



MONITORING DEVELOPMENT PLAN – GROUNDWATER, MONTENEGRO

EU 4 Green Recovery:

Support the implementation of the Green Agenda for the Western Balkans

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ABBREVIATIONS

| | |
|----------|---|
| ADA | Austrian Development Agency |
| DG | Directorate General (of the European Union) |
| DWM | Directorate of Water Management |
| EC | European Commission |
| EEA | European Environment Agency |
| EIONET | (European) Environmental Information and Observation Network |
| EPA | Agency for Environmental Protection in Montenegro |
| EU | European Union |
| GAWB | Green Agenda for the Western Balkans |
| GoM | Government of Montenegro |
| GSM | Geological Survey of Montenegro |
| GGWB | Group of Groundwater Bodies |
| GWB | Groundwater Body |
| GWD | Groundwater Directive |
| ICPDR | International Commission for the Protection of the Danube River |
| IHMS | Institute of Hydrometeorology and Seismology of Montenegro |
| IPA | Instrument for Pre-Accession (of the EU) |
| MAFWM | Ministry of Agriculture, Forestry and Water Management |
| MNE | Montenegro |
| MONTSTAT | Statistical Office of Montenegro |
| MoU | Memorandum of Understanding |
| NFP | National Focal Point |
| NGO | Non-Governmental Organisation |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PFAS | Perfluoroalkyl and Polyfluoroalkyl Substances |
| QM | Quality Management |
| RBD | River Basin District |
| RBMP | River Basin Management Plan |
| UBA | Umweltbundesamt GmbH |
| UMM | Union of Municipalities of Montenegro |
| UWWTD | Urban Waste Water Treatment Directive |
| UWWTP | Urban Waste Water Treatment Plant |
| WA | Water Administration |

| | |
|------|--|
| WB | Western Balkans |
| WB6 | Albania, Bosnia and Herzegovina, Kosovo [*] , Montenegro, North Macedonia, Serbia |
| WFD | Water Framework Directive |
| WISE | Water Information System Europe |
| WP | Work Package |

^{*} This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

1. EXECUTIVE SUMMARY

This Monitoring Development Plan (MDP) outlines the status, challenges, and recommended actions for improving groundwater monitoring in Montenegro, aligning with the EU Water Framework Directive and the Green Agenda for the Western Balkans. This plan serves as a guiding framework for improving Montenegro's groundwater monitoring infrastructure, data quality, institutional capacity, and compliance with EU requirements. The report can be used as a living document by following developments and updating the further steps to go.

Key findings:

- The current groundwater monitoring network in Montenegro is limited, under-resourced and needs extension.
- Current monitoring is very limited, with limited coordination and data exchange between institutions.
- There are major gaps in the monitoring network, parameters, monitoring frequency as well as in QA/QC practices and available sampling and monitoring equipment. The gaps and ways forward are partly addressed in the Adriatic and Danube River Basin Management Plans (RBMPs).
- The assessment of the monitoring data according to the requirements of the Water Framework Directive has not yet been implemented.

Recommendations:

- Take care of establishing long-term sustained funding of groundwater monitoring considering infrastructure needs (refurbish, install, maintain), operational costs, staff and training.
- Develop a multipurpose groundwater monitoring program in a stepwise and risk-based way, which covers all relevant international and national water related legislation and reporting needs, as partly described in the river basin management plans.
- Revise and extend the groundwater monitoring networks for each groundwater body as planned.
- Increase the monitoring frequency as planned and increase the scope of monitored parameters.
- Establish posts and hire well-paid staff, invest in staff training and modern sampling equipment.
- Establish the water information system and consider all national and international reporting obligations in the design of the database.
- Establish appropriate methodologies for assessing the data, in particular for assessing risk, status and trends according to the Water Framework Directive and the Groundwater Directive.

2. INTRODUCTION AND SCOPE

EU4Green is an important element of the continuous support by the European Union to empower and assist the Western Balkans' transition to modern, resource-efficient and competitive economies where growth is decoupled from emissions of greenhouse gases, resource use and waste generation and where climate resilience is pursued. It is the general objective of the project to support the Western Balkans in the implementation of the Green Agenda, thus in the development and transformation towards sustainability and reaching climate neutrality by 2050. Accordingly, EU4Green is a very broad initiative building on the combined expertise and cooperation within the thematic areas EU ETS MRVA, Circular Economy, Depollution Water, Depollution Air, Depollution Soil, Biodiversity, Sustainable Agriculture, Communication, Green Education, Stakeholder participation and Green Finance.

River basin management is based on monitoring of groundwater and surface water resources and plays a central role in any River Basin Management Plan (RBMP). Groundwater monitoring consists of quantity monitoring (groundwater levels) and chemical monitoring. Both monitoring is needed to supplement and validate the characterisation and risk assessment, to establish the groundwater status of groundwater bodies (GWBs) and to evaluate the effectiveness of the measure which were set in order to achieve and to keep good groundwater quantity and chemical status. In addition, groundwater chemical monitoring is needed to detect the presence of statistically significant and sustainable upward trends in the concentration of pollutants and the reversal of such trends.

Sound monitoring is a powerful basic instrument in good groundwater governance. It provides all stakeholders with up-to-date information about groundwater in the river basin and enables meaningful decisions on groundwater management and a program of measures to achieve the environmental objectives laid down by the Water Framework Directive (WFD).

This Groundwater Monitoring Development Plan (GW-MDP) deals with quantity and chemical monitoring of groundwater in the light of the requirements of the WFD. The comparison with the actual situation lays the groundwork for drawing conclusions and formulating options towards a successful implementation of WFD compliant groundwater monitoring.

3. WFD GROUNDWATER MONITORING

The WFD sets out the requirements for the different groundwater monitoring programs in its Annex V (2.2 and 2.4) and Annex II (2.3). The guidance document No 15 (EC 2007) of the Common Implementation Strategy (CIS) for the WFD, which was jointly elaborated by representatives of the EU Member States, the European Commission and various stakeholders, provides specific guidance and best practice on properly implementing the WFD requirements.

This chapter briefly summarizes the most important cornerstones of WFD compliant groundwater monitoring and picks out selected aspects from CIS guidance document No 15 (EC 2007). These requirements are the targets that the current monitoring situation is compared with.

3.1. Purpose of WFD monitoring

A WFD conform groundwater monitoring must include (EC 2007):

- A quantitative monitoring network to:
 - supplement and validate the Article 5 characterisation and risk assessment procedure with respect to risks of failing to achieve good groundwater quantitative status in all GWBs, or groups of bodies.
 - facilitate quantitative status assessment.
- A chemical surveillance monitoring network to:
 - supplement and validate the Article 5 characterisation and risk assessment procedure with respect to the risks of failing to achieve good groundwater chemical status;
 - provide information for use in the assessment of long-term trends in natural conditions and in pollutant concentrations resulting from human activity and;
 - to establish, in conjunction with the risk assessment the need for operational monitoring.
- A chemical operational monitoring network to:
 - establish the status of all GWBs, or groups of bodies, determined as being 'at risk', and
 - establish the presence of significant and sustained upward trends in the concentration of pollutants.
- Appropriate monitoring to support the achievement of Drinking Water Protected Area (DWPA) objectives.

The results of the monitoring must be used to (EC 2007):

- establish the chemical and quantitative status of GWBs (including an assessment of the available groundwater resource);

- identify whether the available groundwater resource is not exceeded by the long-term annual average rate of abstraction;
 - identify saline or other intrusions resulting from alterations of flow within the GWB;
 - identify impacts on associated aquatic and dependent terrestrial ecosystem
 - identify exceedances of groundwater quality standards and threshold values;
 - identify impairment of legitimate uses of groundwater;
- assist in further characterisation of groundwater bodies;
 - validate the risk assessments carried out under Article 5;
 - estimate the direction and rate of flow in groundwater bodies that cross Member States' boundaries;
 - assist in the design of programs of measures;
 - evaluate the effectiveness of programs of measures;
 - demonstrate compliance with objectives for DWPA and other protected area;
 - characterize the natural quality of groundwater including natural trends (baseline); and
 - identify anthropogenically induced trends in pollutant concentrations and their reversal.

