entities, agricultural and non-abstractive water use), Figure 8.2 illustrates the structure of water in the Danube River Basin.

Figure 8.2 The structure of value of water by source in the Danube River Basin

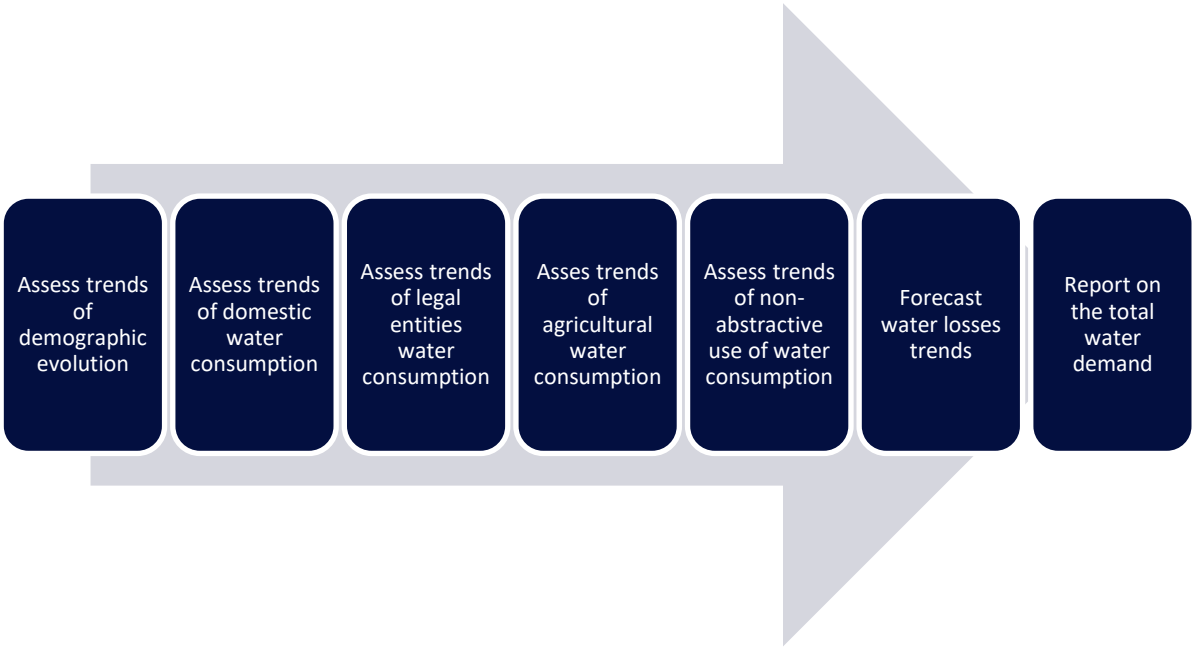


8.7 Trend Projections

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 8.3. 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 8.3 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. The area of DRB includes all or part of 13 municipalities of the Northern region. Gusinje and Petnjica are newly created municipalities in Montenegro. Gusinje was previously part of Plav in 2015, while Petnjica was previously part of Berane in 2014. The previous sections of this survey dealt with 2011 Census data which didn't include both municipalities since no data as cadastral maps, water tariffs, etc. yet exist for these areas.

Regarding territory, the largest administrative unit is the Municipality of Pljevlja with 1,346 km^2, followed by the municipality of Bijelo Polje with 924 km^2. The smallest complete municipal area is Andrijevica, with just 283 km^2.

The Danube River Basin is characterized by mountain areas with a low population density of on average 20 inhabitants/km^2. Extremely low population density is noted in the municipalities of Šavnik and Plužine, which is less than 5 inhabitants/km^2, while Žabljak and Kolašin have less than 10 inhabitants/km^2. The highest population density is in the Municipality of Berane(51 inh/km^2), followed by the Municipality of Bijelo Polje (50 inh/km^2).

8.7.1 Existing demographic situation and projections

According to an estimation made in 2017[201], birth rates are generally 10/1000 inhabitants[202] while deaths were 11.8/1000 inhabitants[203], implying an overall declining population in the basin.

[201] Monstat, Estimated number of population in municipalities mid year - 2017

[202] CIA World Factbook

[203] World Bank: Support to water resources management in the Drina River Basin: Montenegro – IWRM study and plan – background paper -volume 1 – main report - 2016

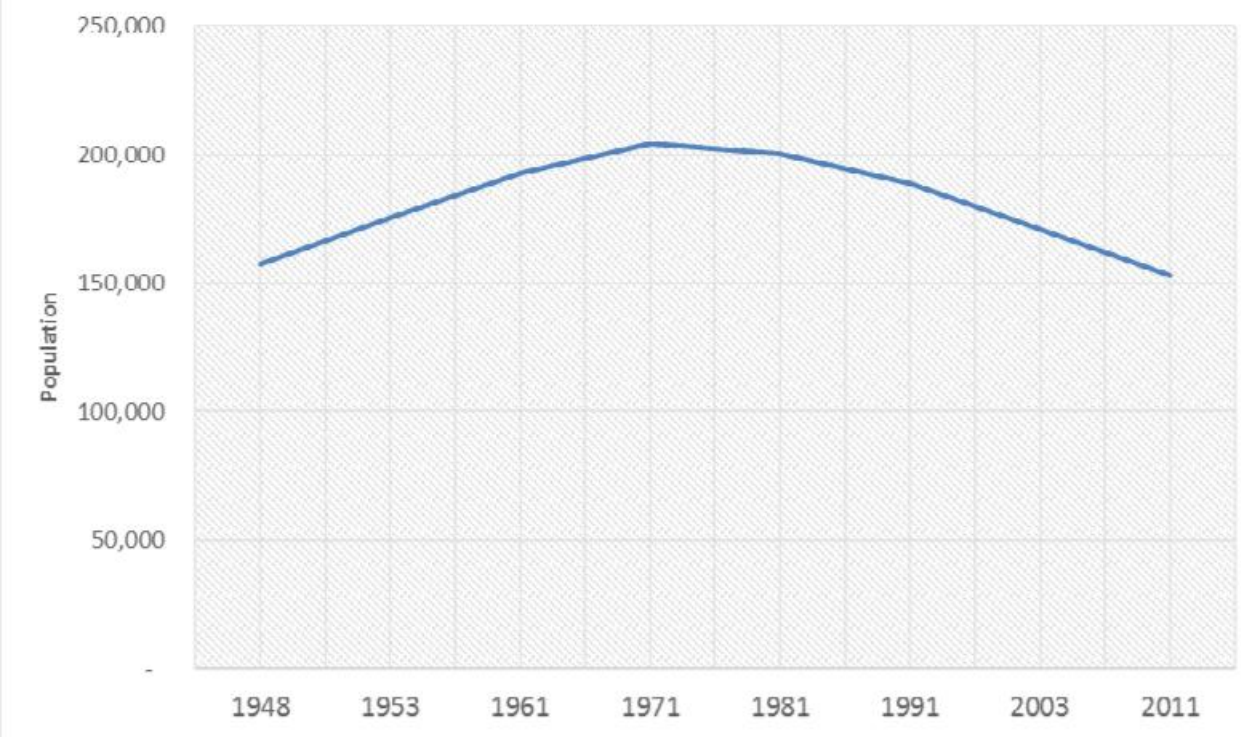
Table 8.20 Current 'estimated' population in the Danube River Basin (2018)

Municipality	Population (Number of Inhabitants)	N⁰ of Settlements	Municipal Surface Area km²
Andrijevica	5,071	24	283
Berane	33,970	66	544
Bijelo Polje	46,051	137	924
Žabljak	3,569	27	445
Kolašin	8,380	67	897
Mojkovac	8,622	15	367
Plav	13,108	23	328
Plužine	3,246	154	854
Pljevlja	30,786	42	1346
Rožaje	22,964	26	432
Šavnik	2,070	27	553
Gusinje	3,894	NA	157
Petnjica	5,215	NA	173
Total	**186,946**	**608**	**7,303***

*Not directly attributable to the Danube River Basin surface area.

In the period from 1948 to 1971, the population of the municipalities in the Danube River Basin increased steadily, reaching the value of 204,000 inhabitants in 1971 (according to the 1971 Census). After 1971, the decreasing trend started and it lasts until today as reflected in the 2011 Census. The Census 2011 noted the lowest number of inhabitants in the area of Danube River Basin in Montenegro since 1948. This is a cause for concern for the long-term sustainability of the basin.

Figure 8.4 Demographic evolution in the Danube River Basin between 1948 and 2011[204]



Monstat survey "Projekcije stanovništva Crne Gore do 2060. godine sa strukturnom analizom stanovništva Crne Gore" 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

Table 8.21 Demographic projections – Danube River Basin (Northern Montenegro)[205]

Projection variant	Hypothesis			Growth index (2061)
	Fertility	Mortality	Migrations	
Low fertility	Low	Expected	Expected	72
Mean fertility	Mean	Expected	Expected	80.5
High fertility	High	Expected	Expected	87.6
Constant mortality	Mean	Constant	Expected	71.4
Zero migration balance	Mean	Expected	Zero migration balance	101.4

These scenarios do not take into consideration NRW, which is assumed to improve in the future. The declining population in the Danube River Basin is a tangible issue, evidenced by the increasing number of abandoned dwellings in more remote villages. There is no evidence to suggest that this decline will change.

[204] World Bank: SUPPORT TO WATER RESOURCES MANAGEMENT IN THE DRINA RIVER BASIN: MONTENEGRO – IWRM STUDY AND PLAN –BACKGROUND PAPER -VOLUME 1 – MAIN REPORT - 2016

[205] MONSTAT: Projekcije stanovništva Crne Gore do 2060. godine sa strukturnom analizom stanovništva Crne Gore

8.7.2 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 industrial, commercial and institutional (legal entities) water consumption trends are driven by the changes in economic activity (new industries, new technologies, volume of production, employment, etc.). As no relevant and reliable data were available regarding these changes in the region, the economic activity was considered to be static in the next period.

Industrial demand also appears to be flat and there is no sign of any upturn in industrial activity in the basin. 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. There could be small increases in demand from tourism, but this is not expected to be significant. Hydropower could also influence water use, but the water is likely to be retained within the river system.

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 217 l/c/d in the year 2031 and 2061;
- Animal farm water use (2.4 Mm3/year in 2014) is excluded from these estimations;
- The industrial and agricultural water demand will be considered to be constant until the year 2061, as no any data are available regarding changes in this area

Based on the above assumptions, the following trends in domestic, industrial and agricultural water consumption were identified in the river basin:

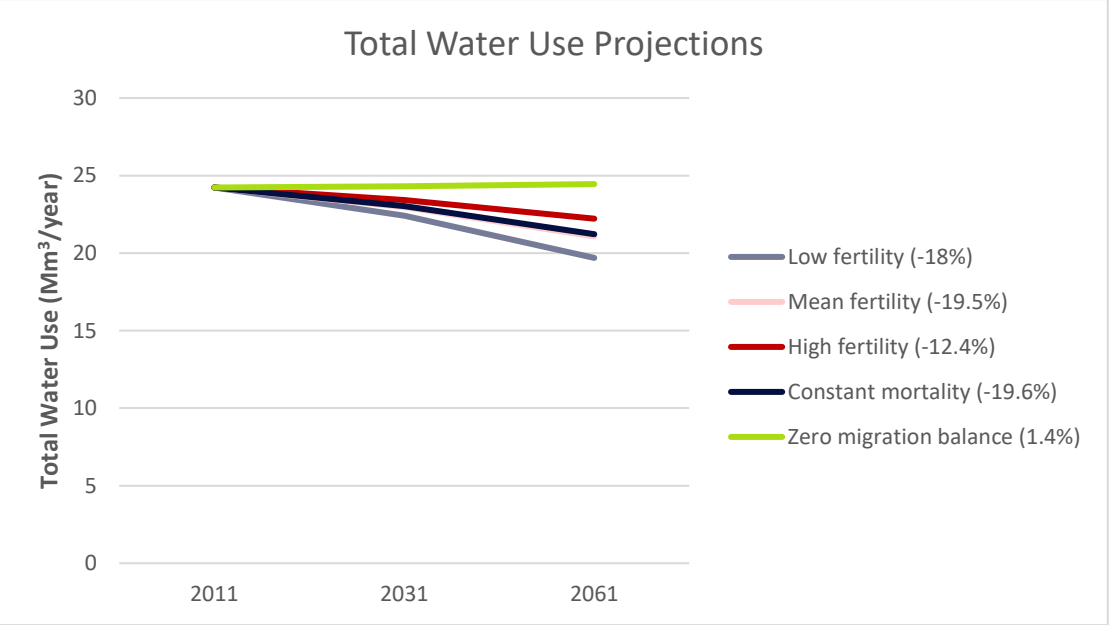
Table 8.22 Future Total Water Use Projections in the Danube River Basin

Scenario	Domestic (Mm^3/year)			Industrial (Mm^3/year)			Agricultural (Mm^3/year)			Total Water Use (Mm^3/year)		
	2011	2031	2061	2011	2031	2061	2011	2031	2061	2011	2031	2061
Low fertility (-18%)	16.2	14.38	11.66	3.43	3.43	3.43	4.6	4.6	4.6	24.23	22.41	19.69
Mean fertility (-19.5%)	16.2	14.94	13.04	3.43	3.43	3.43	4.6	4.6	4.6	24.23	22.97	21.07
High fertility (-12.4%)	16.2	15.40	14.19	3.43	3.43	3.43	4.6	4.6	4.6	24.23	23.43	22.22
Constant mortality (-19.6%)	16.2	15.00	13.19	3.43	3.43	3.43	4.6	4.6	4.6	24.23	23.03	21.22
Zero migration balance (1.4%)	16.2	16.29	16.42	3.43	3.43	3.43	4.6	4.6	4.6	24.23	24.32	24.45

Most of the available data suggest that the actual water use within the Danube River Basin will be somewhere between Low fertility and Mean fertility scenarios with overall water use varying between 22.41-22.97 Mm^3/year in 2031 and 19.69-21.1 Mm^3/year in 2061. Animal farm water use (2.4 Mm3/year in 2014) is excluded from these estimations (Figure 8.5).

The trend is decreasing due to the decrease of domestic consumption as the ICI and agricultural consumptions were considered to be constant during the period. As this assumption was taken in the lack of better available data, if any ICI or agricultural developments will be recorded in the river 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 8.5 Trends in domestic, ICI and agricultural water consumption in the Danube River Basin



8.8 Non-abstractive water consumption trends

8.8.1 Hydropower

The potential for new hydropower schemes is high in Montenegro. However, severe environmental dispositions have reduced considerably the portfolio of implementable projects. Out of the many imagined new HPPs in Montenegro, only six have reasonable chances of being implemented. Three are located along the Ćehotina River, two on the Lim River and one on the Piva/Komarnica River (with inter-basin water transfer). The total additional generation capacity would amount to 284 MW, for a total expected energy production of 571 GWh. Three scheme are of the non-diversion type (HPP in immediate dam vicinity), three of the diversion type (with conduits up to 6.2 km).

The total investment to activate for the realization of these six projects would reach 565 million Euros.[206]

8.8.2 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 Danube River Basin; and some farms possess the potential to increase their current capacity as long as water resources are available. Lakes and reservoirs present an option for appropriately located cage operations (such as Piva Lake) that would not have issues with continuous water supply. 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

[206] World Bank: SUPPORT TO WATER RESOURCES MANAGEMENT IN THE DRINA RIVER BASIN: MONTENEGRO – IWRM STUDY AND PLAN –BACKGROUND PAPER -VOLUME 1 – MAIN REPORT - 2016

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).