Transboundary groundwater bodies: Specific provisions concern those bodies of groundwater which cross the boundary between two or more Member States. Bilateral agreement should be reached on monitoring strategies, which requires coordination of conceptual model development, the exchange of data and QA and QC aspects (in line with the requirements of Article 13(2) of the WFD). The provisions for the surveillance monitoring require transboundary groundwater bodies to be monitored for those parameters, which are relevant for the protection of all uses supported by the groundwater flow. (EC 2007)

3.2. Conceptual models

The monitoring design should be based on conceptual model/understandings, which are simplified representations or working descriptions of the hydrogeological system being investigated. A conceptual model represents the current understanding of the groundwater system based on the knowledge of its natural characteristics (e.g. the aquifer type, three-dimensional structure, dynamics and boundary conditions), perceived pressures and knowledge of impacts. This conceptual understanding is to be tested and validated by monitoring data and improved in a cyclic manner. Consequently, conceptual models do not need to be perfect and definitive, but are instead necessarily always work in progress. The complexity of conceptual models depends on the complexity of the hydrogeological system and the significance of the anthropogenic pressures. (EC 2007)

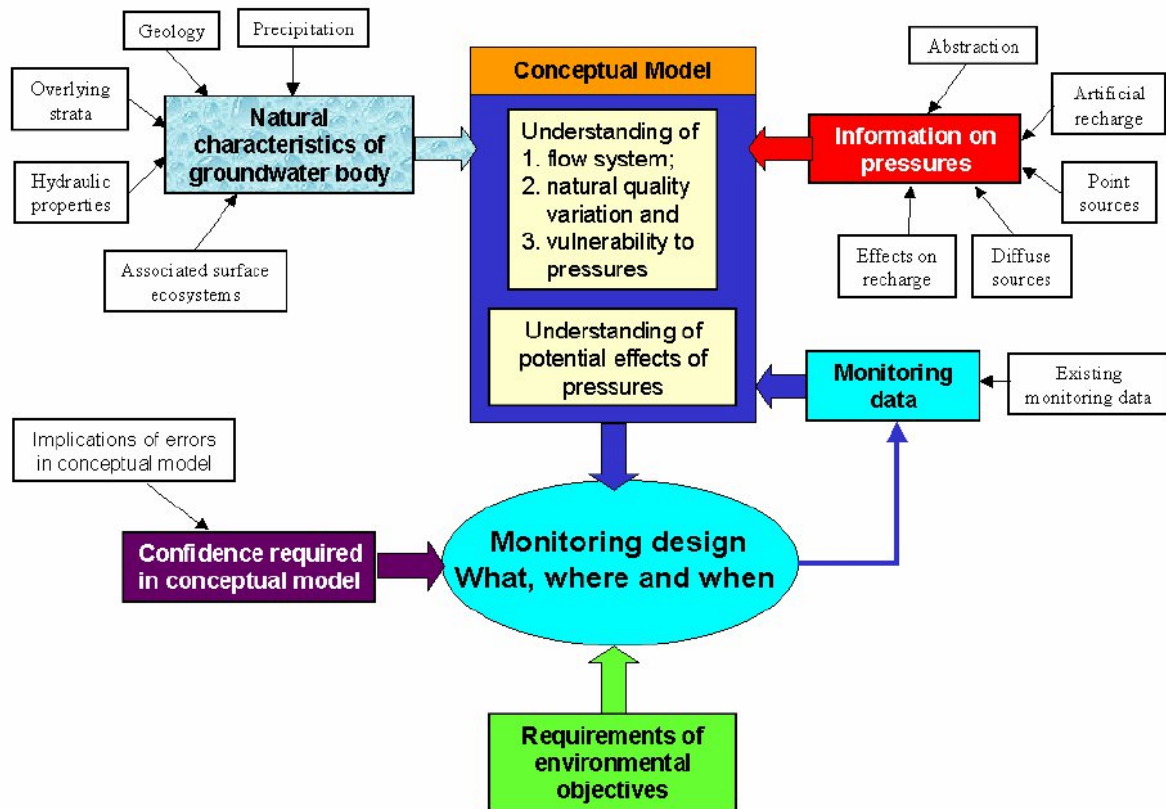


Figure 1: Link between the conceptual model/understanding and monitoring (EC 2004)

3.3. Chemical groundwater monitoring

3.3.1. Surveillance monitoring

SELECTION OF MONITORING SITES

The selection of sampling sites is of major importance for the results of the later assessment procedure, especially as contaminants are often unevenly distributed across a GWB. Additionally, a GWB is three-dimensional and the concentration of contaminants may vary significantly in vertical and lateral direction.

The distribution of surveillance monitoring sites within a GWB should be representative of the whole GWB. The selection of sites should be based on the conceptual model considering the hydrogeological properties, the distribution of different anthropogenic pressures and practical considerations relating to the suitability of individual sampling points (e.g. easily accessible, secure and able to provide long-term access agreements). (EC 2007)

Within the elaboration of recommendations for WFD conform statistical methodologies for the aggregation of chemical monitoring data and the assessment of groundwater pollution trends it was concluded that due to statistical reasons a minimum number of 3 monitoring sites per GWB is recommended. (EC 2001)

MONITORING PARAMETERS

The following core parameters are mandatory by the WFD: oxygen content, pH-value, electrical conductivity (EC), nitrate, and ammonium.

Parameters such as temperature and a set of major and trace ions are not formally required by the WFD but may be helpful to validate the Article 5 risk assessment and the conceptual models. Selective parameters (e.g. heavy metals and relevant basic radionuclides) will be needed for assessing natural background levels. Additional indicators of anthropogenic contaminants typical of land use activities in the area and with the potential to impact on groundwater will also be required on an infrequent basis to provide additional validation of WFD risk assessments and to check for any new identified pressure.

In addition, at all sites monitoring of the water level is recommended in order to describe (and interpret) the 'physical status of the site' and to interpret (seasonal) variations or trends in chemical composition of groundwater. (EC 2007)

MONITORING FREQUENCY

According to the WFD, surveillance monitoring must be undertaken during each planning cycle. No minimum duration or frequency is specified for the surveillance program.

The monitoring frequency has to be selected accordingly in order to characterise the variability of groundwater quantity and quality adequately. It is recommended, to select an appropriate monitoring frequency based on the conceptual understanding; in less dynamic groundwater systems (confined aquifers) two (or even one) samples per year may be sufficient initially for surveillance monitoring. In more dynamic systems (shallow aquifers) four samples per year are recommended. (EC 2007)

3.3.2. Operational monitoring

SELECTION OF MONITORING SITES

The operational monitoring network should be based on the monitoring sites that are part of the surveillance monitoring network and consider the potential integration of additional monitoring site from other monitoring networks for different purposes (e.g. drinking water, specific ecosystems). (EC 2007)

MONITORING PARAMETERS

In addition to the WFD core parameters, selective parameters will need to be monitored at specific locations, or across GWBs, where the risk assessments indicate that they are at risk of failing to achieve relevant objectives. These parameters will have to be considered when establishing groundwater threshold values and in the assessment of chemical groundwater status.

The sets of chemical monitoring parameters must be reviewed on a regular basis to ensure that they provide representative information and data on groundwater quality and fully support the risk assessment process. (EC 2007)

MONITORING FREQUENCY

According to the WFD, operational monitoring must be carried out at least once a year during periods between surveillance monitoring for all GWBs that are identified at risk of failing to achieve good chemical status objectives. Operational monitoring must be as sufficient as necessary to establish the status of GWBs at risk and the presence of significant and sustained upward trend in pollutant concentrations. As for surveillance monitoring, it is recommended to select the appropriate monitoring frequency on the basis of the conceptual understanding of each GWB, the seasonal effects of pollutants, as well as the seasonal use or application of pollutants.

3.4. Quantitative groundwater monitoring

SELECTION OF MONITORING SITES

As with other networks, the selection of monitoring points should be based on a conceptual understanding of the groundwater system and the pressures. The key elements of the quantitative conceptual understanding are: assessments of recharge and water balance; and/or existing groundwater level or discharge assessments and relevant information on the risks for groundwater dependent surface waters and groundwater dependent terrestrial ecosystems.

MONITORING PARAMETERS

Although the WFD identifies the metric of water levels only in assessing the quantitative status, it is highly recommended to also consider spring flows, flow characteristics and/or stage levels of surface watercourses during drought periods or stage levels in significant groundwater dependent wetlands and lakes.

MONITORING FREQUENCY

The amount and frequency of monitoring is required to be sufficient and will be determined by the data needed to determine risk and status, and where necessary to support the design and assessment of a program of measures.

Frequency of monitoring predominantly depends of the characteristics of the water body and the monitoring site respectively. Sites with significant annual variability should be monitored more frequently than sites with only minor variability. In general, monthly monitoring will be sufficient for quantity monitoring where variability is low. (EC 2007)

4. GROUNDWATER MONITORING IN MONTENEGRO – CURRENT STATE

Montenegro is divided into two River Basin Districts (RBD). The two River Basin Management Plans (RBMPs) for the Danube and Adriatic RBD have been finalized in 2020. Both RBDs are transboundary.

4.1. Legal setup

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. In 2015, the Law on Water was amended in order to further align with the requirements of the WFD. It is the main instrument transposing the WFD.

The Official Gazette of Montenegro, No. 33/08 of 27 May 2008 regulates the content and management of the water information system which will comprise 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.

The Law on Environment (Official Gazette of Montenegro, No. 52/16) defines the roles of national and local self-government authorities in planning, implementation, monitoring and reporting, and defines also the sources of financing for environmental protection. The law sets the framework and responsibilities for environmental monitoring. This law designates the Agency for Environmental Protection (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.

Résumé: Key to successful implementation of sustainable groundwater monitoring is the legal basis and long-term secured and sufficient budget exclusively devoted to groundwater monitoring considering all aspects of network establishment, equipment, maintenance of both, operating materials (e.g. gasoline) and consumables (e.g. calibration standards) and all aspects of staff availability as sufficient posts, payment, regular training.

The groundwater-related monitoring aspects seem to be well reflected in the new Law on Water and the Law on Environment, but despite the legal provisions, the availability of the necessary budget as well as the enforcement of the provisions and requirements is still needed.

4.2. Financial setup

The annual monitoring program is funded by the state budget, which was previously provided by the Ministry. But now, the Institute of Hydrometeorology and Seismology of Montenegro (IHMS) is obliged to use its own budget to cover the monitoring obligations.

Although budget is available, staff and equipment are lacking which leads to subcontracting of activities. Improvement of groundwater sampling equipment is needed e.g. appropriate vehicles for transport and sensors for water quantity monitoring. Unfortunately, the service centers for servicing and maintaining the equipment are in Serbia, outside of MNE.

The operational budget available for groundwater monitoring is insufficient to allow for extending the monitoring network and for increasing the monitoring frequency, which is needed.

Résumé: Governmental understanding of the necessity, importance and benefits of water monitoring in the light of the role of water for the regional economies is needed. Financing groundwater monitoring should be sufficient and sustainable in the long term, considering all aspects of monitoring (staff, training, infrastructure, maintenance, equipment, and consumables).

Outsourcing services to other institutes or private companies is per se not always a disadvantage. It can save money by stipulating competition and make best use of available staff and budgets.

4.3. Administrative setup

The Ministry of Agriculture, Forestry and Water Management (MAFWM), through the 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. 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 related directives.

Water Administration is an administrative body responsible for the implementation of water management strategies and plans, and it is among other things responsible for creating and operating the water information system.

The Agency for Environmental Protection as well as the under the Ministry of Ecology, Sustainable Development and Northern Region Development is responsible for planning and participation in environmental monitoring.

The Institute of Hydrometeorology and Seismology of Montenegro (IHMS) under the Ministry of Ecology, Sustainable Development and Northern Region Development is a key player in water monitoring as well. According to the Water Law (Article 83, paragraph 5), *'Monitoring of surface and groundwater and protected areas is carried out by the body*

responsible for hydrometeorological affairs.' According to the Law on Hydrometeorological Services, the IHMS has a mandate for *control and estimation of quality of surface and ground waters, precipitation and air quality, based on analysis of physic-chemical, biochemical and microbiological parameters.*

Résumé: The administrative setup is well defined and well established in Montenegro. The responsible institutions have solid experience and do not need external support or recommendations on the administrative setup.

It was reported that the Water Administration is understaffed, which should be addressed.

4.4. Groundwater bodies

For the two RBDs in Montenegro, the Danube RBD and the Adriatic RBD, groundwater bodies (GWBs) have been delineated and presented in the RBMPs which were prepared in 2020. For the first GWB delineation, a series of information was considered: e.g. geological and hydrogeological setting, aquifer classification, catchment of springs, recharge and discharge zones, expert judgement, etc. In total 30 GWBs were delineated in Montenegro. Not all of Montenegro is covered by GWBs. Some zones, which lack groundwater, contain minimal reserves (aquifuges) or are not connected to adjacent aquifers, are not attributed to GWBs and displayed on the maps as blank polygons. The coding of GWBs follows a standardized system.

- Adriatic RBD (Figure 2, Table 1): 13 GWBs (4 GWBs and 9 groups of GWBs). 11 GWBs are transboundary.
- Danube RBD (Figure 3, Table 2): 17 GWBs (4 GWBs and 13 groups of GWBs). 5 GWBs are transboundary

Résumé: So far, 30 groundwater bodies have been delineated, characterized and reported in the two RBMPs (Adriatic and Danube).

The delineation and characterisation of groundwater bodies is an important basis in the design of a WFD compliant monitoring network. GWBs might be amended if needed but need to stay unchanged for a whole RBM Plan period.



Figure 2: Adriatic RBD: location of the groundwater bodies

Table 1: Adriatic RBD: List of groundwater bodies

| GWB code | Name | Character | Size [km ²] |
|----------------|---------------------------------|---------------|-------------------------|
| ME_AB_GGW_K_1 | Southern Rim of the Skadar Lake | Inner | 243.3 |
| ME_AB_GW_I_1 | Ulcinjско polje | Transboundary | 111.1 |
| ME_AB_GGW_K_2 | Možura - Paštrovići | Inner | 399.0 |
| ME_AB_GGW_K_3 | Grbalj - Luštica | Inner | 225.9 |
| ME_AB_GW_K_4 | Opačica - Morinj | Transboundary | 136.0 |
| ME_AB_GW_K_5 | Orjen | Transboundary | 409.6 |
| ME_AB_GW_K_6 | Lovćen (Njegusi) | Inner | 330.2 |
| ME_AB_GGW_C_1 | Orahovštica - Rijeka Crnojevića | Inner | 241.3 |
| ME_AB_GGW_K_7 | Karuč - Sinjac | Inner | 277.2 |
| ME_AB_GGW_I_2 | Zeta Valley | Inner | 248.5 |
| ME_AB_GGW_C_2 | Prekornica - Bjelopavlići | Inner | 418.0 |
| ME_AB_GGW_K_8 | Garač | Inner | 338.4 |
| ME_AB_GGW_K_9 | Vojnik | Inner | 448.5 |
| ME_AB_GGW_C_3 | Nikšićko polje | Inner | 990.2 |
| ME_AB_GGW_K_10 | Trebišnjica (Bilečko Lake) | Transboundary | 575.5 |
| ME_AB_GGW_C_4 | Kući | Transboundary | 430.8 |
| ME_AB_GGW_K_11 | Morača | Inner | 355.2 |