8.9 Water returns

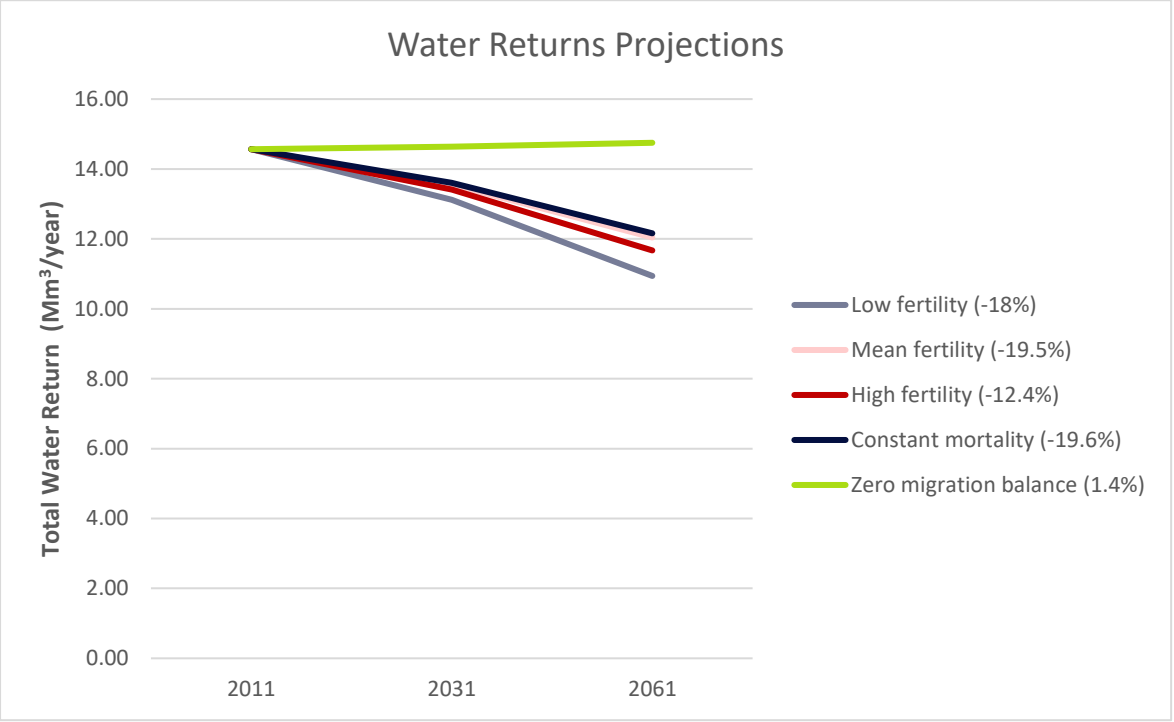
The assumption regarding water returns to the basin (through surface water or to the groundwater) are as follows:

- 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 8.23 Future Water Returns in the Danube River Basin

Scenario	Domestic (Mm^3/year)			Industrial (Mm^3/year)			Irrigation (Mm^3/year)			Total Water Return (Mm^3/year)		
	2011	2031	2061	2011	2031	2061	2011	2031	2061	2011	2031	2061
Low fertility (-18%)	12.96	11.51	9.33	0.69	0.69	0.69	0.92	0.92	0.92	14.57	13.12	10.94
Mean fertility (-19.5%)	12.96	11.95	10.43	0.69	0.69	0.69	0.92	0.92	0.92	14.57	13.56	12.04
High fertility (-12.4%)	12.96	11.80	10.06	0.69	0.69	0.69	0.92	0.92	0.92	14.57	13.41	11.67
Constant mortality (-19.6%)	12.96	12.00	10.55	0.69	0.69	0.69	0.92	0.92	0.92	14.57	13.61	12.16
Zero migration balance (1.4%)	12.96	13.03	13.14	0.69	0.69	0.69	0.92	0.92	0.92	14.57	14.64	14.75

Figure 8.6 Projections of future water returns in the Danube River Basin



8.10 Net Water Use

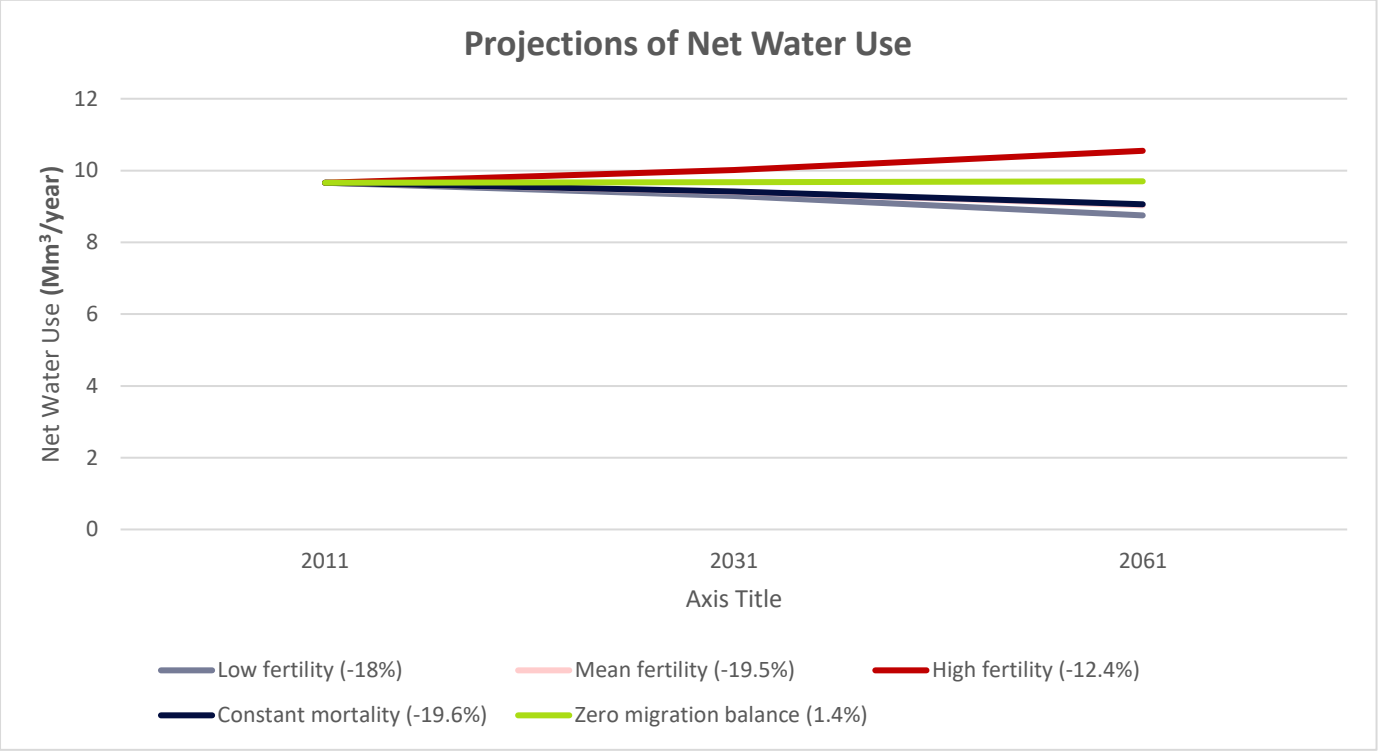
Net water use is arrived by subtracting the water returns (Table 8.23) from the gross water use (Table 8.22). The results are shown in the Table 8.24 below. If we assume that the actual net water use evolution will lie somewhere between the "Low fertility scenario" and the "Mean fertility scenario", net water use should vary between 9.3 – 9.41 Mm³/year in 2031 and 8.75 – 9.03Mm³/year in 2061. Animal farm water use is still excluded from these estimations. In the next sections of this chapter we will consider only Low and Mean fertility scenarios, which we highlighted as the most probable for the Danube River Basin.

Table 8.24 Future Net Water Use Projections in the Danube River Basin

Scenario	Domestic (Mm³/year)			Industrial (Mm³/year)			Irrigation (Mm³/year)			Total Water Use (Mm³/year)		
	2011	2031	2061	2011	2031	2061	2011	2031	2061	2011	2031	2061
Low fertility (-18%)	3.24	2.876	2.33	2.74	2.74	2.74	3.68	3.68	3.68	9.66	9.3	8.75
Mean fertility (-19.5%)	3.24	2.988	2.61	2.74	2.74	2.74	3.68	3.68	3.68	9.66	9.41	9.03
High fertility (-12.4%)	3.24	3.596	4.13	2.74	2.74	2.74	3.68	3.68	3.68	9.66	10.02	10.55

Constant mortality (-19.6%)	3.24	3	2.64	2.74	2.74	2.74	3.68	3.68	3.68	9.66	9.42	9.06
Zero migration balance (1.4%)	3.24	3.256	3.28	2.74	2.74	2.74	3.68	3.68	3.68	9.66	9.68	9.7

Figure 8.7 Projections of future net water use in the Danube River Basin



8.11 Non-Revenue Water

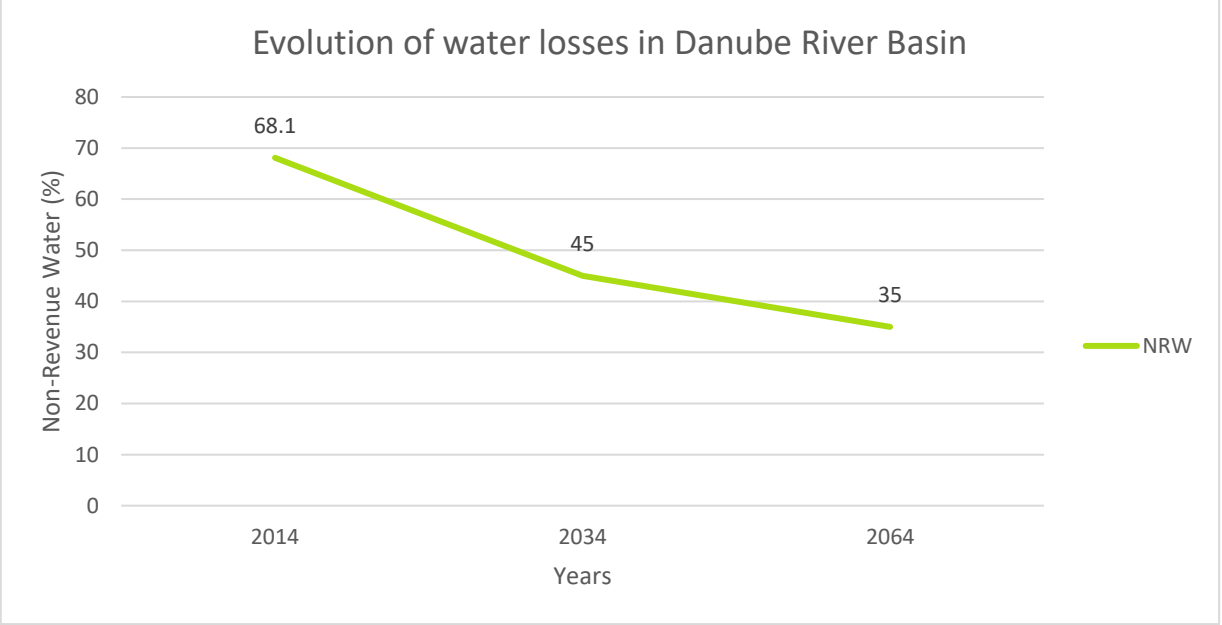
This net water use projection assumes that the level of Non-Revenue Water[207] will remain constant over the projection period. As we mentioned earlier, the main reasons for this large gap are deficiencies in the water transport network (technical losses) as well as unregistered and illegal connections 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 68.1 % in the Danube River Basin.

[207] The term Non-revenue water (NRW) and water losses are used interchangeably throughout the chapter due to data limitations. The water balance typically contains the following categories: billed authorized consumption, unbilled authorized consumption, commercial losses and technical losses. However, the source of data at the disposal of the team (Annual report on water use in Montenegro from 2016), did not allow for accurate differentiation between these categories, but rather billed consumption and other. Consultant is aware that when referring to the unbilled consumption as water losses, there is the portion of unbilled authorized consumption which is incorrectly classified as a water loss.

Assuming no investment is done in Water Supply infrastructures until 2064 (the NRW values), the estimated projections of future net water use in the Danube River Basin will remain as above. However, it is highly unlikely that the water losses will remain steady in the Danube River 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 Danube River 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 2034 and 35% in 2064. 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 8.8 Assumed trajectory of the share of NRW



8.12 Total water demand trends in the river 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. Due to the similar trends of the consumption and the water losses, both decreasing, major changes in the total water demand were identified in the river basin. We expect quite sizeable decrease in the total net water demand of water in the Danube River Basin, within the 2031 - 2061 time horizon.

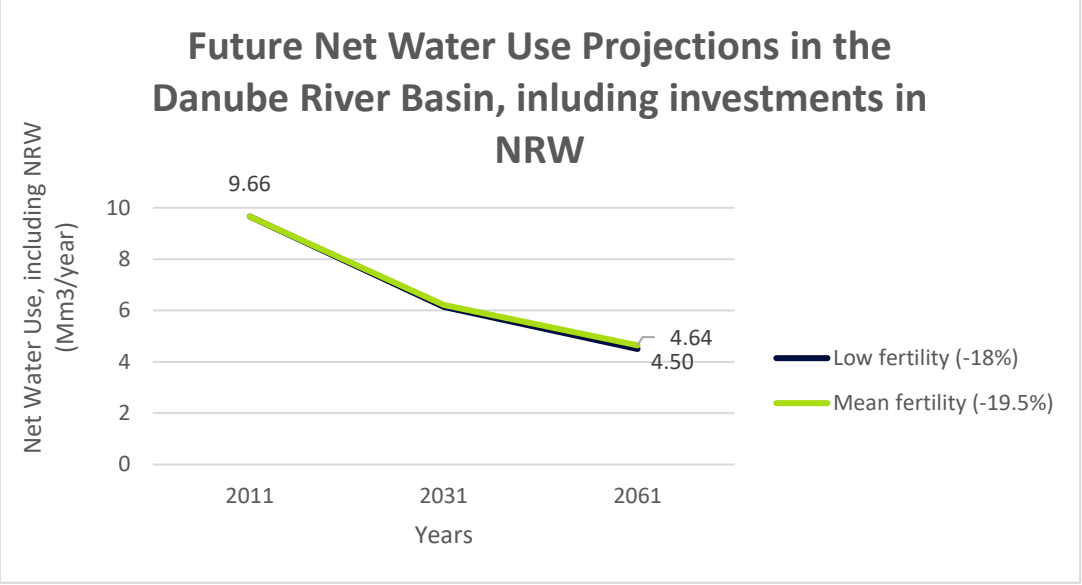
These are the key assumptions behind this expectation:

- Low fertility (i.e. -18%) or Mean fertility (i.e. -19.5%) 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 8.25 Future Net Water Use Projections in the Danube River Basin, including NRW investments assumptions

Scenario	Net Water Use (Mm^3/year)		
	2011 (NRW = 68.1%)	**2031 (NRW = 45%)**	**2061 (NRW = 35%)**
Low fertility (-18%)	9.66	6.14	4.50
Mean fertility (-19.5%)	9.66	6.22	4.64

Figure 8.9: Projections of future net water use in the Danube River Basin, including investments from Public Water Utilities in NRW



The NRW volume is so big that even small reductions command large changes in the net water use for the Danube River Basin. The projection was based on the declining population trend in the basin, present from 1971 to date. In fact, the low fertility scenario projected net water use to be 9.66 Mm^3/year while it now stands at 6.14 Mm^3/year with the envisaged reduction of NRW from 60.27% to 40% going from 2011 to 2031. Further, in 2061, within the same scenario net water use is projected to be at 4.5 Mm^3/year which reflects further reduction of the share of NRW to 30%. Finally, in the Mean fertility scenario (assuming population growth of -19.5% for the period of 50 years) the projected net water use is 6.22 Mm3/year in 2031 and 4.64 Mm^3/year in 2061.

8.13 Cost Recovery of Water Services

The approach that was used for analyzing and reporting on cost recovery is according to the "Guidance Document No 1: Economics and the Environment – The Implementation Challenge of the Water Framework Directive"[208].

8.13.1 Identified water services in the River 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) waste water 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 Danube River 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

[208] http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

8.13.2 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.[209].

Municipalities in the central and northern region of Montenegro, region covering the Danube River Basin, have public enterprises in charge of water supply and sewerage exercising water supply and wastewater management activities, and public enterprises in 6 Municipalities of Andrijevica, Žabljak, Mojkovac, Plav, Plužine and Šavnik exercise other utility services in addition to 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[210].

The 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[211].

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.

[209] 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)

[210] Government of Montenegro, MSDT, Podgorica, September 2013, p. 6.