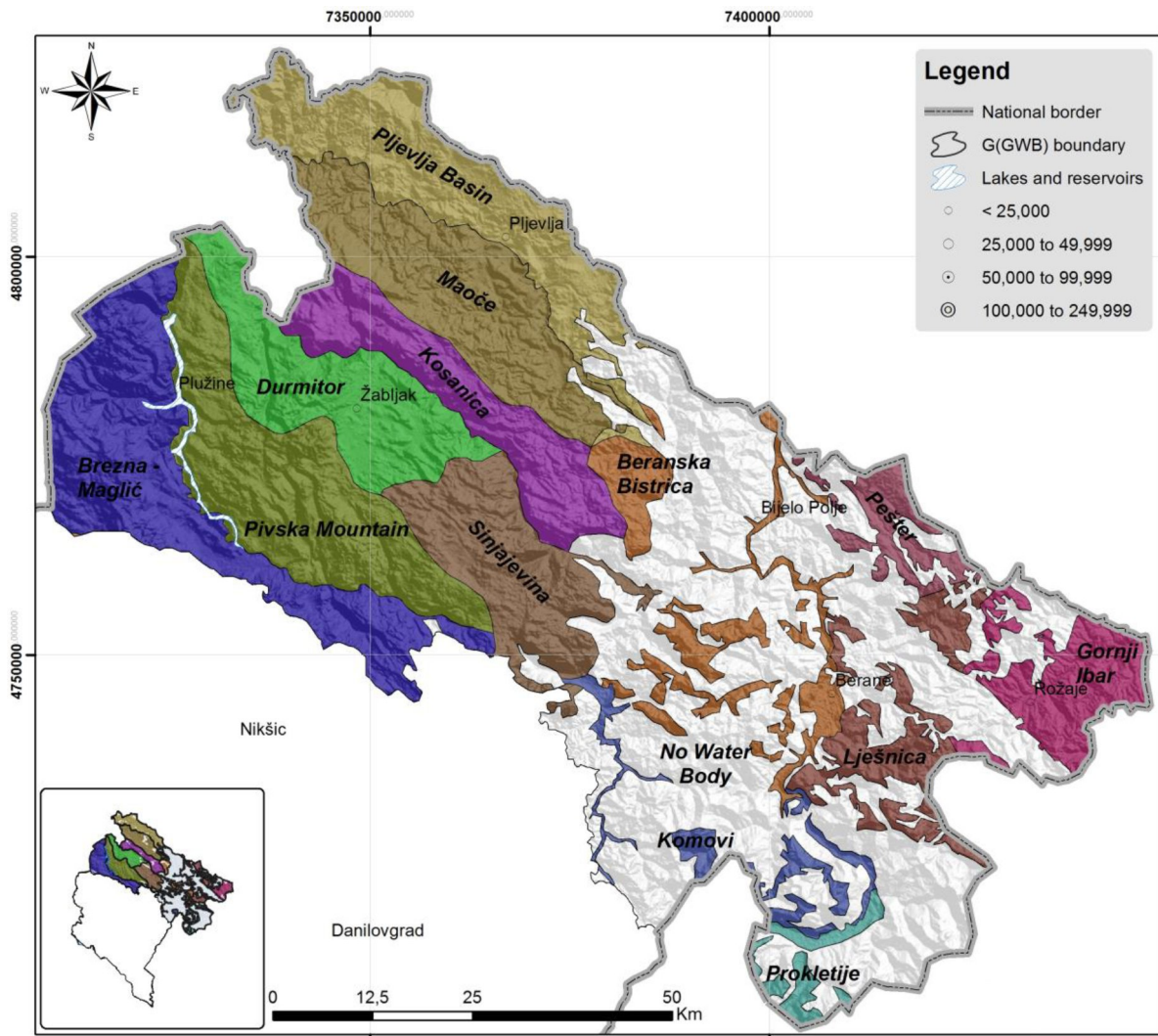


Figure 3: Danube RBD: location of the groundwater bodies

Table 2: Danube RBD: List of groundwater bodies

| GWB code | Name | Character | Size [km ²] |
|----------------|-------------------------------|---------------|-------------------------|
| ME_DB_GW_K_1 | Brezna - Maglič | Transboundary | 702.9 |
| ME_DB_GW_K_2 | Pivska Mountain | Inner | 629.9 |
| ME_DB_GW_K_3 | Sinjajevina | Inner | 406.0 |
| ME_DB_GGW_K_4 | Durmitor | Transboundary | 429.1 |
| ME_DB_GW_K_5 | Kosanica | Transboundary | 377.5 |
| ME_DB_GGW_C_1 | Maoče | Transboundary | 526.7 |
| ME_DB_GGW_I_1 | Pljevlja basin | Transboundary | 554.0 |
| ME_DB_GGW_K_6 | Prokletije | Transboundary | 69.1 |
| ME_DB_GGW_K_7 | Komovi | Transboundary | 127.7 |
| ME_DB_GGW_C_2 | Beranska Bistrica - Ljuboviđa | Transboundary | 327.7 |
| ME_DB_GGW_K_8 | Lješnica | Transboundary | 239.9 |
| ME_DB_GGW_K_9 | Pešter | Transboundary | 117.0 |
| ME_DB_GGW_K_10 | Gornji Ibar | Transboundary | 253.0 |

4.5. Groundwater monitoring design

As already mentioned, the Institute of Hydrometeorology and Seismology of Montenegro (IHMS) under the Ministry of Ecology, Sustainable Development and Northern Region Development is the key player in groundwater monitoring.

4.5.1. Monitoring network

The existing groundwater monitoring network is described and illustrated in the RBMPs. There are 26 monitoring sites in the Danube RBD (see Figure 4 and Table 4) and 43 in the Adriatic RBD (see Figure 5 and Table 4).

As the actual situation of groundwater monitoring is not satisfactory, a new monitoring network of Montenegro will be gradually built. According to both RBMPs, the target for its completion should be the year 2027 or 2028. It is intended to oblige waterworks and companies that receive concessions for water extraction, to regularly observe discharges, water tables and chemistry of tapped springs and wells and to deliver this data to responsible authorities.