[211] 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 8.26 Water and wastewater service providers in the Danube River Basin

Municipality	Name of the company
Andrijevica	"VODOVOD I KANALIZACIJA" ANDRIJEVICA
Berane + Petnjica	"VODOVOD I KANALIZACIJA" BERANE
Bijelo Polje	VODOVOD "BISTRICA" BIJELO POLJE
Žabljak	"KOMUNALNO I VODOVOD" ŽABLJAK
Kolašin	"VODOVOD I KANALIZACIJA" KOLAŠIN
Mojkovac	"KOMUNALNE USLUGE - GRADAC" MOJKOVAC
Plav	"KOMUNALNE DJELATNOSTI" PLAV
Gusinje	"KOMUNALNE DJELATNOSTI" GUSINJE
Plužine	"KOMUNALNO PLUŽINE" PLUŽINE
Pljevlja	"VODOVOD" PLJEVLJA
Rožaje	"VODOVOD I KANALIZACIJA" ROŽAJE
Šavnik	"KOMUNALNE DJELATNOSTI" ŠAVNIK

8.14 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
- The number of industrial, commercial and institutional water and wastewater connections

Table 8.27 Population covered by the public water services in the Danube River Basin, 2014[212]

Municipality	Population (inhabitants)	Number of households	Households Connected to Public Water Supply (%)	Population Served by Public WS services	Households Connected to Public Sewerage System (%)	Population Served by Public WW services
Andrijevica	5,071	1,700	47	2383	12	609
Berane + Petnjica	33,970	9990	72	24,458	40	13,588
Bijelo Polje	46,051	13200	50	23,026	32	14,736
Žabljak	3569	1270	74	2641	26	928
Kolašin	8380	2850	53	4441	12	1006
Mojkovac	8622	2820	59	5087	30	2587
Plav + Gusinje	13,108	3740	54	7078	43	5636
Plužine	3246	1140	62	2013	55	1785
Pljevlja	30,786	10790	44	13,546	34	10,467
Rožaje	22,964	5680	54	12,401	42	9645
Šavnik	2070	700	29	600	15	311
Total	**177,837**	**53,880**	**58**	**103,145**	**37**	**66,617**

Around 58% of the Danube River Basin households are connected to Public Water Supply. While, only 37% of the Danube River Basin households is covered by sewage collection systems. Legal entites on the other hand are fully connected to water supply system, while sewage coverage is over 95%. A very low proportion of the population have sewer connections and there is only three WWTP operational in the Danube River Basin, i.e. in Mojkovac, Šavnik and Žabljak. All wastewater in other settlements flows to the rivers untreated. Another WWTP is being built at Berane and Pljevlja, with 6 more WWTPs planned in the tender stage.

[212] 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 8.28 Legal Entities and Agricultural water users in Danube River 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	
Andrijevica	5071	85	0	12	80
Berane + Petnjica	33,970	755	1	0	660
Bijelo Polje	46,051	872	0	13	791
Žabljak	3569	110	3	1	61
Kolašin	8380	144	0	15	169
Mojkovac	8622	232	3	3	227
Plav + Gusinje	13,108	300	0	0	714
Plužine	3246	53	0	290	32
Pljevlja	30,786	679	15	60	330
Rožaje	22,964	330	0	12	25
Šavnik	2070	30	0	11	90
Total	**177,837**	**3,590**	**439**		**3,179**

8.15 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 river 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, the utility companies in the municipalities of Andrijevica, Žabljak, Mojkovac, Plav, Plužine and Šavnik render communal services to its citizens other than water and wastewater related ones. These services are also not reported separately from one another 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. However, not all public utility companies' data was available. Data could not be obtained for the municipalities of Mojkovac, Plav, Plužine and Šavnik (i.e. those indicates with "*" in the Table 8.29). Their financial data was approximated using the total amount of supplied water corrected for the difference in the tariff level in case of revenues. All financial data shown below refers to the end of 2017.

Table 8.29 Financial costs for water and wastewater services in the Danube River Basin (2017)

Water & WWServices	Andrijevica	Berane + Petnjica	Bijelo Polje	Žabljak	Kolašin	Mojkovac	Plav + Gusinje *	Plužine*	Pljevlja	Rožaje	Šavnik*	Total
Operating and Maintenance costs												
Labor cost	44,396	373,735	637,151	218,124	183,631	63,054	97,394	21,627	980,171	297,655	4,846	**2,921,783**
Material costs (incl. Chemicals)	9,127	58,462	153,023	91,369	5,368	16,526	25,526	5,668	357,437	16,681	1,270	**740,457**
other costs	18,574	151,157	168,093	23,211	30,292	13,306	20,553	4,564	165,113	45,112	1,023	**640,998**
Capital Costs												
Capital Costs			19,496	11,376	64,221	2,694	4,161	924	11,077	7,399	207	**121,555**
Other financial expenses		2,903	8,532		1,059	490	757	168	8,571	973	47	**23,500**
Taxes and Subsidies												
Taxes and duties		1,395	19,594		6,697	616	951	211			47	**29,511**
	72,097	**587,652**	**1,005,889**	**344,080**	**291,268**	**96,685**	**149,342**	**33,162**	**1,522,369**	**367,820**	**7,440**	**4,477,804**

8.16 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.

Due to the relatively low industrial and agricultural activity in the area of the river basin and the availability of the water resources, no resource costs were identified in this analysis.

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.

In the river basin, there are some cases of water pollution due to the untreated wastewater discharges in the river. Unfortunately, due to the lack of trustworthy data, the value of these damage costs couldn't be estimated. 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.

Results of water quality analysis have indicated that the Ćehotina Sub Basin together with its tributary, Veţišnica, is the most polluted in Montenegro along with Lim. This is principally caused by industrial activity, the presence of Pljevlja TPP, the Pljevlja Coal Mine and the Šuplja stijena lead and zinc mine. The wastewater outfalls and sewage from Pljevlja city are also causing excessive contamination[213].

Limited hydrochemical analysis from 14 different spring sources in Danube River Basin has shown that the Ca/Mg mole ratio is affected by sources of pollution such as high nutrients from agriculture, untreated wastewater and sewage from settlements and some industrial discharge. Notwithstanding, the share of industrial output appears to be decreasing over the last decade due to the global economic downturn which implies a reduction in potential pollutants.

The dams have created lakes which change the water ecosystem (fast flowing waters become stagnant waters) now mostly inhabited by untypical species for this part of Danube River Basin. Dams have also created separate sections of the river, disturbing the normal fish migration routes which are causing some species to be lowered to undetectable level, especially for the Danube Salmon. The exploitation of the dams can also lead to fast fluctuation of the water level in the river downstream (hydro-peaking) or to significant variation of the water level of the reservoir. These water fluctuations create significant damages during breeding period, between March and May. Birds and bats living in cliffs are threatened by the creation of new dams and subsequent canyon flooding

[213] World Bank: SUPPORT TO WATER RESOURCES MANAGEMENT IN THE DRINA RIVER BASIN: MONTENEGRO – IWRM STUDY AND PLAN –BACKGROUND PAPER -VOLUME 1 – MAIN REPORT - 2016

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.). In the Danube River Basin, the minimal value varies between 1.3 and 2.1 m^3/s for Ćehotina River and between 1.1 and 13.7 m^3/sec for the Piva, Tara and Lim rivers. By far the greatest stress is on the Lim river which has the largest demand of EF.

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 decline compared with today due to decreasing population trend and the continual migration of people from the basin. We believe the actual water use within the Danube River Basin will be somewhere between the Mean fertility and Low fertility Scenarios, with overall water use around 24.3 Mm^3/year at present day, to 22.4-23 Mm^3/year in 2031 and 19.7-21.1 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 9.3-9.41 Mm^3/year in 2031 to between 8.75 Mm^3/Year and 9.03 in 2061.

Identified key drivers were:

- Water supply for the population,
- Water supply for agriculture (irrigation & livestock),
- Water supply for industry,
- Hydropower production,
- 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
- Avoid and/or better regulate gravel exploitation within riverbeds
- Build new sanitary landfill away from groundwater protection zones and from riverbeds
- Close existing landfills and move them away from riverbanks and flood plains
- The concept of flood protection to be coordinated

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. Measures will have to be implemented to modernize equipment to reduce water loss and to promote fish growth efficiency.

8.17 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%[214].

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 Danube River Basin. As we saw above, household tariffs go from 0.12 EUR/m3 in Šavnik to 0.52 EUR/m3 in Kolašin. 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 Danube River Basin are shown in Table 8.30.

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 portion of non-revenue water in the water supply system. Currently they are circulating around 68.1%.

[214] Montenegro: Environmental Performance Review (Third Review) – 2015 - UNECE

- 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 8.30 Tariffs applied by the water utilities in the Danube River Basin, 2014[215]

Municipality	Water services (€/m³)		Wastewater services (€/m³)		Total water and sewerage price (€/m³)		REVENUE COLLECTION (%)
	Households	Legal Entities	Households	Legal Entities	Households	Legal Entities	
Andrijevica	0.14	0.41	0.04	0.16	0.18	0.57	65
Berane + Petnjica	0.24	0.92	0.12	0.46	0.35	1.38	87.47
Bijelo Polje	0.39	1.35	0.19	0.67	0.58	2.02	57.4
Kolašin	0.52	1.57	0.27	0.79	0.79	2.36	66.06
Mojkovac	0.37	1.34	0.19	0.67	0.56	2	65
Plav + Gusinje	0.22	0.54 /0.75	0.11	0.27/0.375	0.33	0.81/1.12	NA
Pljevlja	0,34	1,22	0,14	0,52	0,48	1,74	100
Plužine	0.26	1.13	0.19	0.8	0.45	1.93	75.89
Rožaje	0.21	0.83	0.11	0.42	0.32	1.25	71
Šavnik	0.12	0.5	0.06	0.25	0.18	0.75	40
Žabljak	0,41	1,67	0,21	0,84	0,62	2.51	57

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 2012, the average municipal household tariff for water supply and sewerage amounted to €0.67 per m3, while the average tariff for legal entities was nearly three times as high at €1.87. Tariffs have nearly doubled in nominal terms since 2005, 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

[215] 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

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 8.31 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. Data were missing for the companies coming from municipalities of Mojkovac, Plav, Plužine and Šavnik. They were estimated using the differences in water supplied by these companies corrected for the tariffs in force and the revenue collection rates across water utility companies

Table 8.31 Revenues from water services in the Danube River Basin, 2017

Municipality	Revenue from water & wastewater services
	(€)
Andrijevica	19,892
Berane + Petnjica	552,760
Bijelo Polje	956,755
Žabljak	332,275
Kolašin	285,802
Mojkovac*	87,836
Plav + Gusinje *	135,674
Plužine*	30,127
Pljevlja	1,439,463
Rožaje	363,556
Šavnik*	6,750
Total	**4,210,891**

8.18 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 Danube 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 Danube River Basin, having different financial data, reports a different financial cost recovery rate. Table 8.32 below shows the aggregate financial cost-recovery at the level of the whole Basin.

Table 8.32 Financial cost recovery in the Danube River Basin, 2015

Financial Costs– Water and Wastewater	4,477,804€
Financial Revenues– Water and Wastewater	4,210,891€
Financial Cost recovery rate (%)	**94.0 %**

Financial cost recovery is very high – at 94%. 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 but the following corrections were applied:

- 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. Bijelo Polje, Berane and Pljevlja) 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 8.33 below.

Table 8.33 Economic cost recovery in the Danube River Basin, 2015

Economic Costs	
Expenditure item	**Operating and Maintenance costs**
Labor cost	2,030,639
Material costs (incl. Chemicals)	592,366
other costs	512,798
	Capital Costs
Capital Costs	97,244
	Administrative Costs
Other expenses	18,800
	Taxes and Subsidies
Taxes and duties	0
Total Economic Cost	**3,251,847**
Economic Revenues	
Total Economic Revenues	**2,526,535**
Economic Cost Recovery Rate	
77.7%	

The result of the adjustment of financial figures to reflect the economic context is that the cost-recovery percentage dropped from 94% to 77.7% 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.

8.19 Conclusions

This section represents an analytical effort aimed at gathering relevant data on the Danube River Basin and putting it 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 Danube River Basin. This section of the report offers a summary with key observations and the resulting recommendations for future actions.

There are tremendous losses incurred in the water supply system all across the Danube 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 68.1%[216]. 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 or commercial losses). Such high level (i.e. European average is in the range between 10% and 25%) puts enormous pressure on local utility companies. Naturally, **both**

[216] Water losses should exclude the authorized unbilled consumption. Due to data unavailability, the water losses estimated here encompass this category. Hence, the losses may be overestimated for this amount.

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 Danube River 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. 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 77.7% 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.

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 Danube River Basin based on pressure and risk analysis and in-field surveillance monitoring (Sections 4 and 7, respectively).

The clarification of the environmental objectives for the river basin provides a clear focus for management with regard to attaining the agreed goals[217], which are in line with the UN Sustainable Development Goals[218]. 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 exemptions:

- 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

[217] Environmental objectives under the Water Framework Directive, Water Directors' meeting on 20 June 2005 in Mondorf-les-Bains

[218] https://sustainabledevelopment.un.org/sdgs

- 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
- 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 Danube 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[219].

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 and indicators for the Danube River Basin are presented in Table 9.1.

Table 9.1 Proposed environmental objectives, actions and indicators for the Danube River Basin

Environmental Objective/Actions	Measurable Units[220]
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

[219] Stra Tegija Upra Vljanja Vodama Crne Gore, December, 2015

[220] 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[220]
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
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)

Environmental Objective/Actions	Measurable Units[220]
4. Reducing the adverse effects of floods on human health, the environment, cultural heritage and the economy [221]	
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

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. 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; 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; 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; (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.

[221] Implementation of the Floods Directive is the focus of EU assistance project, which will run from 2019-2022

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 9.3. 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

Issue	Considerations
	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.
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. 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[222].

Table 9.4 shows that out of the 48 surface water bodies, 17 can be considered for exemption but solely based on the need for extended deadlines in order to reach good status. Where SHPPs are indicated as causing pressure on the surface water bodies, mitigation measures are judged to be possible in the mid-term in order to ensure good status.

One surface water body, Piva (SWB 15), is judged to be unable to reach the good status by 2033 since the river is under pressure from hydropeaking. 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 (Pljevlja basin) is judged not to be able to meet its objective until 2033 due to point source pollution arising from the coal mine at Pljevlja and the TE Plant, which may be disproportionately expensive to remedy. However, in this case, the burden of cost is the responsibility of the industry.

[222] 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[223]

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							
6.	ME_DB_GGW_C_1 (Maoče)	No	Yes	Yes	No		
7.	ME_DB_GGW_I_1 (Pljevlja Basin)	No	Yes	Yes	Yes	Yes	No
10.	ME_DB_GGW_C_2 (Beranska Bistrica – Ljubovića)	No	Yes	Yes	No		
13	ME_DB_GGW_K_10 (Gornji Ibar)	No	Yes	Yes	No		
Surface Water Bodies							
1.	Opasanica / Verušica	Yes[224]	Yes	Yes	No		
3.	Tara_2	No	Yes	Yes	No		
5.	Tara_3	No	Yes	Yes	No		
7.	Tara_4	No	Yes	Yes	No		
18.	Piva	No	Yes	No	Yes	No	Yes
23.	Plavsko Lake	No	Yes	Yes	No		

[223] '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.

[224] Although technically feasible, the reduction of erosion, which is the consequence of foresty activities would be disproportionaltely expensive in the short term.

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
24.	Lim_1	No	Yes	Yes	No		
25.	Komarača	No	Yes	Yes	No		
27.	Lim_2	No	Yes	Yes	No		
28.	Bistrica	No	Yes	Yes	No		
33.	Bistirca (Lj)	No	Yes	Yes	No		
34.	Lim_3	No	Yes	Yes	No		
36.	Bistrica (L)_2	No	Yes	Yes	No		
39.	Ibar_2	No	Yes	Yes	No		
44.	Ćehotina_4	No	Yes	No	Yes	Yes	No
45.	Vezišnica	No	Yes	Yes	No		
46.	Ćehotina_5	No	Yes	Yes	No		
48.	Ćehotina_6	No	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 10.2) 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[225]

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

[225] 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.

Information on **each individual measure is provided in this section,** 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 27 'supplementary measures', all of which are grouped according to priority, indicated as either as high, medium or low. Of the basic measures, 21 are classed 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 DB MNE 1 -52 below indicate the compentent authority for each specific measure together with other relevant authorities.

Table 10.3 List of measures proposed for the Danube River Basin

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
DB MNE 01	Reduction of sediment from soil erosion and surface run-off in Tara river spring area (Komovi massif)	3		x	Opasanica / Verušica	Podgorica	40k
DB MNE 02	Measures to prevent or control the input of pollution from urban areas, transport and built infrastructure in region of Opasanica / Verušica WB	2		x	Opasanica / Verušica	Podgorica	50k
DB MNE 03	Improvement of aquaculture in order to reduce nutrient and organic matter loading in region of Opasanica / Verušica WB	3		x	Opasanica / Verušica	Podgorica	15k
DB MNE 04	Improving of hydromorphological conditions of Tara_2 WB bodies other than longitudinal continuity	1	x		Tara_2	Kolašin	250-500k
DB MNE 05	Construction of wastewater treatment plants for Kolašin municipality	1	x		Tara_3	Kolašin	6.6M
DB MNE 06	Construction of communal waste transfer station for Kolašin municipality	1	x		Tara_3	Kolašin	400k
DB MNE 07	Control of adverse impacts of recreation in Kolašin municipality	3		x	Tara_3	Kolašin	52k
DB MNE 08	Construction of sewer system for Mojkovac municipality	1	x		Tara_4	Mojkovac	2.2M

[226] Priorities are classified as either 1- high priority, 2 – medium priority or 3 – low priority

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
DB MNE 09	Study/research on upgrade or improvements of industrial wastewater treatment plants (including farms) in Mojkovac municipality	2		x	Tara_4	Mojkovac	35k
DB MNE 10	Construction of communal waste transfer station for Mojkovac municipality	1	x		Tara_4	Mojkovac	480k
DB MNE 11	Control the adverse impacts of recreation in Mojkovac municipality	3		x	Tara_4	Mojkovac	52k
DB MNE 12	Construction of wastewater treatment plants for Plav/Gusinje municipalities	1	x		Plavsko Lake	Plav /Gusinje	9.229M
DB MNE 13	Reduce sediment from soil erosion, surface run-off and prevent sediment loading in Plavsko Lake	2	x		Plavsko Lake	Plav /Gusinje	-[227]
DB MNE 14	Construction of wastewater treatment plants for Andrijevica municipality	1	x		Lim_1 Beranska Bistrica – Ljubovića GWB	Andrijevica	4.66M
DB MNE 15	Construction of communal waste transfer station for Andrijevica municipality	1	x		Lim_1 Beranska Bistrica – Ljubovića GWB	Andrijevica	180k

[227] Costs dependent on other measures

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
DB MNE 16	Upgrades or improvements of industrial wastewater treatment plants (including farms) in Plav and Andrijevica municipality	2		x	Lim_1 Beranska Bistrica – Ljubovića GWB	Plav/Andrijevica	35k
DB MNE 17	Study/research on reduction of sediment from soil erosion and surface run-off in Plav and Andrijevica municipality	3		x	Lim_1	Plav/Andrijevica	40k
DB MNE 18	Improving longitudinal continuity on Komarača surface WB	2	x		Komarača	Plav	80k
DB MNE 19	Improvements in flow regime and/or establishment of ecological flows on Komarače surface WB	2	x		Komarača	Plav	50k
DB MNE 20	Construction of communal waste transfer station for Plav municipality	1	x		Komarača	Plav	320k
DB MNE 21	Construction of wastewater treatment plants for Berane municipality	1	x		Lim_2 Beranska Bistrica – Ljubovića GWB	Berane	10.98M
DB MNE 22	Construction of communal waste transfer station for Berane municipality	1	x		Lim_2 Beranska Bistrica – Ljubovića GWB	Berane	2.88M

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
DB MNE 23	Study/research on upgrade or improvements of industrial wastewater treatment plants (including farms) in Berane municipality	2		x	Lim_2 Beranska Bistrica – Ljubovića GWB	Berane	35k
DB MNE 24	Study/research on reduction of sediment from soil erosion and surface run-off in Berane and Bijelo Polje municipality	3		x	Lim_2	Berane / Bijelo Polje	40k
DB MNE 25	Control the adverse impacts of recreation in Berane municipality	3		x	Lim_2	Berane	15k
DB MNE 26	Improving longitudinal continuity on Bistirca surface WB	1	x		Bistrica	Berane	80k
DB MNE 27	Improvements in flow regime and/or establishment of ecological flows on Bistrica surface WB	1	x		Bistrica	Berane	50k
DB MNE 28	Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Bistrica WB	2		x	Bistrica Beranska Bistrica – Ljubovića GWB	Berane	140k
DB MNE 29	Improving longitudinal continuity on Bistirca (Lj) surface WB	1	x		Bistrica (Lj)	Bijelo Polje	20k
DB MNE 30	Improvements in flow regime and/or establishment of ecological flows on Bistrica (Lj) surface WB	1	x		Bistrica (Lj)	Bijelo Polje	50k
DB MNE 31	Construction of wastewater collection and wastewater treatment plants for Bijelo Polje municipality	1	x		Lim_3	Bijelo Polje	40M

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
DB MNE 32	Study/research on upgrade or improvements of industrial wastewater treatment plants (including farms) in Bijelo Polje municipality	2		x	Lim_3	Bijelo Polje	35k
DB MNE 33	Construction of communal waste landfill, regional and for Bijelo Polje municipality	1	x		Lim_3	Bijelo Polje	15.3M
DB MNE 34	Remediation of contaminated sites within Bijelo Polje municipality	2		x	Lim_3	Bijelo Polje	45k
DB MNE 35	Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Lim_3 WB	3		x	Lim_3	Bijelo Polje	40k
DB MNE 36	Control the adverse impacts of recreation in Bijelo Polje municipality	3		x	Lim_3	Bijelo Polje	15k
DB MNE 37	Water efficiency, implementation of technical measures for irrigation, aquaculture, energy and households water sharing in Bistrica (L)_2 WB	3		x	Bistrica (L)_2	Bijelo Polje	14k
DB MNE 38	Reduction of nutrient and organic matter loading in fish farms of Bistrica (L)_2 WB	2		x	Bistrica (L)_2	Bijelo Polje	15k
DB MNE 39	Construction of wastewater treatment plants for Rožaje municipality	1	x		Ibar_2 Gornji Ibar GWB	Rožaje	12.10M

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
DB MNE 40	Study/research on upgrade or improvement of industrial wastewater treatment plants (including farms) in Rožaje municipality	2		x	Ibar_2 Gornji Ibar GWB	Rožaje	35k
DB MNE 41	Construction of communal waste transfer station for Rožaje municipality	1	x		Ibar_2 Gornji Ibar GWB	Rožaje	480k
DB MNE 42	Remediation of contaminated sites within Rožaje municipality	2		x	Ibar_2 Gornji Ibar GWB	Rožaje	45k
DB MNE 43	Control the adverse impacts of recreation in Rožaje municipality	2		x	Ibar_2	Rožaje	15k
DB MNE 44	Construction of wastewater treatment plants for Pljevlja municipality	1	x		Ćehotina_4 and Ćehotina_5 Pljevlja Basin GWB Maoče GWB	Pljevlja	6M
DB MNE 45	Upgrades or improvements of industrial wastewater treatment plants (including farms) in Pljevlja municipality	1		x	Ćehotina_4 and Ćehotina_5 Pljevlja Basin GWB Maoče GWB	Pljevlja	35k
DB MNE 46	Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of	1		x	Ćehotina_4	Pljevlja	60k

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
	emissions, discharges and losses of Priority Substances in Ćehotina_4 WB				Pljevlja Basin GWB		
DB MNE 47	Remediation of contaminated sites within Ćehotina_4 WB	2		x	Ćehotina_4 and Ćehotina_5 Pljevlja Basin GWB	Pljevlja	45k
DB MNE 48	Improving hydromorphological conditions of Ćehotina_4 WB (other than longitudinal continuity)	3	x		Ćehotina_4	Pljevlja	20M[228]
DB MNE 49	Study/research on upgrade or improvement of industrial wastewater treatment plants (Thermo plant – Pljelvja)	1		x	Vezišnica Pljevlja Basin GWB	Pljevlja	75k
DB MNE 50	Remediation of contaminated sites within Ćehotina_6 WB (Jalovište Gradac)	2		x	Ćehotina_6 Pljevlja Basin GWB	Pljevlja	50k
DB MNE 51	Upgrades or improvements of industrial wastewater treatment plants (“Šuplja Stijena” Mine)	1		x	Ćehotina_6	Pljevlja	30k

[228] Investment expected only in the longer term.

ID (preliminary)	Measure	Priority [226]	Type of Measure		Related Water Bodies (Surface & Groundwater)	Municipality	Indicative Costs (EURO)
			Basic	Supplementary			
					Pljevlja Basin GWB		
DB MNE 52	Improving longitudinal continuity of Ćehotina_6 WB (downstream of Jalovište Gradac)	1		x	Ćehotina_6 Pljevlja Basin GWB	Pljevlja	30k

Characteristics		Reduction of sediment from soil erosion and surface run-off in Tara river spring area (Komovi massif)	ID DB MNE 01
Location	Municipality	Podgorica	
	Water body	Opasanica / Verušica	
	Watercourse	Opasanica / Verušica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Sediment flushing from surrounding mountain area	
	Key Type of Measure	KTM17	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Reduction of sediment from soil erosion and surface run-off in Tara river spring area (Komovi massif)**	
Production of study and action plan of forestry within this region with attention on sustainable forestry and afforestation activities in order to reduce soil erosion from surrounding mountain slopes.		
Project Investor	Municipality of Podgorica	
Investment Costs	40,000 EURO	
Maintenance Costs	There is no maintenance coast. This action would constitute a 3-Year duration measure. Year 1 for production of study and action plan and Years 2 and 3 for afforestation activities.	
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); Podgorica Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium	
Other Remarks	Reduction of sediment flushing by afforestation areas in surrounding mountain region (Forestry)	
Priority (first / second / third)	Third	

Characteristics		Measures to prevent or control the input of pollution from urban areas, transport and built infrastructure in region of Opasanica / Verušica WB	ID DB MNE 02
Location	Municipality	Podgorica	
	Water body	Opasanica / Verušica	
	Watercourse	Opasanica / Verušica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Water flushing of solid waste, waste water and construction materials	
	Key Type of Measure	KTM21	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Reduction of input of pollution from settlement areas, transport and built infrastructure**

Study/research on Veruša and other regional settlements impacts on this WB. The study/research should find best possible and the most effective solutions in order to improve of solid waste and waste water management, and to secure strict enforcement of construction related regulation. Recommendations would be implemented through a sunsequent phase.

Project Investor	Municipality of Podgorica	
Investment Costs	150,000 EURO	
Maintenance Costs	There are no maintenance costs. This is at least two-year duration complex measure. It consists of several activities: study /research and construction related regulation enforcement.	
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); Podgorica Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium	
Other Remarks	Measure/activities were not considered during spatial planning of this area.	
Priority (first / second / third)	Third	

Characteristics		Improvement of aquaculture in order to reduce nutrient and organic matter loading in region of Opasanica / Verušica WB	ID DB MNE 03
Location	Municipality	Podgorica	
	Water body	Opasanica / Verušica	
	Watercourse	Opasanica / Verušica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Supplementary 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
	Other		

Description of the Measure	**Reduction of Nutrient and organic matter loading from the fish farms**	
Precise calibration of feeding regime in order to minimize organic matter loading. Balancing of diet. Upgrading of filtration/precipitation in fish farm releasing waters system.		
Project Investor	Privat companies, fish-farm owners, Ministry of Agriculture and Rural Development (MARD)	
Investment Costs	15,000 EURO	
Maintenance Costs	Not exceeding 1,000 EURO per fish farm per 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 Water Administration (WA); Podgorica Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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)	Second	

Characteristics		Improving of hydromorphological conditions of Tara_2 WB body other than longitudinal continuity.	ID DB MNE 04
Location	Municipality	Kolašin	
	Water body	Tara_2	
	Watercourse	Tara River	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Destruction of Tara riverbed due to Highway construction	
	Key Type of Measure	KTM6	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Riverbed restoration toward original condition before highway construction (as much as it is possible)**	
The riverbed of Tara river in WB Tara_2 is physically changed due to highway construction. Once the highway construction is finished, the contracting company need to remove all the remains of material as well as to bring back this Tara river sector in original condition.		
Project Investor	Chine Road and Bridge Corporation (CRBC)	
Investment Costs	250,000 - 500,000 EURO	
Maintenance Costs	There are 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 Kolašin Municipality	
Status of Implementation (Operation and Maintenance)	Conditions of EIA	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant	
Other Remarks	This WB status depends on this measure and if it will be applied correctly Tara_2 WB will be removed from HMWB status in to GOOD status.	
Priority (first / second / third)	First	

Characteristics		Construction of wastewater treatment plants for Kolašin municipality	ID DB MNE 05
Location	Municipality	Kolašin	
	Water body	Tara_3 Komovi GWB	
	Watercourse	Tara River	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	No wastewater treatment for Kolašin municipality and therefore discharges are 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**

Construction of wastewater treatment plants has been planned in two phases. In the first phase, to be implemented by 2020, all facilities and equipment of the system on the line of wastewater system, waste materials and sludge for the load capacity of 4,000 population equivalent (PE) are being implemented. For the second (final) phase to be implemented by 2035, the additional units have been developed for the pre-treatment (aerated sand trap), biological treatment (biodiscs) and sludge treatment for the additional load of 3,000 PE. All other supporting infrastructure has been implemented in the first phase. Thickened sludge is transported to a device for dehydration. After dehydration, a sludge cake containing up to 25% of dry substance, is disposed in a container and then transported to the nearest sanitary landfill, or is applied in agriculture

Project Investor	Kolašin municipality	
Investment Costs	6,600,000 EURO	
Maintenance Costs	300,000 EURO – 450,000 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 Water Administration (WA); Kolašin Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Feasibility Study/Detailed Design preparation	
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		Construction of communal waste transfer station for Kolašin municipality	ID DB MNE 06
Location	Municipality	Kolašin	
	Water body	Tara_3	
	Watercourse	Tara River	
	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**

A waste from the territory of Kolasin municipality is disposed to the non-sanitary landfill at Bakovići. Annually about 12,500t of waste is disposed. According to the Special Waste Management Plan for Montenegro for The Period 2015-2020, adopted in 2015, envisages the construction of a regional waste management center in the municipality of Bijelo Polje. The construction of transfer stations for communal waste and construction waste are planned in other municipalities, where the collected waste will be temporarily disposed and then transported to regional waste management centers. It is envisaged that waste from the transfer waste station in Kolasin will be disposed to the landfill in Bijelo Polje. Improvement of waste management, raising of awareness, investing in infrastructure, production of accompanied documents has to be carried out in parallel with building of communal waste transfer center.

Project Investor	Kolašin municipality	
Investment Costs	Building of transfer station - 200,000 EURO Improvement of waste management – 200,000 EURO	
Maintenance Costs	Estimated on 70,000 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 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	Increased communal waste management efficiency will cause decreasing of leakage and pollution of related ground and surface WB	
Priority (first / second / third)	First	

Characteristics		Control of adverse impacts of recreation in Kolašin municipality	ID DB MNE 07
Location	Municipality	Kolašin	
	Water body	Tara_3	
	Watercourse	Tara River	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Intensive eco-tourism and illegal fishing on river	
	Key Type of Measure	KTM19	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Regulation of tourism and nature-based activities and strict enforcement of Law on freshwater fishery and aquaculture**

Lately Kolašin is become fast developing center for tourism (winter and summer). Winter tourism is based on ski resorts on Bjelasica mountain while the summer tourism is mainly based on eco-tourism (nature-based 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 this municipality to achieve proclaimed sustainably goal and will reduce pressure on related WB.

Illegal fishing is main cause of low number of fish within this Tara sector. All fishery related research in Montenegro have recorded a continual decrease of fish abundance which could not be correlated to any other cause than poaching (water quality is more than excellent for the fish population without any heavy industrial pollution except in Ćehotina river and lower part of Lim river). Therefore, strict enforcement of Law on freshwater fishery and aquaculture as well as production of strict 6 – years plan for fish population management will improve present situation.