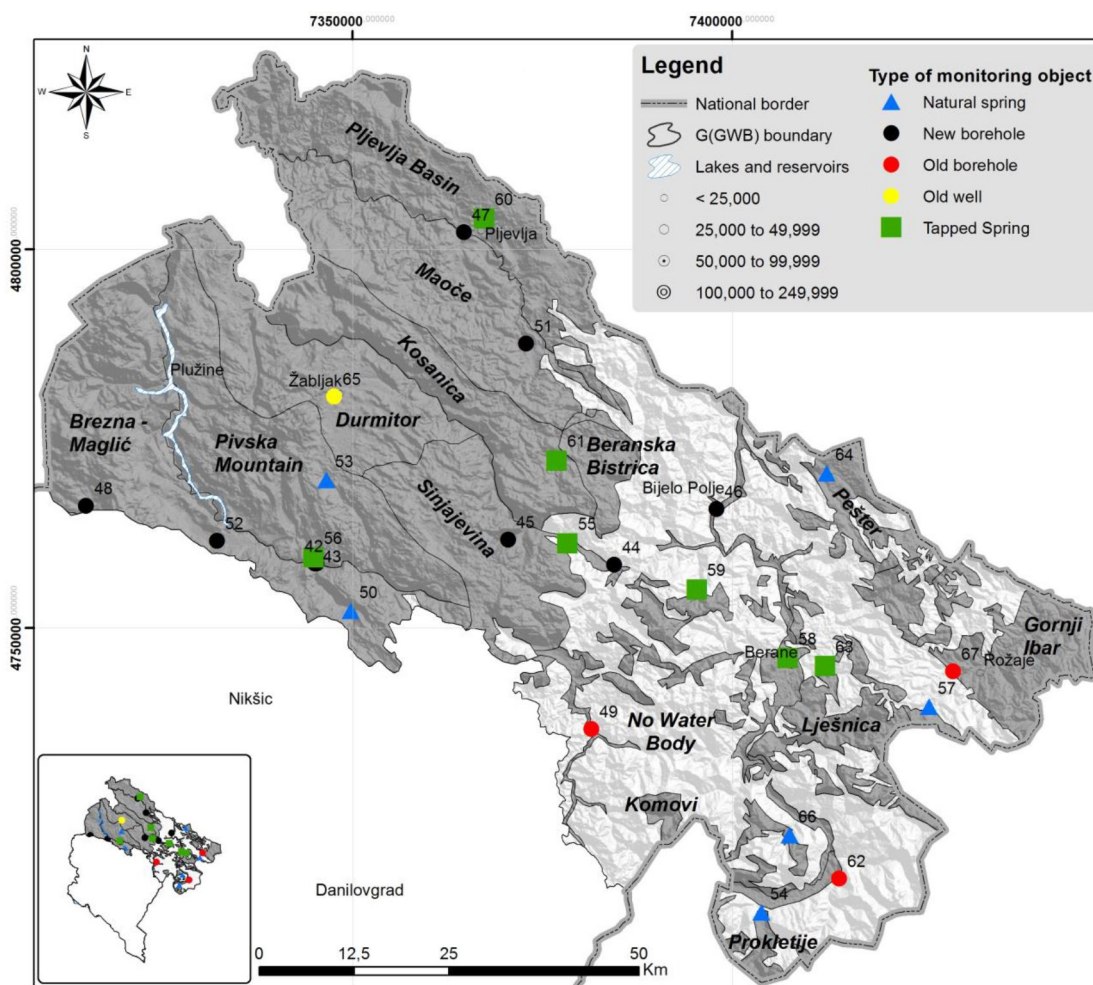


Figure 4: Location of groundwater monitoring in the Danube River Basin

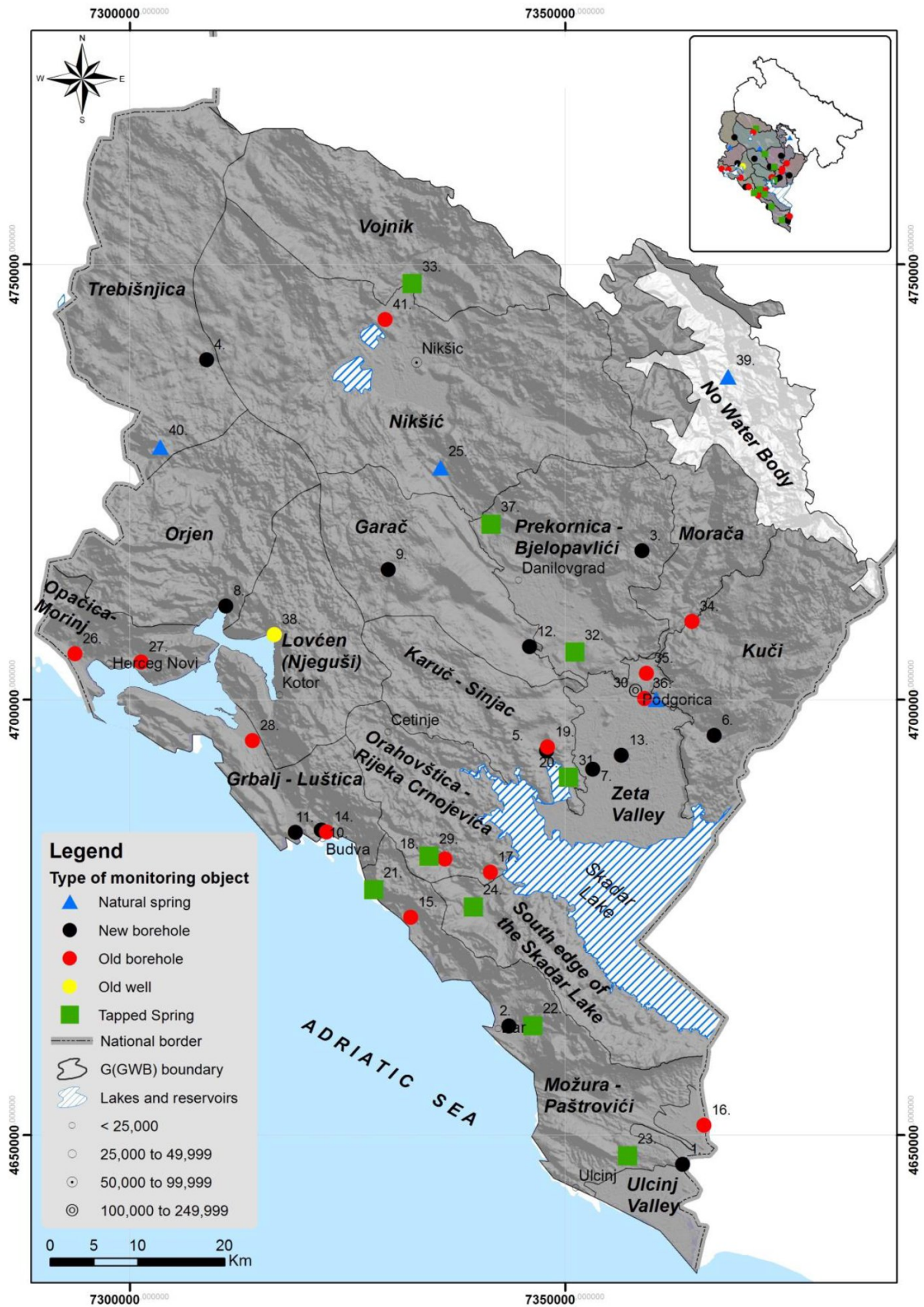


Figure 5: Location of Groundwater monitoring stations in the Adriatic River Basin

Table 4: Monitoring sites per groundwater body in Montenegro

| RBD | Code of GWB/group of GWBs | Name of GWB | No of GW monitoring sites |
|----------|---------------------------|---------------------------------|---------------------------|
| Adriatic | ME_AB_GGW_C_1 | Orahovštica – Rijeka Crnojevića | 3 |
| Adriatic | ME_AB_GGW_C_2 | Prekornica - Bjelopavlići | 3 |
| Adriatic | ME_AB_GGW_C_3 | Niškičko polje | 2 |
| Adriatic | ME_AB_GGW_C_4 | Kuč | 3 |
| Adriatic | ME_AB_GGW_I_2 | Zeta Valley | 4 |
| Adriatic | ME_AB_GGW_K_1 | Southern Rim of the Skadar Lake | 1 |
| Adriatic | ME_AB_GGW_K_10 | Trebišnjica (Bilećko Lake) | 2 |
| Adriatic | ME_AB_GGW_K_11 | Morača | 1 |
| Adriatic | ME_AB_GGW_K_2 | Možura - Paštrovići | 4 |
| Adriatic | ME_AB_GGW_K_3 | Grbalj - Luštica | 4 |
| Adriatic | ME_AB_GGW_K_7 | Karuč - Sinjac | 4 |
| Adriatic | ME_AB_GGW_K_8 | Garač | 2 |
| Adriatic | ME_AB_GGW_K_9 | Vojnik | 1 |
| Adriatic | ME_AB_GW_I_1 | Ulcinjско polje | 2 |
| Adriatic | ME_AB_GW_K_4 | Opačica - Morinj | 2 |
| Adriatic | ME_AB_GW_K_5 | Orjen | 1 |
| Adriatic | ME_AB_GW_K_6 | Lovćen (Njegusi) | 1 |
| Adriatic | ME_AB_GGW_K_2 | Možura - Paštrovići | 1 |
| Danube | ME_DB_GGW_C_1 | Maoče | 1 |
| Danube | ME_DB_GGW_C_2 | Beranska Bistrica - Ljuboviđa | 3 |
| Danube | ME_DB_GGW_I_1 | Pljevlja basin | 2 |
| Danube | ME_DB_GGW_K_10 | Gornji Ibar | 2 |
| Danube | ME_DB_GGW_K_4 | Durmitor | 1 |
| Danube | ME_DB_GGW_K_6 | Prokletije | 2 |
| Danube | ME_DB_GGW_K_7 | Komovi | 2 |
| Danube | ME_DB_GGW_K_8 | Lješnica | 1 |
| Danube | ME_DB_GGW_K_9 | Pešter | 1 |
| Danube | ME_DB_GW_K_1 | Brezna - Maglić | 5 |
| Danube | ME_DB_GW_K_2 | Pivska Mountain | 2 |
| Danube | ME_DB_GW_K_3 | Sinjajevina | 3 |
| Danube | ME_DB_GW_K_5 | Kosanica | 1 |

According to the Adriatic and Danube RBMPs 13 respectively 17 additional monitoring sites are proposed to be established until 2027 respectively 2028 (see Table 9 in the Annex). This revision will happen in stages, prioritizing GWBs under already recognized or assumed pressures.

Résumé: The present groundwater monitoring network does not fully meet the requirements of the WFD. Although the existing network covers all GWBs and groups of GWBs, the number of monitoring sites per GWB is quite low, in several cases only one or two sites.

Regarding the planned revision and extension of the network and the monitoring activity, the operative budget was reported to be insufficient, needing an extension to complete and improve hydrochemical monitoring and to include new boreholes for quantity monitoring. Budget is needed for maintenance and/or renewal of existing sites. When improving the network, it is highly recommended to go for a multipurpose network covering the WFD, Nitrates Directive and further water related legislation.

4.5.2. Monitoring parameters and frequency

Groundwater quantity

Data on the groundwater levels of dug or drilled wells are very rarely measured in entire Montenegro, while sporadically collected data of spring discharges are found in available literature (see List of References in Annex 1).

- 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.

Although some general information on the springs' discharges is indeed available ($Q_{min}/av/max$), such data has been systematically collected for very few springs (IHMS, 2007–2016).

Groundwater chemistry

The examination of groundwater quality is performed by the IHMS. This program 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 in %, 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.

Résumé: Groundwater chemical and quantitative monitoring is overall very weak in terms of both measured and analysed parameters and monitoring frequency, hence not allowing comprehensive and reliable status and trend assessments.

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, to predict the water balance dynamics with any accuracy, according to the full requirements of the WFD.

4.5.3. Transboundary groundwater monitoring

According to the Law on Water, transboundary cooperation and information sharing in management of international RBDs is under the responsibility of MAFWM/WA.

Montenegro shares one aquifer of the Dinaric Karst Aquifer System with Albania (Adriatic RBD) and one aquifer of the Dinaric Karst Aquifer System with Bosnia and Herzegovina (Danube RBD). In total 16 of 30 GWBs are identified as transboundary in the Adriatic and Danube RBMPs.

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 and is contracting party to the International Commission for the Protection of the Danube River (ICPDR).