Project Investor	Kolašin municipality	
Investment Costs	Production of study on tourism risks and mitigation measures with action plan – 15,000 EURO Implementation of mitigation measures with action plan – 25,000 EURO Production of 6 – years plan for fish population management – 12,000 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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Construction of sewer network for Mojkovac municipality	ID DB MNE 08
Location	Municipality	Mojkovac	
	Water body	Tara_4	
	Watercourse	Tara River	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Lack of sewage connections for Mojkovac municipality WWTP and therefore those waters discharge 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**

In the urban area of Mojkovac there is a sewer network for waste water divided into two basins, i.e. a sewage system for the upper and lower part of the city. It is estimated that approximately 3.000 inhabitants are connected to this network or 70%. Fecal waste water together with the atmospheric waters are drained by the collector from the lower part of the city to wastewater treatment system. In the upper part of the city fecal waste water and atmospheric waste water flow by collector into the Juškovića stream, which is a direct tributary of the river Tara. The existing wastewater treatment plant has a capacity of 5,000 population equivalent.

The Project proposes the construction of a new sewer system for wastewater in Gornji Mojkovac, Donji Mojkovac and Gornja Polja. The existing, mixed sewer system would be turned into storm water sewer. Waters from the area of the upper and lower part of the city would flow to the WWTP by gravity. The construction of the pumping station with pressure pipeline would resolve the issue of treating waste water on the left bank of the river Tara, where currently there is no established system of channeling.

Project Investor	Mojkovac Municipality	
Investment Costs	2,200,000 EURO	
Maintenance Costs	200,000– 300,000 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 Water Administration (WA); Mojkovac Municipaity	
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 - 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		Study/research for upgrade or improvement of industrial wastewater treatment plants (including farms) in Mojkovac municipality	ID DB MNE 09
Location	Municipality	Mojkovac	
	Water body	Tara_4	
	Watercourse	Tara River	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	No existing wastewater treatment for several smaller plants (non IED plant) and animal farms	
	Key Type of Measure	KTM16	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Loading decrease of WB with organic compounds and nutrients**

There are currently several small capacities of crafts, metalworking and mainly woodworking production. These are smaller capacities - employing from few, to less than 100 workers. The biggest is weapon/explosives factory "Tara Aerospace and Defense Products" works with 93 employees.

Here are several mini sheep farms (with about 6 and 10 heads of sheep) and 22 farms with 50 heads of sheep, as well as pig farms, then several cow farms, as well as several farms of hens (in MZ Polje, Stevanovac and Mines) and fattening chicks (in Podbišće and Poljice). Neither of this non - IED plants/farms have any treatment facility for the waste waters. Where there is no possibility of joining the city sewage and city waste or it is inadequate considering the water load type, 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 be making of study with suggested solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm. The third step is installation/building of suggested individual wastewater treatment facilities.

Project Investor	Mojkovac municipality, non-IED pollutant plants/farms	
Investment Costs	Establishment of non-IED pollutant company/farm cadaster on municipality level – 5,000 EURO Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 20,000 EURO Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm - 10,000 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 Water Administration (WA)	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium
Other Remarks	Increased groundwater and surface water protection by avoiding the infiltration of used waters from non -IED plants/farms into the groundwater as well as in recipient SWB
Priority (first / second / third)	Second

Characteristics		Construction of communal waste transfer station for Mojkovac municipality	ID DB MNE 10
Location	Municipality	Mojkovac	
	Water body	Tara_4	
	Watercourse	Tara River	
	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**

Communal waste from the territory of the municipality of Mojkovac is deposited on a temporary communal waste storage facility at the location "Zakrsnica", on the left bank of the Tara River along the main road Bijelo Polje - Mojkovac - Kolasin. The mentioned temporary storage is foreseen for closing and remediation. According to the estimation of the utility company, annually about 800t of solid municipal waste is collected.

According to the Special Waste Management Plan for Montenegro for The Period 2015-2020, adopted in 2015, envisages the construction of a waste management center in the municipality Bijelo Polje. The construction of transfer station for communal waste and construction waste are planned in other municipalities, where the collected waste will be temporarily disposed and then transported to regional waste management centers. It is envisaged that waste from the transfer waste station in Mojkovac will be disposed to the landfill in Bijelo Polje.

Improvement of waste management, raising of awareness, investing in infrastructure, production of accompanied documents has to be done in parallel with building of communal waste transfer center.

Project Investor	Mojkovac Municipality	
Investment Costs	Building of transfer station - 200,000 EURO Improvement of waste management – 200,000 EURO Building small recycling yard – 80,000 EURO	
Maintenance Costs	85,000 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 Water Administration (WA) Mojkovac Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Control the adverse impacts of recreation in Mojkovac municipality	ID DB MNE 11
Location	Municipality	Mojkovac	
	Water body	Tara_4	
	Watercourse	Tara River	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Development of intensive eco - tourism and illegal fishing on river	
	Key Type of Measure	KTM19	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Regulation of tourism and nature-based activities and strict enforcement of Law on freshwater fishery and aquaculture**

Mojkovac is rapidly developing as a center for winter tourism. Winter tourism is based on existing and planned ski resorts on Bjelasica mountain. The summer tourism is mainly based on eco-tourism (nature-based 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 this municipality to achieve proclaimed sustainably goal and will reduce pressure on related WB.

Illegal fishing is main cause of low number of fishes within this Tara sector. All fishery related research in Montenegro have noticed a constant decrease of fish abundance which could not be correlated 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 Low on freshwater fishery and aquaculture as well as production of strict 6 – years plan for fish population management will improve pthe resent situation.

Project Investor	Mojkovac municipality	
Investment Costs	Production of study on tourism risks and mitigation measures with action plan – 15,000 EURO Implementation of mitigation measures with action plan – 25,000 EURO Production of 6 – years plan for fish population management – 12,000 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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Construction of wastewater treatment plants for Plav/Gusinje municipalities	ID DB MNE 12
Location	Municipality	Plav /Gusinje	
	Water body	Plavsko Lake and Prokletije GWB	
	Watercourse	Ljuča/Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	No wastewater treatment for Plav /Gusinje municipality 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**

In Gusinje, most of the sewage network is 5.5 km long, serving approximately 40% of the population, but the biggest communal problem of this area is the discharge of wastewaters without prior purification into the Ljuca River through which they reach the Plavsko jezero and Lim.

The feasibility study foresees the construction of a wastewater treatment plant for Plav and Gusinje at the site "Pjeskovi". According to the Feasibility Study, the total load of the future wastewater treatment plant is 18,000 ES, which would consist of two lines of 9,000 ES. However, since in the meantime the Gusinje became an independent municipality, a revision of the proposed solutions is needed.

Project Investor	Plav/Gusinje municipalities	
Investment Costs	9,229,000 EURO	
Maintenance Costs	350,000 – 400,000 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 Water Administration (WA)	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Feasibility Study (revision proposed)	
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		Reduce sediment from soil erosion, surface run-off and prevent sediment loading in Plavsko Lake	ID DB MNE 13
Location	Municipality	Plav	
	Water body	Plavsko Lake	
	Watercourse	Ljuča/Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Due to natural erosion processes and anthropogenic factors the sediment and organic material are rapidly depositing in Plavsko Lake	
	Key Type of Measure	KTM17	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☒ Yes	☐ No

Description of the Measure	**Prevent depositing of the sediment and organic material in to Plavsko Lake**	
Due to natural erosion processes and anthropogenic factors, the Plavsko jezero is rapidly deposited with sand and gravel and the accumulation of biomass in the shallow parts of the lake. It is necessary to protect the lake from further sprinkling by sand and gravel, reducing the external and internal intake of nutrients as needed, and rehabilitating the parts of the lake that are largely accumulating sand and gravel		
Project Investor	Plav municipality	
Investment Costs	Integrated with other measures (see below)	
Maintenance Costs	Unknown	
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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Feasibility Study (revision proposed)	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant	
Other Remarks	This measure is highly complex and it is dependable on other measures (e.g. waste water treatment, water regulation etc.)	
Priority (first / second / third)	Second	

Characteristics		Construction of wastewater treatment plants for Andrijevica municipality	ID DB MNE 14
Location	Municipality	Andrijevica	
	Water body	Lim_1; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	No wastewater treatment for Andrijevica municipality 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 length of the existing sewerage network in the Municipality of Andrijevica is approximate 3 km. Approximately 1000 users are connected to it, while businesses and schools are not connected to the network but have their septic tanks. Waste waters flow into the Zlorečica and Lim rivers without any treatment.

The master plan for sewage drainage and treatment in the central and northern regions of Montenegro (2005) envisages the construction of a sewage network and wastewater treatment plants in two phases. The reconstruction of the existing and the construction of a new sewerage network with the construction of a wastewater treatment plant in Andrijevica municipality is foreseen.

Project Investor	Andrijevica municipality	
Investment Costs	4,660,000 EURO.	
Maintenance Costs	200,000 – 250,000 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; Water Administration (WA); Andrijevica municipality	
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 - 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		Construction of communal waste transfer station for Andrijevica municipality	ID DB MNE 15
Location	Municipality	Andrijevica	
	Water body	Lim_1; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Lim	
	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 existing municipal waste landfill is an inadequate landfill of temporary character, 5 km away from the city Andrijevica. In accordance with the Strategic Master Plan for Waste Management a small recyclable yard will be made. Collected waste will be separated and / or compacted before transfer to a regional sanitary landfill in the Bijelo Polje. Improvement of waste management, rising of awareness, investing in infrastructure, production of accompanied documents has to be done in parallel with building of communal small recycling yard.	
Project Investor	Andrijevica Municipality
Investment Costs	Building small recycling yard – 80,000.00 EURO Improvement of waste management – 100,000 EURO
Maintenance Costs	50,000 – 100,000 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; Water Administration (WA)
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Upgrades or improvements of wastewater treatment (including farms) in Plav and Andrijevica municipality	ID DB MNE 16
Location	Municipality	Plav/Andrijevica	
	Water body	Lim_1; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	No existing wastewater treatment of few smaller plants (non IED plant) and animal farms	
	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**

There is currently only one non-IED plant (Brickyard) in Andrijevica municipality and few small crafts - metalworking and mainly woodworking production. There are also several mini sheep farms, pig farms, then several cow farms, and poultry farms and there are all in forms of households. None have treatment facilities for their wastewaters collection.

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 would involve a study with suggested solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm.

Project Investor	Andrijevica municipality, non-IED pollutant plant, Individual households.	
Investment Costs	Establishment of non-IED pollutant company/farm cadaster on municipality level – 5,000 EURO Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 20,000 EURO Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm - 10,000 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; Water Administration (WA); Andrijevica municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium
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)	Second

Characteristics		Study/research on the reduction of sediment from soil erosion and surface run-off in Plav and Andrijevica municipality	ID DB MNE 17
Location	Municipality	Plav/Andrijevica	
	Water body	Lim_1	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Sediment flushing from surrounding mountain area	
	Key Type of Measure	KTM17	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Reduction of sediment from soil erosion and surface run-off in Lim river**	
Production of study and action plan of forestry within this region with spatial attention on sustainable forestry and afforestation activities in order to reduce soil erosion from surrounding mountain slopes.		
Project Investor	Andrijevica municipality, Plav municipality	
Investment Costs	40,000 EURO	
Maintenance Costs	There is no maintenance cost. This is at least three-year duration measure, first year for production of study and action plan and second and third year for afforestation activities.	
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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design /	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium	
Other Remarks	Reduction of sediment flushing by afforestation of catted areas in surrounding mountain region (Forestry)	
Priority (first / second / third)	Third	

Characteristics		Improving longitudinal continuity on Komarača surface WB	ID DB MNE 18
Location	Municipality	Plav	
	Water body	Komarača	
	Watercourse	Komarača	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility change the river ecology since it caused river flow discontinuity	
	Key Type of Measure	KTM5	
Restrictions	Protected Area	☒ Yes	☐ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**The management of the SHPP and its maintenance in order to ensures the adequate flow for fish pass (longitudinal river connectivity)**
On the river Komaraca there is SHPPs, already constructed or planned. Total design capacity is 7.09 MW and annual production 21.41 MWh. Also, on the Metška river, the Komaraca tributaries, the construction of a SHPP is with a design capacity of 0.68 MW and annual production of 1.6 MWh is also planned. The construction of the another SHPP on the Komaraci River is planned, with a design capacity of 4.0 MW and annual production of 10.80 MWh. This measure is related to inspection of SHPP and estimation of effectiveness of existing fish passage and suggestions for its improvement or design of new fish passage in order to improve longitudinal riverine connectivity.	
Project Investor	SHPP owner company
Investment Costs	80,000 EURO
Maintenance Costs	5,000 EURO
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); Plav Municipality
Status of Implementation Construction Design / Construction Supervision / Operation and Maintenance)	Construction Design / Operation and Maintenance
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant
Other Remarks	Establishment and maintenance of longitudinal river connectivity is of essential importance for preservation minimal river ecosystem functionality
Priority (first / second / third)	Second

Characteristics		Improvements in flow regime and/or establishment of ecological flows on Komarače surface WB	ID DB MNE 19
Location	Municipality	Plav	
	Water body	Komarača	
	Watercourse	Komarača	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility change the river ecology since it caused river flow discontinuity and remain river sector bypassed with pipeline almost without water	
	Key Type of Measure	KTM7	
Restrictions	Protected Area	☒ Yes	☐ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**The management of the SHPP and its maintenance in order to ensure minimal ecological flow in bypassed river sector**

On the river Komaraca there is SHPPs, already constructed or planned. Total design capacity is 7.09 MW and annual production 21.41 MWh. Also, on the Metška river, the Komaraca tributaries, the construction of a SHPP is with a design capacity of 0.68 MW and annual production of 1.6 MWh is also planned. The construction of the another SHPP on the Komaraci River is planned, with a design capacity of 4.0 MW and annual production of 10.80 MWh. Ecological flow is amount of water which should ensure the survival of downstream riverine ecosystem. This measure concerns the estimation of the ecosystem status and the possibility for its improvement in terms of the water amount on disposal for river sector from which water is directed into SHPP tube system as well as on a system of controlling of the water amount downstream of the extraction point.

Project Investor	SHPP owner company	
Investment Costs	50,000 EURO	
Maintenance Costs	10,000 EURO	
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 (Construction Design / Construction Supervision / Operation and Maintenance)	Construction Design / Operation and Maintenance	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant	
Other Remarks	Monitoring of minimal ecological flow in bypassed river sectors is of essential importance to give any chance for river ecosystem to somehow sustain and function.	
Priority (first / second / third)	Second	

Characteristics		Construction of communal waste transfer station for Plav municipality	ID DB MNE 20
Location	Municipality	Plav	
	Water body	Komarača	
	Watercourse	Komarača	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Inadequate communal waste management	
	Key Type of Measure	KTM21	
Restrictions	Protected Area	☒ Yes	☐ No
	Flood Area	☐ Yes	☒ No
	Proposed Emerald site	☒ Yes	☐ No
	Other		

Description of the Measure	**Improvement of communal waste management**

The existing municipal waste landfill is an inadequate landfill of temporary character, with a surface area of 4000 m^2, 3 km away from the city, which has been used since 1999. In the area of the landfill Komaraca, about 4,830 m^3 of waste collected from the territory of the urban part of the municipality of Plav has been deposited annually. Existing solid waste landfills are inconvenient because municipal and industrial waste is deposited on unsuccessful and temporary landfills without treatment. The landfill is unregulated and uninsured.

Having in mind the current state of the landfill, it is necessary to complete the complete disposal of the landfill. Also, in order to manage waste manually, a small recyclable yard and transfer stations will be made. Collected waste at the transfer station will be separated and / or compacted before transfer to a regional sanitary landfill in the Bijelo Polje, which is envisaged Spatial Plan and the Strategic Master Plan for Waste Management.