On 3 July 2018, Montenegro and Albania signed the Framework Agreement between on Mutual Relations in Transboundary Water Resources Management, which covers all water resources of common interest. The focus of this Agreement is on water use, water protection and flood management. Except for a requirement to exchange hydrogeological data, groundwater falls outside its scope, although it is included in the definition of “transboundary waters”.

An agreement between the Government of Montenegro and the Government of Croatia on mutual relations in the area of water management was signed at Zagreb on 4 September 2007 (Official Gazette of Montenegro, No. 1/08 of 10 January 2008). The agreement covers all water resources of common interest, whether surface or underground.

There are no agreements between Montenegro and Bosnia and Herzegovina, except for a memorandum of understanding on cooperation in the implementation of the West Balkans Drina River Basin Management Project (dated 9 May 2016)¹. No agreements exist with Serbia and Kosovo. Montenegro holds the status of observer in the International Commission for the Sava River Basin.

Résumé: About half of the delineated GWBs are transboundary. Montenegro is contracting party of the ICPDR and observer in the Sava Commission. A bilateral agreement with Albania on transboundary water resources management exists, but it mainly excludes groundwater aspects. There are no agreements with Bosnia and Herzegovina, Kosovo and Serbia.

It is highly recommended to push the establishment of transboundary agreements with all neighbors, which cover groundwater quantity and chemical aspects and conjunctive management of surface and groundwater resources. The latter is of particular importance in karstic aquifer systems.

¹ Between the MAFWM and the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina.

4.5.4. Data management

The water information system demanded by the Law on Water is online accessible under the Geoportal of the Water Administration (<https://wis.gov.me/>). There is a decree on the content and management of the water information system (Official Gazette of Montenegro, No. 33/08 of 27 May 2008) and the Water Administration (WA) is among other things responsible for creating and operating the water information system

Regarding groundwater, the Geoportal shows aquifers, groundwater bodies, groundwater monitoring sites, the characterization of groundwater bodies (data sheets) and meta data on the sampling sites.

4.5.5. Reporting

Only a limited amount of information of sufficient quality is available in Montenegro to properly 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 both RBDs.

Reporting to the Water Information System Europe (WISE) was not yet needed. Hence, reporting according to the WISE format needs to be developed and a respective training workshop was held in May 2025 under activity WP1-4 of the EU4Green program.

5. THE WAY TOWARDS WFD MONITORING

Based on the projects assessment, the status quo of the implementation of WFD compliant groundwater monitoring in Montenegro is briefly indicated in Table 4.

WFD compliant monitoring has to provide evidence, whether the objectives are achieved (status, trends), provide information about the significance of various pressures and impacts to establish appropriate measures, and has to demonstrate the effectiveness of measures implemented. This overview allows for planning the next steps towards establishing a comprehensive and really WFD compliant monitoring system.

Table 4: Status quo towards WFD compliant groundwater monitoring

| | Steps | Danube and Adriatic RBD | Target date | |
|----|---|---|---|--------------|
| 1 | Delineate GWBs | Completed | | |
| 2 | Characterise GWBs | Completed | | |
| 3 | Pressure/impact (Risk) assessment for GWB | Completed | | |
| 4 | Quantity monitoring | Legal basis | In line with WFD | |
| | | Operative budget | Available but needs extension to cover review and extension of network and frequencies | 2027 or 2028 |
| | | Network density | Not representative. Review per GWB is needed and planned. | |
| | | Practical implementation | Insufficient due to budget constraints. | |
| 5 | Chemical monitoring | Legal basis | In line with WFD | |
| | | Operative budget | Available but needs extension to cover review and extension of network and frequencies | 2027 or 2028 |
| | | Network density | 67 sites existing but significant extension is needed and planned | |
| | | Practical implementation | Insufficient in terms of sites, parameters and frequency. Proposals on monitoring frequencies in RBMPs | |
| 6 | Sampling | Training | Accredited staff for sampling available at CETI. Training on monitoring design, sampling and QA appreciated. | |
| | | Equipment | Improvement of equipment (e.g. pumps, vehicle, sensors) needed. Budget constraints. No service centre available within MNE. | |
| 7 | Data management | Water information system is online - Geoportall. Access to the monitoring data is still needed. | | |
| 8 | Set GW threshold values | Not established | | |
| 9 | Natural GW background levels | Not established | | |
| 10 | Status and trend assessment | Establish methods | Not established | |
| | | Perform assessment | Not established | |

Within the WP1-4 regional workshop on the benefits of monitoring (June 2024, Podgorica) the representatives of Montenegro identified the aspects of monitoring which need highest attention (see Table 5).

Table 5: Challenges identified by representatives of Montenegro in 2024*.

| Questions | Answers |
|---|---|
| Most urgent challenges towards WFD compliant monitoring | <ul style="list-style-type: none"> • Financial and human resources. • Review and update of the monitoring network. |
| Elements in need of most attention | <ul style="list-style-type: none"> • Funding. Better coordination with all institutions. • Analysis of the reporting needs. |
| Next steps taken | <ul style="list-style-type: none"> • Meet more often. • Prepare draft MoU. |
| Project support needed | <ul style="list-style-type: none"> • Inform Ministry of Finance about this workshop and forward presentations. |

*... WP1-4 regional workshop on the benefits of water monitoring (June 2024, Podgorica)

Monitoring capacities depend on personnel resources, monitoring infrastructure (networks), equipment including consumables and finally, as the underlying factors, a legal basis and long-term assigned financial resources. The following sub-chapters provide some recommendations on how to improve groundwater monitoring as a whole and finally to comply with the requirements of the WFD and other water related legislation in the sense of multipurpose monitoring covering:

- Monitoring budget
- Groundwater body delineation
- Groundwater monitoring design
- Data assessment

MONITORING BUDGET AND CAPACITIES

The main bottleneck towards representative, WFD compliant and multi-purpose water monitoring in Montenegro is insufficient governmental understanding of the necessity, importance and benefits of water monitoring in the light of the role of water for the national economy. Hence, the lack of awareness and strong visions in the responsible administrations result in insufficient and unsustainable financing of water monitoring activities and finally in insufficient technical (monitoring infrastructure, the lack of proper equipment etc.) and human resources (insufficient, not well-paid staff and limited expertise). The significant help of EU and international donors and funding through projects is highly appreciated in the WB6 economies; nevertheless, strong governmental commitments would significantly push forward the progress towards sustainable water monitoring efforts and avoid frequent setbacks caused by temporal gaps in national funding.

The evidence of the economic, societal, and environmental benefits of comprehensive water monitoring was demonstrated at the regional workshop under WP1-4 on 5-6 June 2024.

- There is a need for better governmental understanding of the necessity, importance and benefits of water monitoring and for **strong commitment of sufficient sustainable financing** of groundwater monitoring.
- There is a need to establish posts and hire **well-paid and educated staff** which is primarily focusing on long-term management of water monitoring.
- **Detailed cost estimations** are needed, covering all aspects of monitoring. The estimate should distinguish between
 - sufficient one-time budget to cover the investment costs like infrastructure, equipment etc.
 - sufficient long-term guaranteed permanent budget to cover maintenance of infrastructure and equipment; and
 - operational costs for staff, training and consumables.
- It is necessary to **demonstrate** to the political decision makers the **benefits of monitoring**. The costs of monitoring should be compared with the national economic benefits gained from e.g. water industries and water related tourism. Such a comparison could strongly convince decision makers in the importance of comprehensive water monitoring.

GROUNDWATER BODIES DELINEATION

The GWB delineation is finalized and reported in the Adriatic and Danube RBMPs. Transboundary GWBs are identified as well.

- It is necessary to establish bilateral agreements with the neighbors, addressing bilateral characterization of water bodies, joint monitoring, data exchange and joint data assessment as well as conjunctive management of surface and groundwaters is highly recommended, in particular for karstic aquifers.

GROUNDWATER MONITORING DESIGN

As mentioned in the RBMPs, the current groundwater monitoring design is not in line with the requirements of the WFD. All GWBs seem to be covered by monitoring sites but the number of sites per GWB is very low. The groundwater monitoring network needs to be representative for each GWB as a whole. The WFD CIS guidance 18 recommends a minimum number of three monitoring sites for homogenous hydrogeological condition for statistical reasons. For karstic GWBs, the number of monitoring sites is very much depending on the heterogenic character of the aquifers and each GWB. It is highly recommended to consider multipurpose monitoring covering all needs of further international and national legislation and reporting needs.

Monitoring network

The following activities are recommended and are already addressed in the RBMPs:

- Check the current network:
 - Assess for each individual GWB the existing monitoring network on its representativeness in terms of hydrogeology, spatial coverage and the distribution of existing anthropogenic pressures. Perform the assessment for both aspects separately, for groundwater quantity and quality.
 - As appropriate, check existing monitoring sites, which fit to a representative network, on their technical status in terms of accessibility and allowing for quality assured sampling and field measurements and allowing for delivering reliable and representative monitoring data.
 - As appropriate, refurbish suitable existing sites.
- If the existing monitoring network (quantity and chemical) in a GWB is not sufficient:
 - Check whether existing wells/springs are available and appropriate for inclusion into a representative network. The inclusion of existing wells is more cost efficient than drilling new wells (guarantee long-term access to the wells).
 - Make an inventory of existing springs, try to identify the recharge area by tracer/isotope analysis and include into the monitoring network those that are identified representative in terms of the natural characteristics and the anthropogenic pressures in the GWB.
 - Establish new wells and select new springs to be added to the network.
 - When equipping monitoring sites with self-recording devices, high investment costs, continuous long-term maintenance, replacement costs and the risk of data losses in case of equipment damage must be considered.
 - As recommended by respective EU CIS guidance documents, the GW monitoring network should also include wells, springs and points for measuring surface water levels during the dry period as well as waterlogged territories and lakes that are essentially dependent on GW.
- Transboundary network
 - Identify / establish monitoring sites for the transboundary GWBs which should be subject of joint monitoring and mutual data exchange.
 - Establish bilateral agreements for joint monitoring and data exchange with the neighbors.

Monitoring parameters and frequency

In terms of groundwater monitoring, the WFD follows a risk-based approach with surveillance and operational monitoring, and it is necessary to tailor the scope (parameters) and frequency of monitoring to the natural properties and to the significance of human pressures affecting groundwater. This means that the national monitoring program needs to reflect this approach by a certain level of flexibility in its legal provisions. Risk-based monitoring contributes to focused and cost-efficient monitoring.

The RBMPs (chapter 6.3.2) already propose monitoring frequencies for surveillance and operational monitoring, which are in line with the requirements of the WFD. The schema considers aquifer flow type (confined, unconfined), transmissivity, vulnerability and pressures.

- The proposed list of parameters for surveillance and operational monitoring is very short, only covering the WFD core parameters and the parameters causing a risk. It is highly recommended to extend the basic list of chemical parameters by the major ions, heavy metals and selected organic substances, which can be very useful in the characterisation of aquifers, in the assessment of long-term trends and in establishing natural background concentrations
- It is highly recommended to monitor a basic set of parameters (major ions, heavy metals, selected organic substances) which are not causing risk in the remaining five years between the surveillance monitoring at a lower monitoring frequency, to collect data for GWB characterisation and trend assessment.
- It is mentioned in the RBMPs that the WFD does not consider “investigative monitoring” for groundwater, but in fact the role of surveillance monitoring is indeed a kind of investigative or screening monitoring, validating the risk assessment. This means that the screening of an extended list of parameters should allow for assessing whether impacts from identified pressures are evident (e.g. nutrients and pesticides in agricultural areas) but also for assessing whether impacts are evident but anthropogenic pressures have been overlooked (e.g. PFAS, heavy metals).

SAMPLING AND EQUIPMENT

Monitoring and sampling equipment is insufficient and not modern:

- Make an inventory of available sampling equipment and check functionality. Calibrate the equipment according to the manuals.
- Identify the needed vehicles for transport and sensors for water quantity monitoring.
- Make an inventory of all necessary consumables (e.g. filters, stabilizers, calibration standards, batteries or gasoline for pumps) for sampling, stabilization and cooling of samples.
- Prepare a list of needed equipment and consumables together with a cost estimate, considering the stepwise extension of the network. Consider replacing outdated equipment and consider back-up equipment units. Distinguish the costs by one-time investment costs, costs for regularly replacing equipment and permanent costs for maintenance and consumables.
- Identify the need for additional staff and for training needed.

DATA MANAGEMENT

A fully developed and implemented water information system compatible with international and national information databases is demanded by the Law on Water. As listed in the RBMPs, the main aims are to enable international data sharing with the ICPDR, the Sava Commission, to enable reporting to the EEA and to enable national data sharing with the environmental information system and the IHMS information system. The establishment of such a system is under the responsibility of the WA, EPA and IHMS. Until 2026 it is expected to develop procedures for data recording into the water information system for Montenegro and also for data analysis and reporting as required by the EEA.

The WebGIS of the Water Administrations Geoportal currently displays the groundwater bodies, aquifers and groundwater monitoring sites and gives access to data sheets with the characterization of the groundwater bodies. Access to the monitoring data is still needed.

DATA ASSESSMENT

The assessment of groundwater quantitative and chemical risk and status for the current RBMPs was not done based on defined methodologies but rather based on expert opinion.

- Establish groundwater threshold values according to the requirements of the EU Groundwater Directive and based on the related CIS guidance document No 18 on Groundwater Status and Trend Assessment.
- Identify the natural background levels of substances naturally occurring, which are needed for the threshold value establishment
- Establish methodologies for groundwater quantity and chemical risk assessment
- Establish methodologies for groundwater quantity and chemical status assessment
- Establish methodologies for trend and trend reversal assessment.

COORDINATION, PERSONNEL AND TRAININGS

Although the budget for monitoring activities is available, the personnel situation is unsatisfying:

- Establish a national working group on groundwater under the lead of WA (or IHMS), which brings together the main national expertise in groundwater management (institutes, university and regional administration) to communicate and discuss approaches about the implementation of the groundwater related aspects of the WFD.
- Establish sufficient well-paid posts;
- Hire sufficient and well-paid staff for the open posts (e.g. responsible for groundwater monitoring design, sampling, quality assurance and quality management and the assessment of status and trends);
- Regularly train the own staff in groundwater sampling (train the trainer is needed);
- Training on various aspects is recommended (see Table 6)

Table 6: Proposed groundwater training (to be amended as needed)

| Activity / Training | Competence profiles | Training targets |
|---|--|---|
| Training on GWB monitoring design | <ul style="list-style-type: none"> • Principal understanding of the WFD principles and approach, the implementation steps, the role of monitoring and their design. • Understanding of subsidiary principle in the implementation of the WFD and the need for developing tailored, national approaches. | <ul style="list-style-type: none"> • Analysis of the current monitoring design (network, parameters, frequency). • Full understanding of the WFD principles of GWB surveillance and operational monitoring with examples from EU Member States and EU guidance documents. • Hands-on exercise in GWB monitoring design for an RBD. |
| Hands-on training on the development of a tailored WFD assessment methodology for risk, status and trends – for GW quantity and chemistry | <ul style="list-style-type: none"> • Ability to applying different methods of data aggregation and interpretation of the results. • Ability to judge the methods used by different countries and to conclude on most appropriate national approaches | <ul style="list-style-type: none"> • Common discussion of the current proposals of (aggregating and) analysing monitoring data and in concluding on the status. • Main emphasis on GWBs with only few data. • Discussion and interpretation of the testing results of different approaches. • Development of national approaches |
| Theoretical and practical training on GW sampling. Preparation of GW manual and survey | <ul style="list-style-type: none"> • Understanding of the role of monitoring in GW management. • Awareness for quality assurance and quality control in field measurements, GW sampling, sample stabilisation and transport. • Practical handling of equipment and check. • Importance of careful survey planning, possible mistakes in sampling and consequences. | <ul style="list-style-type: none"> • Theoretical training in survey planning, handling and treatment of field equipment, coordination with the laboratory, sample treatment and conservation, documentation. • Practical sampling training in the field. • Discussion of experiences and need for equipment. • Careful preparation of a GW survey. Preparation of a survey manual and discussion of deliverables of a survey. |
| Workshop on certified sampling, theory and practise. | <ul style="list-style-type: none"> • Practical experience in GW sampling. • Practical handling of equipment and check. | <ul style="list-style-type: none"> • Sampling according to ISO standards. • Awareness of importance of QA/QC in all aspects of GW sampling. • Sampling mistakes and consequences. • Certification of sampling. |
| Refresh witness audit of GW sampling. | <ul style="list-style-type: none"> • Solutions for questions raised during routine sampling work. • Awareness for QA/QC in field measurements, GW sampling, sample stabilisation and transport. • Practical handling of equipment and check. | <ul style="list-style-type: none"> • Refresher training in survey planning, handling and treatment of field equipment, coordination with the laboratory, sample treatment and conservation, documentation. • Witness-check of practical sampling in the field. • Discussion of experiences and need for equipment. |
| Training on data validation, interpretation, assessment and reporting | <ul style="list-style-type: none"> • Experience with electronic data management and calculation. • Principle understanding of natural and anthropogenic impacts on water | <ul style="list-style-type: none"> • Validation of monitoring data in cooperation with the laboratory. • Interpretation of the data and identification of errors • Application of the assessment methods • Preparation of easy-to-read figures and messages summarising monitoring and assessment results. |
| GIS training | <ul style="list-style-type: none"> • Experience in GIS systems and data structuring. | <ul style="list-style-type: none"> • Enhanced structuring of GIS data (INSPIRE conform) • Design and preparation of appropriate maps. • Establishment of WebMap Services |