Improvement of waste management, raising of awareness, investing in infrastructure, production of accompanied documents has to be done in parallel with building of communal transfer station small recycling yard

Project Investor	Plav municipality	
Investment Costs	Building of communal transfer station - 200,000 EURO Building small recycling yard – 80,000 EURO Improvement of waste management – 100,000 EURO	
Maintenance Costs	50,000.00 – 100,000 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; Water Administration (WA)	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Construction of wastewater treatment plants for Berane municipality	ID DB MNE 21
Location	Municipality	Berane	
	Water body	Lim_2; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Wastewater for Berane municipality is unprocessed in the recipient WBs	
	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 project "Construction of sewerage network and WWTP waste water treatment plant in Berane municipality" is being implemented and works began in June 2016. Design and construction of a wastewater treatment plant in the Berane municipality was signed at 6,101,740 EURO, while the construction of the sewage network in Berane Municipality was signed at 4,881,918 EURO, out of which 85% of the grant was financed by the European Union through IPA funds. The remaining funds, in the amount of 15%, are the co-financing funds provided through the Capital Budget of the state of Montenegro. PPOV was put into trial in April 2019.		
Project Investor	Berane municipality	
Investment Costs	10,983,658 EURO	
Maintenance Costs	450,000 – 500,000 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; Water Administration (WA); Berane Municipality	
Status of Implementation Construction Design / Construction Supervision / Operation and Maintenance)	Construction Design / Construction Supervision	
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 as well as in recipient SWB	
Priority (first / second / third)	First	

Characteristics		Construction of communal waste transfer station for Berane municipality	ID DB MNE 22
Location	Municipality	Berane	
	Water body	Lim_2; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Lim	
	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 municipality of Berane has a long-standing problem with finding out the location of waste disposal. For many years, until 2015, waste was disposed of at the location “Vasove vode” located on the banks of the Lim river. After the citizens' protest, the disposal of waste was discontinued and for this purpose the site of the Rujiška was and still is used.

In accordance with the Strategic Master Plan for Waste Management, the construction of transfer stations for communal waste and construction waste are planned in other municipalities, where the collected waste will be temporarily disposed and then transported to regional waste management center – Bijelo Polje. Collected waste at the transfer station will be separated and / or compacted before transfer to a regional sanitary landfill in the Bijelo Polje.

It is necessary to carry out the rehabilitation of the old landfill "Vasove vode"

Improvement of waste management, raising of awareness, investing in infrastructure, production of accompanied documents has to be done in parallel with building of communal transfer station small recycling yard

Project Investor	Berane municipality	
Investment Costs	Building of communal transfer station - 700,000 EURO Building recycling yard – 380,000 EURO Improvement of waste management – 300,000 EURO Rehabilitation of the old landfill "Vasove vode" – 1,500,000 EURO	
Maintenance Costs	400,000 – 450,000 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; Water Administration (WA); Berane Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Study/research on the upgrade or improvement of industrial wastewater treatment plants (including farms) in Berane municipality	ID DB MNE 23
Location	Municipality	Berane	
	Water body	Lim_2; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	No wastewater treatment of several smaller plants (non IED plant) and animal farms	
	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**

There are currently several small capacities of crafts, metalworking and mainly woodworking production. These are smaller capacities - employing from few, to less than 100 workers. There are several non – IED plants among which the most important are “Poliex” (Chemical industy) and “Kps-Polimka” (Leather processing industry). There is also milk processing plant “Zora”. There are several mini and mid-size sheep farms, as well as pig farms, then several cow farms, as well as several poultry farms.

None of the non -IED plants/farms have any treatment facility for the waste waters (or if they are non-functional). Where there is no possibility of joining the city sewage and city waste or it is inadequate considering the water load type, 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 would be a study with suggested solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm.

Project Investor	Berane municipality, non-IED pollutant plants/farms	
Investment Costs	Establishment of non-IED pollutant company/farm cadaster on municipality level – 5,000 EURO Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 20,000 EURO Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm - 10,000 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; Water Administration (WA); Berane Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	High
Other Remarks	Increased groundwater and surface water protection by avoiding the infiltration of used waters from non-IED plants/farms into the groundwater as well as in recipient SWB
Priority (first / second / third)	Second

Characteristics		Study/research on the reduction of sediment from soil erosion and surface run-off in Berane and Bijelo Polje municipality	ID DB MNE 24
Location	Municipality	Berane / Bijelo Polje	
	Water body	Lim_2	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Sediment flushing from surrounding mountain area	
	Key Type of Measure	KTM17	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☒ Yes	☐ No

Description of the Measure	**Reduction of sediment from soil erosion and surface run-off in Lim river**	
Production of study and action plan of forestry within this region with attention on sustainable forestry and afforestation activities in order to reduce soil erosion from surrounding mountain slopes		
Project Investor	Berane municipality, BIjelo Polje municipality	
Investment Costs	40,000 EURO	
Maintenance Costs	There is no maintenance coast. This is at least three-year duration measure, first year for production of study and action plan and second and third year for afforestation activities.	
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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	High	
Other Remarks	Reduction of sediment flushing by afforestation of catted areas in surrounding mountain region (Forestry)	
Priority (first / second / third)	Third	

Characteristics		Control the adverse impacts of recreation in Berane municipality	ID DB MNE 25
Location	Municipality	Berane	
	Water body	Lim_2	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Control the adverse impacts of recreation including angling in Berane municipality	
	Key Type of Measure	KTM19	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☒ Yes	☐ No

Description of the Measure	**Strict enforcement of Law on freshwater fishery and aquaculture**	
Illegal fishing is main cause of low number of fish within this Lim sector. All fishery related research in Montenegro have noticed a constant decrease of fish abundance which could not be correlated to any other cause than poaching (water quality is more than excellent for the fish population without any heavy industrial pollution except in the Ćehotina river and the lower part of Lim river). Therefore, strict enforcement of Law on freshwater fishery and aquaculture as well as production of strict 6 – years plan for fish population management will improve present situation.		
Project Investor	Berane municipality	
Investment Costs	Production of 6 – years 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); EPA; Water Administration (WA)	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium	
Other Remarks	Bringing of fishery in sustainable frame will not only improve the WB status but It will also provide opportunity for additional income (sport / recreational fishing)	
Priority (first / second / third)	Third	

Characteristics		Improving longitudinal continuity on Bistirca surface WB	ID DB MNE 26
Location	Municipality	Berane	
	Water body	Bistrica	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility change the river ecology since it caused river flow discontinuity	
	Key Type of Measure	KTM5	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**The management of the SHPP and its maintenance in order to ensures the adequate flow for fish pass (longitudinal river connectivity)**
On the river Bistrica there is a system of several SHPPs of total 8.02 MW designed capacity and 30,65 MWh of annual production. In addition, there is one more SHPP planned for this WB. This measure is related to the inspection of SHPP and estimation of effectiveness of the existing fish passage and suggestions for its improvement or design of new fish passage in order to improve longitudinal riverine connectivity.	
Project Investor	SHPP owner company
Investment Costs	80,000 EURO
Maintenance Costs	5,000 EURO
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 of Montenegro (WA)
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Construction Design / Operation and Maintenance
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant
Other Remarks	Establishment and maintenance of longitudinal river connectivity is of essential importance for preservation minimal river ecosystem functionality
Priority (first / second / third)	First

Characteristics		Improvements in flow regime and/or establishment of ecological flows on Bistrica surface WB	ID DB MNE 27
Location	Municipality	Berane	
	Water body	Bistrica	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility change the river ecology since it caused river flow discontinuity and remain river sector bypassed with pipeline almost without water	
	Key Type of Measure	KTM7	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No
Description of the Measure	**The management of the SHPP and its maintenance in order to ensure minimal ecological flow in bypassed river sector**		
On the river Bistrica there is a system of several SHPPs of total 8.02 MW designed capacity and 30,65 MWh of annual production. In addition, there is one more SHPP planned for this WB. Ecological flow is amount of water which should ensure the survival of downstream riverine ecosystem. This measure concerns the estimation of the ecosystem status and the possibility for its improvement in terms of the water amount on disposal for river sector from which water is directed into SHPP tube system as well as on a system of controlling of the water amount downstream of the extraction point.			
Project Investor	SHPP owner company		
Investment Costs	50,000 EURO		
Maintenance Costs	10,000 EURO		
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); Berane Municipality		
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Construction Design / Operation and Maintenance		
Impact Assessment - Improvement of the Ecological	Significant		

or Chemical Status of the Water Bodies (significant / high / medium / low)	
Other Remarks	Monitoring of minimal ecological flow in bypassed river sectors is of essential importance to give any chance for river ecosystem to somehow sustain and function.
Priority (first / second / third)	First

Characteristics		Water efficiency[229], implementation of technical measures for irrigation, industry, energy and households water sharing in Bistrica WB	ID DB MNE 28
Location	Municipality	Berane	
	Water body	Bistrica; Beranska Bistrica – Ljubovića GWB	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility as well as the pipeline for water transport on turbine caused irregular water sharing and posing of SHPP as priority in water usage.	
	Key Type of Measure	KTM8	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Technical measures with purpose to satisfy other than SHPP needs for water and to ensure strict enforcement of Law on Water.**
On the river Bistrica there is a system of several SHPPs of total 8.02 MW designed capacity and 30,65 MWh of annual production. In addition, there is one more SHPP planned for this WB. The management of the operation of small hydropower plants must be such as to provide sufficient quantities of water to all consumers. Article 47 of the Law on Water stipulates that the use of water for the water supply in the following order: supplying the population with drinking water, land defense, sanitation and livestock feeds have priority over the use of water for other purposes.	
Project Investor	Municipality of Berane, SHPP owner company
Investment Costs	Production of detail analysis of water needs in Bistrica WB (present and foreseen according to developmental goals for this region) - 20,000 EURO 40,000 EURO - Study on of minimal ecological flow in bypassed river sectors 40,000 EURO - Study on technical measures for achieving of water efficiency 40,000 EURO - Implementation of foreseen technical measures
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); Berane Municipality
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design /	Construction Design / Operation and Maintenance

[229] 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

Construction Supervision / Operation and Maintenance)	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	High
Other Remarks	Monitoring of minimal ecological flow in bypassed river sectors is of essential importance to give information on amount of water derived in to pipe system.
Priority (first / second / third)	Second

Characteristics		Improving longitudinal continuity on Bistirca (Lj) surface WB	ID DB MNE 29
Location	Municipality	Bijelo Polje	
	Water body	Bistrica (Lj)	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility change the river ecology since it caused river flow discontinuity	
	Key Type of Measure	KTM5	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**The management of the SHPP and its maintenance in order to ensures the adequate flow for fish pass (longitudinal river connectivity)**	
On the river Bistrica (Lj) there is one SHPPs of total 3.5 MW designed capacity and 11.3 MWh of annual production. This measure is related to the inspection of SHPP and estimation of effectiveness of the existing fish passage and suggestions for its improvement or design of new fish passage in order to improve longitudinal riverine connectivity.		
Project Investor	SHPP owner company	
Investment Costs	20,000 EURO	
Maintenance Costs	5,000 EURO	
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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Operation and Maintenance	
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 minimal river ecosystem functionality	
Priority (first / second / third)	First	

Characteristics		Improvements in flow regime and/or establishment of ecological flows on Bistrica (Lj) surface WB	ID DB MNE 30
Location	Municipality	Bijelo Polje	
	Water body	Bistrica (Lj)	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	Existence of SHPP and barrier for intake SHPP facility change the river ecology since it caused river flow discontinuity and remain river sector bypassed with pipeline almost without water	
	Key Type of Measure	KTM7	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**The management of the SHPP and its maintenance in order to ensure (improve) minimal ecological flow in bypassed river sector**
On the river Bistrica (Lj) there is one SHPPs of total 3.5 MW designed capacity and 11,3 MWh of annual production. Ecological flow is amount of water which should ensure the survival of downstream riverine ecosystem. This measure concerns the estimation of the ecosystem status and the possibility for its improvement in terms of the water amount on disposal for river sector from which water is directed into SHPP tube system as well as on a system of controlling of the water amount downstream of the extraction point.	
Project Investor	SHPP owner company
Investment Costs	50,000 EURO
Maintenance Costs	10,000 EURO
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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Operation and Maintenance
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant
Other Remarks	Monitoring of minimal ecological flow in bypassed river sectors is of essential importance to give any chance for river ecosystem to sustain and function.
Priority (first / second / third)	First

Characteristics		Construction of wastewater collection and treatment plant for Bijelo Polje municipality	ID DB MNE 31
Location	Municipality	Bijelo Polje	
	Water body	Lim_3 and Kosanica GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	No wastewater treatment in Bijelo Polje municipality and therefore wastewaters discharge directly into 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 sewage network in Bijelo Polje is in very poor condition and only 50% of the city population is connected to it. Waste water is discharged without prior treatment into the Lim River, as well as in the Ljubovje, Lipica and Lipnica watercourses. The realization of the project "Construction of a Wastewater Treatment Plant and Improvement of the Sewerage Network in the Municipality of Bijelo Polje" started in 2007 by developing the feasibility of the study. It is envisaged that the project is implemented in three phases and includes the Construction of a Wastewater Treatment Plant, a capacity of 40,000 equivalent inhabitants (PE) and the construction of a main collector and sewage network with an approximate length of 52 km.		
Project Investor	Bijelo Polje municipality	
Investment Costs	40,000,000 EURO	
Maintenance Costs	700,000 – 800,000 EURO/Year	
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); Water Administration (WA); EPA; Bijelo Polje Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Study/research on the upgrade or improvement of industrial wastewater treatment plants (including farms) in Bijelo Polje municipality	ID DB MNE 32
Location	Municipality	Bijelo Polje	
	Water body	Lim_3	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	No existing wastewater treatment of several non IED plants and animal farms	
	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**

There are currently several small capacities of crafts, metalworking and mainly woodworking production. In this municipality there are several non IED plants: slaughterhouse, diary, meet processing plants, paper product industry; as well as several animal farms.

Non - IED plants/farms do not have any treatment facilities for their waste waters (or if they are non-functional). 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 involves a study with suggested solutions for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm.

Project Investor	Bijelo Polje municipality, non-IED pollutant plants/farms	
Investment Costs	Establishment of non-IED pollutant company/farm cadaster on municipality level – 5,000 EURO Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 20,000 EURO Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm - 10,000 EURO	
Maintenance Costs		
Necessity of Permit Procedure	☐ Yes	☒ No
Competent Water Authority	Ministry of Agriculture and Rural Development (MARD)	
Other Relevant Authorities	Water Administration (WA); Ministry of Sustainable Development and Tourism (MSDT); EPA; Bijelo Polje Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium
Other Remarks	Increased groundwater and surface water protection by avoiding the infiltration of used waters from non-IED plants/farms into the groundwater as well as in recipient WB
Priority (first / second / third)	Second

Characteristics		Construction of communal waste landfill, regional and for Bijelo Polje municipality	ID DB MNE 33
Location	Municipality	Bijelo Polje	
	Water body	Lim_3 and Kosanica GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	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**

About 12,000 tons of waste is produced annually in the municipality of Bijelo Polje, 80% of which are collected. Waste is disposed at the landfill "Kumanica", located 17 km from the city center. The landfill is located on the hillside, in three cascades, one part, which was previously used, is partially covered, while the other, which is used uncovered. The embankment is visible from the main road, the Lim River is 300 meters away.

According to the Special Waste Management Plan for Montenegro for the period 2015-2020, adopted in 2015, envisages the construction of a regional waste management center in the municipality of Bijelo Polje and Bar. The regional landfill in Bijelo Polje is planned at the location of Celinska Kosa. It is planned to build a regional sanitary landfill, a regional recycling center and composting plants / anaerobic digestion.

It is necessary to carry out the rehabilitation of the old landfill "Kumanica" once the new one landfill is in operation.

Improvement of waste management, raising of awareness, investing in infrastructure, production of accompanied documents has to be done in parallel with building of communal transfer station small recycling yard

Project Investor	Bijelo Polje municipality	
Investment Costs	Building of regional sanitary landfill – 10,000,000 EURO Building regional recycling center – 2,000,000 EURO Building of composting plants/anaerobic digestion facility – 1,000,000 EURO Improvement of waste management – 500,000 EURO Rehabilitation of the old landfill "Kumanica" – 1,800,000 EURO	
Maintenance Costs	700,000 – 800,000 EURO/Year	
Necessity of Permit Procedure	☒ Yes	☐ No
Competent Water Authority	Ministry of Agriculture and Rural Development (MARD)	
Other Relevant Authorities	Water Administration (WA); Ministry of Sustainable Development and Tourism (MSDT); EPA; Bijelo Polje Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 into the groundwater basin as well as in recipient WB
Priority (first / second / third)	First

Characteristics		Remediation of contaminated sites within Bijelo Polje municipality	ID DB MNE 34
Location	Municipality	Bijelo Polje	
	Water body	Lim_3 and Kosanica GWB	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Several places in Bijelo Polje municipality used as illegal dump yards or remains of old factories.	
	Key Type of Measure	KTM4	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Improvement of possible risk of contaminant leakage**

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 disused factories and their dump-yards and waste water outflow places.

First step should be establishment of cadaster of possibly contaminated sites. Next step is to conduct chemical analysis of compounds in contaminated sites. Subsequently, the mitigation measured should be prescribed based in contamination type and implementation of those measures.

Project Investor	Bijelo Polje municipality	
Investment Costs	Production of cadaster of possibly contaminated sites – 10,000 EURO Chemical analysis of compounds in contaminated sites – 25,000 EURO Study on mitigation measures with action plan – 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	Water Administration (WA); Ministry of Sustainable Development and Tourism (MSDT); EPA	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 remediation of contaminated sites.	
Priority (first / second / third)	Second	

Characteristics		Water efficiency, implementation of technical measures for irrigation, industry, energy and households water sharing in Lim_3 WB	ID DB MNE 35
Location	Municipality	Bijelo Polje	
	Water body	Lim_3	
	Watercourse	Lim	
	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 Bijelo Polje municipality**	
Due to agriculture, industry and craft activities within Bijelo Polje municipality there is unknown water mass usage and unknow balance of this usage. In order to secure water balance, it is of curtail importance to know who, when, where and how much water is using from this WB		
Project Investor	Bijelo Polje municipality	
Investment Costs	Production of cadaster of water users within Lim_3 WB – 20,000 EURO Production of detail analysis of water usage in Lim_3 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	Water Administration (WA); Ministry of Sustainable Development and Tourism (MSDT); EPA; Bijelo Polje Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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)	Third	

Characteristics		Control the adverse impacts of recreation in Bijelo Polje municipality	ID DB MNE 36
Location	Municipality	Bijelo Polje	
	Water body	Lim_3	
	Watercourse	Lim	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Control the adverse impacts of recreation including angling in Berane municipality	
	Key Type of Measure	KTM19	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Strict enforcement of Law on freshwater fishery and aquaculture**
Illegal fishing is main cause of low number of fishes within this Lim sector. All fishery related research in Montenegro have noticed a constant decrease of fish abundance which could not be correlated to any other cause than poaching (water quality is more than excellent for the fish population without any heavy industrial pollution except in Ćehotina river and lower part of Lim river). Therefore, strict enforcement of Low on freshwater fishery and aquaculture as well as production of strict 6 – year plan for fish population management will improve present situation.	
Project Investor	Berane municipality
Investment Costs	Production of 6 – year plan for fish population management – 15,000.00 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	Water Administration (WA); Ministry of Sustainable Development and Tourism (MSDT); EPA
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium
Other Remarks	Bringing of fishery in sustainable frame will not only improve the WB status but It will also provide opportunity for additional income (sport / recreational fishing)
Priority (first / second / third)	Third

Characteristics		Water efficiency, implementation of technical measures for irrigation, aquaculture, energy and households water sharing in Bistrica (L)_2 WB	ID DB MNE 37
Location	Municipality	Bijelo Polje	
	Water body	Bistrica (L)_2	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Within this WB waters are used for agriculture, fish farms and households and 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 from Bistrica (L) river**	
Due to agriculture, fish farming and households needs there is unknown water mass usage and unknow balance of this usage. In order to secure the water needs, it is of crucial importance to know who, when, where and how much water is being used from the WBs		
Project Investor	Bijelo Polje municipality	
Investment Costs	Production of cadaster of water users within Lim_3 WB – 7,000.00 EURO Production of detail analysis of water usage in Lim_3 WB - 7,000.00 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	Water Administration (WA); Ministry of Sustainable Development and Tourism (MSDT); EPA	
Status of Implementation: (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 basis for the establishing of water efficiency measures.	
Priority (first / second / third)	Third	

Characteristics		Reduction of nutrient and organic matter loading in fish farms of Bistrica (L)_2 WB	ID DB MNE 38
Location	Municipality	Bijelo Polje	
	Water body	Bistrica (L)_2	
	Watercourse	Bistrica	
	Surrounding Area	Rural	
	WFD Measure according to Art. 11	Supplementary 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 feed stocks are required in order to minimize organic matter loading. Balancing of diet. Upgrading of filtration/precipitation in fish farm releasing waters system.	
Project Investor	Privat companies, fish-farm owners, Ministry of Agriculture and Rural Development (MARD)
Investment Costs	15,000 EURO
Maintenance Costs	It is hard to foresee the maintenance costs but for sure it will not exceed 1,000.00 per fish farm.
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 (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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)	Second

Characteristics		Construction of wastewater treatment plants for Rožaje municipality	ID DB MNE 39
Location	Municipality	Rožaje	
	Water body	Ibar_2; Gornji Ibar GWB	
	Watercourse	Ibar	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	No wastewater treatment in Rožaje municipality and therefore discharges are unprocessed into the 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 sewage system is about 20 km long and covers only the narrower area of Rozaje city. Waste water is directly discharged into receivers without prior treatment in the rivers Lovnicka and Ibar. There are more than 24 sewers. According to the Master Plan for Wastewater Management for the Central and Northern Region, the construction of a collector along the Ibar River bank is planned for the location of the planned WWTP in the length of 2.430 m, the construction of collectors in settlements, and the future waste water treatment plant in the municipality of Rožaje will be designed for a capacity of 20,000 ES. With the mentioned document, the construction of PPOV in Rožaje is classified as the first priority group.		
Project Investor	Rožaje municipality	
Investment Costs	12,100,000 EURO.	
Maintenance Costs	400,000 – 500,000 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; Water Administration (WA)	
Status of Implementation:(Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Feasibility 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	

Characteristics		Study/research for upgrade or improvement of industrial wastewater treatment plants (including farms) in Rožaje municipality	ID DB MNE 40
Location	Municipality	Rožaje	
	Water body	Ibar_2; Gornji Ibar GWB	
	Watercourse	Ibar	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	No wastewater treatment of several 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**

There are currently several small capacities of crafts, metalworking and mainly woodworking production. In this municipality there are several non IED plants: slaughterhouse, diary, paper and cardboard (2), Water bottling and juices production, Wood processing as well as several small animal farms.

Neither of this non-IED plants/farms have any functional treatment facility for the waste waters. 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 undertake a study with suggested solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm.

Project Investor	Rožaje municipality, non-IED pollutant plants/farms	
Investment Costs	Establishment of non-IED pollutant company/farm cadaster on municipality level – 5,000 EURO Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 20,000 EURO Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm - 10,000 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; Water Administration (WA); Rožaje Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 into the groundwater as well as in recipient SWB
Priority (first / second / third)	Second

Characteristics		Construction of communal waste transfer station for Rožaje municipality	ID DB MNE 41
Location	Municipality	Rožaje	
	Water body	Ibar_2; Gornji Ibar GWB	
	Watercourse	Ibar	
	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**

From the territory of the Municipality of Rozaje annually collected about 3,400 tons of waste and deposits it at the location of the temporary storage of Mostine, on the ninth kilometer downstream of the city. In the territory of the Municipality of Rožaje there are 15 more unregulated landfills.

In accordance with the Strategic Master Plan for Waste Management, the construction of transfer stations for communal waste and construction waste are planned in other municipalities, where the collected waste will be temporarily disposed and then transported to regional waste management center – Bijelo Polje. Collected waste at the transfer station will be separated and / or compacted before transfer to a regional sanitary landfill in the Bijelo Polje.

Improvement of waste management, raising of awareness, investing in infrastructure, production of accompanied documents has to be done in parallel with building of communal transfer station small recycling yard

Project Investor	Rožaje municipality	
Investment Costs	Building of communal transfer station - 200,000 EURO Building recycling yard – 80,000 EURO Improvement of waste management – 200,000 EURO	
Maintenance Costs	200,000 – 300,000 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; Water Administration (WA); Rožaje Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 WBs
Priority (first / second / third)	First

Characteristics		Remediation of contaminated sites within Rožaje municipality	ID DB MNE 42
Location	Municipality	Rožaje	
	Water body	Ibar_2; Gornji Ibar GWB	
	Watercourse	Ibar	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Several places in Rožaje municipality are used as illegal dump sites or there are remains of unused factory sites.	
	Key Type of Measure	KTM4	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No
	Proposed Emerald site	☐ Yes	☒ No
	Other		

Description of the Measure	**Improvement of possible risk of contaminant leakage**

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.

First step should be establishment of cadaster of possibly contaminated sites. Next step is to perform chemical analysis of compounds in contemned sites. Subsequently, the mitigation measured should be prescribed based in contamination type and implementation of those measures.

Project Investor	Rožaje municipality	
Investment Costs	Production of cadaster of possibly contaminated sites – 10,000 EURO Chemical analysis of compounds in contemned sites – 25,000 EURO Study on mitigation measures with action plan – 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; Water Administration (WA); Rožaje Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the	High	

Water Bodies (significant / high / medium / low)	
Other Remarks	Increased groundwater and surface water protection by remediation of contaminated sites.
Priority (first / second / third)	Second

Characteristics		Control the adverse impacts of recreation in Rožaje municipality	ID DB MNE 43
Location	Municipality	Rožaje	
	Water body	Ibar_2	
	Watercourse	Ibar	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Control the adverse impacts of recreation including angling in Rožaje municipality	
	Key Type of Measure	KTM19	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Strict enforcement of Law on freshwater fishery and aquaculture**	
Illegal fishing is main cause of low number of fish within this Lim sector. All fishery related research in Montenegro have noticed a constant decrease of fish abundance which could not be correlated to any other cause than poaching (water quality is more than excellent for the fish population without any heavy industrial pollution except in Ćehotina river and lower part of Lim 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	Rožaje municipality	
Investment Costs	Production of 6 – years 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); EPA; Water Administration (WA); Rožaje Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Medium	
Other Remarks	Bringing of fishery in sustainable frame will not only improve the WB status but It will also provide opportunity for additional income (sport / recreational fishing)	
Priority (first / second / third)	Second	

Characteristics		Construction of wastewater collection and treatment plant for Pljevlja municipality	ID DB MNE 44
Location	Municipality	Pljevlja	
	Water body	Ćehotina_4 and Ćehotina_5 ; Pljevlja Basin GWB; Maoče GWB	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	There is no wastewater treatment in Pljevlja municipality and therefore there is discharge of unprocessed wastewater into recipient WBs	
	Key Type of Measure	KTM1	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No
	Proposed Emerald site	☒ Yes	☐ No
	Other		

Description of the Measure	**Decrease of WB loading with organic compounds and nutrients**

Only the urban area of the Municipality of Pljevlja is presently covered by the sewerage system. Wastewater is directly discharged into the Ćehotina River and its tributaries, with no prior treatment. The river also receives wastewater from the Coal Mine, Thermal Power Plant, the Slaughterhouse and other local enterprises, also with no prior treatment. That is why the activities on the extension of the sewer network and the construction of WWTP started in 2007. The project includes the construction of a main collector and the construction of a waste treatment plant with a total capacity of 42,000 ES, the first phase of a WWTP includes a capacity of 28,000 PE.

Project Investor	Pljevlja municipality	
Investment Costs	6,000,000 EURO	
Maintenance Costs	400,000 – 500,000 EURO/Year	
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); Pljevlja Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	Construction Supervision	
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 as well as in recipient WB
Priority (first / second / third)	First

Characteristics		Upgrades or improvements of industrial wastewater treatment plants (including farms) in Pljevlja municipality	ID DB MNE 45
Location	Municipality	Pljevlja	
	Water body	Ćehotina_4 and Ćehotina_5; Pljevlja Basin GWB; Maoče GWB	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	No wastewater treatment for several non IED and 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 inorganic/organic compounds and nutrients**

There are currently several small capacities of crafts, metalworking and woodworking production. In this municipality there are several non IED plants: Bakery, Coal mining, pigs, goat and cow farms Meat processing plant, wood processing and slaughterhouse. There is also one IED plant – Tehremo plant - Pljevlja .

Neither of this IED/ non - IED plants/farms have any treatment facility for the waste waters (or if they have it is unfunctional or insufficient). Special attention should be paid toward individual wastewater treatment.

First step should be establishment of IED/non-IED pollutant company/farm cadaster on municipality level and systematic analysis of their wastewater (chemical analysis of compounds in wastewater). The subsequent step will involve a study with suggested solutions for the best and most appropriate wastewater treatment regime.

Project Investor	Pljevlja municipality, IED/ non-IED pollutant plants/farms	
Investment Costs	Establishment of non-IED pollutant company/farm cadaster on municipality level – 5,000 EURO Systematic chemical analysis of compounds in individual non-IED pollutant company/farm wastewater – 20,000 EURO Study on solution for the best and most appropriate wastewater treatment for each individual non-IED pollutant company/farm - 10,000 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; Water Administration (WA); Pljevlja Municipality	

Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 into the groundwater as well as in recipient SWB
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 Ćehotina_4 WB	ID DB MNE 46
Location	Municipality	Pljevlja	
	Water body	Ćehotina_4; Pljevlja Basin GWB	
	Watercourse	Ćehotina	
	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 Ćehotina_4 WB**
The Coal mining and Thermo Plant are the main pollutant within WB, ether during usual operation or during regular repair maintenance periods. First step should be identification of PHS in waste waters. Second step involves a study on possible solutions with action plan and last step is implementation of solutions and reducing or stopping the of emission. This measure provides for an action plan for control of emissions and discharges. Until this is carried out, implementation of solutions would not be known.	
Project Investor	The Coal Mining, Thermo Plant
Investment Costs	Identification of PHS in Coal Mining and Thermo Plant waste waters – 30,000 EURO Studies on possible solutions with action plan – 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; Water Administration (WA); Pljevlja Municipality
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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		Remediation of contaminated sites within Ćehotina_4 WB	ID DB MNE 47
Location	Municipality	Pljeljva	
	Water body	Ćehotina_4 and Ćehotina_5; Pljevlja Basin GWB	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Several places in Pljeljva along those WBs are used as illegal dump yards or remains of old factories damp yards.	
	Key Type of Measure	KTM4	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Improvement of possible risk of contaminant leakage**	
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. The Ffrst step should be establishment of cadaster of possibly contaminated sites. Next step is to undertake the chemical analysis of compounds in contemned sites. After that the mitigation measured should be prescribed based in contamination type and implementation of those measures.		
Project Investor	Pljeljva municipality	
Investment Costs	Production of cadaster of possibly contaminated sites – 10,000 EURO Chemical analysis of compounds in contemned sites – 25,000 EURO Study on mitigation measures with action plan – 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; Water Administration (WA); Pljevlja Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 remediation of contaminated sites.	
Priority (first / second / third)	Second	

Characteristics		Improving hydromorphological conditions of Ćehotina_4 WB (other than longitudinal continuity)	ID DB MNE 48
Location	Municipality	Pljeljva	
	Water body	Ćehotina_4	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Basic measure	
	Key Aspect/Pressure	In order to continue to use coal deposit, Coal Mine remove Ćehotina river from natural riverbed in opposite part of Pljevlja valley	
	Key Type of Measure	KTM6	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Bringing Ćehotina river in to natural status in terms of riverbed (moving river in to primary riverbed)**
With the need to excavate coal deposited which were near and under the Ćehotina riverbed, coal mine removed Ćehotina river in to opposite direction, in to concrete riverbed and trough two tunnels. This measure is feasible to implement only after finishing of utilization of coal deposit and Coal Mine – Pljevlja is in obligation to return this river part in to original position after finishing of coal utilization.	
Project Investor	Coal Mine - Pljevalj
Investment Costs	20,000,000 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); Pljevlja Municipality
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 remediation of contaminated sites.
Priority (first / second / third)	Third

Characteristics		Study/research for upgradesor improvement of industrial wastewater treatment plants (Thermo plant – Pljelvja)	ID DB MNE 49
Location	Municipality	Pljevlja	
	Water body	Vezišnica; Pljevlja Basin GWB	
	Watercourse	Vezišnica	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Inadequate wastewater treatment in Thermo-plant Pljevlja	
	Key Type of Measure	KTM16	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Decrease of WB loading with inorganic/organic compounds**	
The only one IED plant in Danube drainage areas - Tehremo plant – Pljevlja, has inadequate waste water treatment which cause leakage during regular or unexpected service periods of different pollutant in to river Vezišnica. First step should be detail chemical analysis of waste waters during one-year cycle in order to find out what exactly make such negative impact (exact pollutants). Next step should involve a study with suggested solution for the best and most appropriate wastewater treatment.		
Project Investor	Tehremo plant – Pljevlja	
Investment Costs	Study on detail chemical analysis of waste waters during one-year cycle – 45,000 EURO; Study on solution for the best and most appropriate wastewater treatment - 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; Water Administration (WA); Pljevlja Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 the Thermo plant - Pljevlja	
Priority (first / second / third)	First	

Characteristics		Remediation of contaminated sites within Ćehotina_6 WB (Jalovište Gradac)	ID DB MNE 50
Location	Municipality	Pljeljva	
	Water body	Ćehotina_6; Pljevlja Basin GWB	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Sludge dump site in Gradac, with remains of lead and zinc ore processing	
	Key Type of Measure	KTM4	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Improvement of possible risk of contaminant leakage**	
In Gradac settlement there is a large dump site of sludge as remains of lead and zinc ore processing (dump side of "Šuplja Stijena" Mine). First step should chemical analysis of sludge, following with study on how to solve this problem and implementation of selected solution.		
Project Investor	Pljevlja municipality	
Investment Costs	Chemical analysis of compounds in contaminated sites – 20,000 EURO Study on how to solve the problems associated with the dump site at Gradac - 30,000 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); Pljevlja Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design / Tendering Design / Construction Design / Construction Supervision / Operation and Maintenance)	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 remediation of contaminated sites.	
Priority (first / second / third)	Second	

Characteristics		Upgrades or improvements of industrial wastewater treatment plants ("Šuplja Stijena" Mine)	ID DB MNE 51
Location	Municipality	Pljevlja	
	Water body	Ćehotina_6; Pljevlja Basin GWB	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Inadequate dump-water treatment in "Šuplja Stijena" Mine	
	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 processing of lead and zinc ore processing the chemical remains finished in Ćehotina_6 WB with waters of Medni potok. This makes a problem to biota of Ćehotina river downstream from this point, especially during low water flow in summer season. In order to understand and solve the problem it is required to undertake a chemical analysis of dump waters. The next step is to make a study to underline the most favorable and cost-effective solutions for the best and most appropriate dump-water treatment.		
Project Investor	Tehremo plant – Pljevlja	
Investment Costs	Study on detail chemical analysis of waste waters – 25,000 EURO Study on solution for the best and most appropriate dump water treatment - 30,000 EURO	
Maintenance Costs	50,000.00 – 100,000.00 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; Water Administration (WA); Pljevlja Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study	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 Šuplja Stijena" Mine	
Priority (first / second / third)	First	

Characteristics		Improving longitudinal continuity of Ćehotina_6 WB (downstream of Jalovište Gradac)	ID DB MNE 52
Location	Municipality	Pljeljva	
	Water body	Ćehotina_6; Pljevlja Basin GWB	
	Watercourse	Ćehotina	
	Surrounding Area	Urban/Rural	
	WFD Measure according to Art. 11	Supplementary measure	
	Key Aspect/Pressure	Presence of tunnel through which Ćehotina was directed in order to release space for Jalovšte Gradac dump site	
	Key Type of Measure	KTM5	
Restrictions	Protected Area	☐ Yes	☒ No
	Flood Area	☐ Yes	☒ No

Description of the Measure	**Improvement of bypass tunnel in order to be more natural**	
In Gradac settlement there is large dump site of sludge as remains of lead and zinc ore processing (dump side of "Šuplja Stijena" Mine). In order to dispose of the dump material, the Ćehotina river has been directed into a tunnel. The longitudinal riverine conncotion needs to be improved in order to uprade the river ecosystem ecological potential. The study has to give an answer and solution how to achieve this with present tunnel or to suggest other solution which will avoid river tunneling.		
Project Investor	Pljevlja municipality	
Investment Costs	Study on solution for the best and most appropriate measures to determine an appropriate future solution- 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; Water Administration (WA); Pljevlja Municipality	
Status of Implementation (Desktop Study / Pre-Feasibility Study / Feasibility Study / Detailed Design /	No Status	
Impact Assessment - Improvement of the Ecological or Chemical Status of the Water Bodies (significant / high / medium / low)	Significant	
Other Remarks	Establishment and maintenance of longitudinal river connectivity is of high importance for preservation river ecosystem functionality (reduce fragmentation)	
Priority (first / second / third)	First	

11 NATIONAL STRATEGIC OBJECTIVES AND LINKAGE TO THE DANUBE 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[230]. Furthermore, with respect to water, in accordance with Article 21 of the Water Act, the objective of the Water Management Strategy[231] is designed to achieve a unified and fully harmonized water regime in the territory of the Danube 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.

[230] https://sustainabledevelopment.un.org/sdgs

[231] Stra Tegija Upra Vljanja Vodama Crne Gore, December, 2015

Table 11.1 Key Principles of the strategic objectives for the Danube River Basin

Strategic Objectives	Main results	Verification	Responsible Authorities	Recommendations for the RBMP	Related SDGs[232]
Water Management					
• Integrity - processes in nature, which is an important component of water, as well as the interconnection and interdependence of aquatic ecosystems should not be impaired • Continuous management at all levels of planning and phases of planned use and protection • 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 • 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 • The legislation and regulations are harmonized with the EU. • Internally or externally produced monitoring reports	MARD WA MSDT	• Ensure specific functions and capacities of all water related public institutions as per the water strategy • Ensure all relevant daughter directives of the WFD are transposed into national legislation • Undertake all WFD requirements and recommendations related to environmental objectives, compliant monitoring programmes • Initiate transboundary technical working groups for monitoring of surface and groundwaters • Develop structured educational and training programmes for staff in all public institutions involved in water management activities as per national regulations	6.1 6.2 6.4 6.5 6.6 6.B 16.7

[232] Sustainable Development Goals

Strategic Objectives	Main results	Verification	Responsible Authorities	Recommendations for the RBMP	Related SDGs[232]
Water Quality					
• Long-term protection of quality and all-consuming use of available water sources • 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 • Long-term protection of quality and all-consuming use of available water sources • 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 • 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. • Proposed measures in compliance with the EU legislation for climate change • 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. • Internally or externally produced monitoring reports • Respective legal regulations, which include WFD compliant methodologies for chemical analysis, biological monitoring (5 groups) and hydromorphological assessment.	MARD WA MH IPH EPA IHMS CETI	• Establishment of all water protection zones (1,2, and 3) of the water springs for public water supply. • Designation of vulnerable zones • The designation of a 'reference laboratory' with respect to sampling and chemical analysis to meet the EQS Directive requirements to gain international accreditation • Undertake further technical training for sampling, analysis and reporting of biological quality elements according to WFD guidelines • Define legal regulations for chemical analysis, biological monitoring and supporting hydromorphological assessment • Improve regulatory enforcement capacity • Undertake 'realistic' monitoring programme for surface and groundwaters, taking into account the current technical abilities to conduct WFD compliant monitoring with	6.3 6.6 15.1

Strategic Objectives	Main results	Verification	Responsible Authorities	Recommendations for the RBMP	Related SDGs[232]
				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 • 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 • Clear understanding and planning for irrigation and environmental (ecological) water requirements.	• Internally or externally produced reports	WA IHMS	• Undertake environmental flow analysis on all surface water bodies between 2021 and 2017 • 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 6.6 6.B 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 • 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 EPA IHMS	• Develop procedures for data recording into the water information system for Montenegro and also for data analysis and reporting as required by the EEA • Apply regulations to waterworks and concessionaires to measure and provide data on groundwater quantity and quality	6.A 12.8

Strategic Objectives	Main results	Verification	Responsible Authorities	Recommendations for the RBMP	Related SDGs[232]
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 • Drought Management Plans	MARD WA IHMS MI MH Municipalities	• The implementation of EU Floods Directive • Capacity building and the provision of funding for designing and implementing plans	13.1 13.2 13.3 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 WA	• Undertake the proposed actions included in the RBMP in order to provide information to all stakeholders • 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 Danube 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 Danube 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 WA	√	√	√			
Ensure all relevant daughter directives of the WFD are transposed into national legislation	MARD MSDT	√					
Undertake all WFD requirements and recommendations related to environmental objectives, compliant monitoring programmes	IHMS WA IPH	√	√	√	√	√	√
Initiate transboundary technical working groups for monitoring of surface and groundwaters	MARD 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 WA	√	√	√			
Water Quality							
Establishment of all water protection zones (1,2, and 3) of the water springs for public water supply.	MARD WA IPH	√					
Designation of vulnerable zones	MARD WA	√	√				
The designation of a 'reference laboratory' with respect to sampling and chemical analysis to meet the EQS Directive requirements to gain international accreditation	EPA IHMS CETI	√	√	√			
Undertake further technical training for sampling, analysis and reporting of biological according to WFD guidelines	IHMS	√	√				

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 Companies and other legal entities which discharge waste water MH	√	√	√	√	√	√
Apply regulations to waterworks and concessionaires to measure and provide data on groundwater quantity and quality	MARD WA Water Supply Companies Municipalities	√	√	√	√	√	√
Water Quantity							
Undertake environmental flow analysis on all surface water bodies between 2021 and 2017	IHMS WA	√	√	√			
Further develop hydrological model for use in development of future scenarios for short and longer-term planning in all sub-basins of the River Basin	IHMS 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 EPA IHMS	√	√	√	√	√	√
Risk Management							
The implementation of EU Floods Directive	MARD WA MI	√	√	√	√		
Capacity building and the provision of funding for designing and implementing plans	MARD WA MSDT MI MH	√	√	√			

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 WA	√	√	√	√	√	√
Ensure public participation and feedback in all issues related to water resource management	MARD 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 Montenegro

Annex 3: Comments Received by the Consultant 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 freshwater 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	Danube River Basin
1.	Dinaric Western Balkans_small_mountain_calcareous	1.	Yes
2.	Dinaric Western Balkans_small_mid-altitude_calcareous	1.	Yes
3.	Dinaric Western Balkans_small_lowland_calcareous	2.	
4.	Dinaric Western Balkans_medium_mountain_calcareous	1.	Yes
5.	Dinaric Western Balkans_medium_mid-altitude_calcareous	1.	Yes
6.	Dinaric Western Balkans_medium _lowland_calcareous	2.	
7.	Dinaric Western Balkans_large _mid-altitude_calcareous	3.	Yes
8.	Dinaric Western Balkans_large_lowland_calcareous	3.	
9.	Dinaric Western Balkans_large_lowland_mixed	3.	

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:

Description	Particle Size [mm]	Preliminary Typology	New Type Designation (according to dominant fractions)		
Fine substrate	<0.125	1	1 – fine substrate		
Sand	0.125-2	2		2 – medium sized substrate	
Gravel	2-64	3			3 – hard bottom substrate
Stone	64-256	4			
Rock, basic rock	>256	5			

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: R1, R2, R4, R5

Associated WBs in the Danube River Basin: Tara_1, Tara_2, Drcka, Tušina/Bukovica, Bijela, Komarnica_1, Vrbnica_1, Grlja_1, Grnčar, Komarača, Kutska/Mojanska/, Zlorečica, Popča /, Vrbička Rijeka, Bistirca (Lj), Bistrica (L)_1, Ibar_1, Crnja, Ćehotina_1 /Kozička Rijeka, Vezišnica, Voloder, Bistrica, Lješnica, Ljubovića_1, Bistrica (L)_2, Tara_3, Pridvorica, Grlja_2, Ljuča, Lim_1, Ibar_2, Ćehotina_2, Tara_4, Komarnica_2, Ljubovića_2, Otilovići Reservoir, Ćehotina_3, Ćehotina_4, Ćehotina_5, Ćehotina_6.

Type Group 2

Small and medium sized lowland watercourses with domination of hard and medium sized bottom substrate - **Not relevant for the Danube River Basin**

Type Group 3

Large lowland rivers with domination of medium sized bottom substrates

Associated abiotic water types: R7, R8 and R9

Associated WBs in the Danube River Basin: Tara_5, Piva Reservoir, Piva, Lim_2, Lim_3.

Additional Type Groups of Running Waters:

Type Group 4

Large lowland rivers with domination of fine bottom substrates - **Not relevant for the Danube River Basin**

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 Danube Basin in Montenegro;

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 area.

Type group 5a: Small ephemeral running water bodies primarily located in the Mediterranean Biogrographic Region – **Not relevant for the Danube River Basin**

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 Danube Basin in Montenegro

Note: Type group 5b is 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 - **Not relevant for the Danube River Basin**

Type Group 7

Hilly and mountainous Lakes

Associated WBs in the Danube River Basin: Crno Lake, Biogradsko Lake, Plavsko Lake

Type Group 8

Artificial Water Bodies – **Not relevant for the Danube River Basin**

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[233]					
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[234])		1.70	2.00	2.20	2.60
BMWP Score[235]		110.00	90.00	60.00	40.00
ASPT Score[236]		7.00	6.00	4.00	3.00
Diversity index (Shannon-Weaver[237])		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[238]		18.00	14.00	10.00	6.00
No. of sensitive taxa		5.00	4.00	3.00	2.00
Phytobenthos					

[233] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

[234] Zelinka, M., Marvan, P., 1961. Zur Präzisierung der biologischen Klassifikation der Reinheit fließender Gewässer. Arch. Für Hydrobiol. 389–407

[235] BMWP – Biological Monitoring Working Party is a tool for assessment of water quality using groups of macroinvertebrates (mostly families) as biological indicators

[236] 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

[237] Shannon, C.E., Weaver, W., 1964. The Mathematical Theory of Communication, 10th ed, The mathematical theory of communication. The University of Illinois Press, Urbana

[238] EPT – Ephemeroptera, Plecoptera Trichoptera index

Parameter	Units	Class Boundaries			
		I-II	II-III	III-IV	
IPS index[239]		17	15	12	9
CEE index[240]		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	

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[241]					
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)		1.90	2.10	2.80	3.20
BMWP Score		60.00	45.00	30.00	10.00
ASPT Score		6.00	5.00	4.00	3.00

[239] 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).

[240] 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).

[241] Parameter values for the annual / perennial period are determined as C80 (80 percentile) except for dissolved oxygen, which is designated as C10 (10 percentile)

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	20.00	40.00	70.00
EPT taxa		7.00	5.00	2.00	1.00
No. of sensitive taxa			4.00		
Phytobenthos					
IPS indeks		16	14	12	9
CEE indeks		12	9	7	5
Fish Fauna					
FIS Index (corresponding type 13)		0.71	0.57	0.43	0.29

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 Danube Basin in Montenegro;

Indicative BQE: Aquatic Macroinvertebrates and Phytobenthos

Parameter	Units	Class Boundaries			
		I-II	II-III	III-IV	I-II
PHYSICO-CHEMICAL PARAMETERS[242]					
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
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

[242] 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 7

Hilly and Mountainous Lakes

Indicative BQE: Aquatic Macroinvertebrates, Phytobenthos and Phytoplankton

Parameter	Units	Class Boundaries			
		I-II	II-III	III-IV	IV-V
PHYSICO-CHEMICAL PARAMETERS[243]					
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}		3.00	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)		2.00	2.50	3.00	3.20
BMWP Score		60.00	45.00	30.00	10.00
ASPT Score		6.00	5.00	4.00	3.00
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	7.00	5.00	2.00	1.00
EPT taxa			4.00		
Phytobenthos					
IPS index		16	14	12	9
Phytoplankton					
CYA[244]	% of biomass	2.50	5.00	10.00	20.00
Abundance	cells/ml	2000	5000	15000	25000
biomass phytoplankton	µg/l	25.0	50.0	100.0	250.0
TSI – Trophic index		30	40	50	70
Transparency[245]	M	8	4	2	0.5

[243] 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.

[244] Cyanobacteria

[245] Or to the bottom

Heavily modified Water Bodies

Hilly and Mountainous Reservoirs

Indicative BQE: Aquatic Macroinvertebrates, Macrophytes, Phytobenthos and Phytoplankton

Parameter	Units	Class Boundaries		
		II-III	III-IV	IV-V
PHYSICO-CHEMICAL PARAMETERS[246]				
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}		0.8	
Nitrate (NO_3-N)	mg l^{-1}		6.0	
Orthophosphate (PO_4-P)	mg l^{-1}		0.1	
Total dissolved Phosphate (P)	mg l^{-1}		0.4	
Chloride	mg l^{-1}		100	
BIOLOGICAL PARAMETERS				
Aquatic Macroinvertebrates				
Saprobic index (Zelinka & Marvan)		2.2	2.8	3.2
BMWP		70	50	30
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		4	2	1
Macrophyes				
Total No. of taxa		6	4	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[247]	µg/l	50	100	250

[246] 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

[247] Chlorophyll a