6. REFERENCES

EU Legislation and CIS Guidance documents

1. Directive 2000/60/EC of the European Parliament and of the Council of 23 December 2000 establishing a framework for the Community action in the field of water policy. Official Journal of the European Communities, L 327, 22.12.2000, p. 1-73
2. EC, 2001: Statistical aspects of the identification of groundwater pollution trends, and aggregation of monitoring results. CIS Technical Report No. 1. European Commission.
3. EC, 2007: Guidance on Groundwater Monitoring. CIS Guidance Document No 15. European Commission.
4. EC, 2008: Groundwater Protection in Europe. The new Groundwater Directive – Consolidating the EU Regulatory Framework. European Commission.
5. EC, 2009: Guidance on Groundwater Status and Trend Assessment. CIS Guidance Document No 18. European Commission.
6. EC, 2024: Montenegro 2024 Report. SWD(2024) 694 final.

National documents

7. Law on Water. Official Gazette of Montenegro, Nos. 27/07, 32/11, 48/15 and 84/18.
8. Law on Environment (Official Gazette of Montenegro, No. 52/16).
9. Adriatic River Basin Management Plan. Final Version 27/03/2020. Contract No.383-638: EuropeAid/138151 /DH/SER/ME
10. Danube River Basin Management Plan. Final Version 27/03/2020. Contract No.383-638: EuropeAid/138151 /DH/SER/ME

7. ANNEX

Table 9: List of existing groundwater monitoring sites in Montenegro

| No. | RBD | Name | Type | Code of GWB/GGWB | GW Body |
|-----|----------|---------------------------|-----------------------------|------------------|---------------------------------|
| 1 | Adriatic | Sv. Djordje (Ulcinj) | New borehole | ME_AB_GW_I_1 | Ulcinjско polje |
| 2 | Adriatic | Popovići (Bar) | New borehole | ME_AB_GGW_K_2 | Možura - Paštrovići |
| 3 | Adriatic | Radovče | New borehole | ME_AB_GGW_C_2 | Prekornica - Bjelopavlići |
| 4 | Adriatic | Riječani | New borehole | ME_AB_GGW_K_10 | Trebišnjica (Bilečko Lake) |
| 5 | Adriatic | Goljemadi | New borehole | ME_AB_GGW_K_7 | Karuč - Sinjac |
| 6 | Adriatic | Trgaj (Cijevna) | New borehole | ME_AB_GGW_C_4 | Kuč |
| 7 | Adriatic | Cijevna (mouth) | New borehole | ME_AB_GGW_I_2 | Zeta Valley |
| 8 | Adriatic | Risan (near school) | New borehole | ME_AB_GW_K_5 | Orjen |
| 9 | Adriatic | Čevo | New borehole | ME_AB_GGW_K_8 | Garač |
| 10 | Adriatic | Lugovi (Budva) | New borehole | ME_AB_GGW_K_3 | Grbalj - Luštica |
| 11 | Adriatic | Jaz | New borehole | ME_AB_GGW_K_3 | Grbalj - Luštica |
| 12 | Adriatic | Bandići (Vučiji Studenac) | New borehole | ME_AB_GGW_K_8 | Garač |
| 13 | Adriatic | Plantaze | New borehole | ME_AB_GGW_I_2 | Zeta Valley |
| 14 | Adriatic | Budva (bus station) | Old borehole | ME_AB_GGW_K_3 | Grbalj - Luštica |
| 15 | Adriatic | Buljarica | Old borehole | ME_AB_GGW_K_2 | Možura - Paštrovići |
| 16 | Adriatic | Lisna Bori | Old borehole | ME_AB_GW_I_1 | Ulcinjско polje |
| 17 | Adriatic | Orahovsko polje | Old borehole | ME_AB_GGW_C_1 | Orahovštica - Rijeka Crnojevića |
| 18 | Adriatic | Sjenokos | Old borehole | ME_AB_GGW_C_1 | Orahovštica - Rijeka Crnojevića |
| 19 | Adriatic | Kaludjerovo Oko | Old borehole | ME_AB_GGW_K_7 | Karuč - Sinjac |
| 20 | Adriatic | Bolje Sestre (borehole) | Old borehole | ME_AB_GGW_K_7 | Karuč - Sinjac |
| 21 | Adriatic | Reževića River Spring | Tapped Spring | ME_AB_GGW_K_2 | Možura - Paštrovići |
| 22 | Adriatic | Kajnak Spring | Tapped Spring | ME_AB_GGW_K_2 | Možura - Paštrovići |
| 23 | Adriatic | Gač Spring | Tapped Spring | ME_AB_GGW_K_2 | Možura - Paštrovići |
| 24 | Adriatic | Velje Oko Spring | Tapped Spring | ME_AB_GGW_K_1 | Southern Rim of the Skadar Lake |
| 25 | Adriatic | Obošničko Oko | Natural Spring | ME_AB_GGW_C_3 | Niškičko polje |
| 26 | Adriatic | Sutorinsko polje | Old borehole | ME_AB_GW_K_4 | Opačica - Morinj |
| 27 | Adriatic | Opačica | Old borehole | ME_AB_GW_K_4 | Opačica - Morinj |
| 28 | Adriatic | Grbaljsko polje | Old borehole | ME_AB_GGW_K_3 | Grbalj - Luštica |
| 29 | Adriatic | Podgorska Spring | Tapped Spring | ME_AB_GGW_C_1 | Orahovštica - Rijeka Crnojevića |
| 30 | Adriatic | Ribnička Spring | Natural Spring | ME_AB_GGW_C_4 | Kuč |
| 31 | Adriatic | Bolje Sestre Spring | Tapped Spring | ME_AB_GGW_K_7 | Karuč - Sinjac |
| 32 | Adriatic | Mareza Spring | Tapped Spring | ME_AB_GGW_C_2 | Prekornica - Bjelopavlići |
| 33 | Adriatic | Vidrovan Spring | Tapped Spring | ME_AB_GGW_K_9 | Vojnik |
| 34 | Adriatic | Bioče | Old borehole | ME_AB_GGW_C_4 | Kuč |
| 35 | Adriatic | Zagorič | Old borehole | ME_AB_GGW_I_2 | Zeta Valley |
| 36 | Adriatic | Čemovsko polje | Old borehole | ME_AB_GGW_I_2 | Zeta Valley |
| 37 | Adriatic | Viš springs | Tapped Spring | ME_AB_GGW_C_2 | Prekornica - Bjelopavlići |
| 38 | Adriatic | Orahovac | Old well | ME_AB_GW_K_6 | Lovćen (Njegusi) |
| 39 | Adriatic | Svetigora spring | Natural spring | ME_AB_GGW_K_11 | Morača |
| 40 | Adriatic | Zaslapnica | Natural spring | ME_AB_GGW_K_10 | Trebišnjica (Bilečko Lake) |
| 41 | Adriatic | Niškić (Miločani) | Old borehole | ME_AB_GGW_C_3 | Niškičko polje |
| 42 | Danube | Šavnik (near school) | New borehole ¹⁷² | ME_DB_GW_K_1 | Brezna - Maglić |
| 43 | Danube | Šavnik (alluvium) | New borehole | ME_DB_GW_K_1 | Brezna - Maglić |
| 44 | Danube | Mojkovac | New borehole | ME_DB_GW_K_3 | Sinjajevina |
| 45 | Danube | Ravnjak | New borehole | ME_DB_GW_K_3 | Sinjajevina |
| 46 | Danube | Bijelo Polje | New borehole | ME_DB_GGW_C_2 | Beranska Bistrica - Ljuboviđa |
| 47 | Danube | Pljevlja | New borehole | ME_DB_GGW_I_1 | Pljevlja basin |
| 48 | Danube | Zaljutnica | New borehole | ME_DB_GW_K_1 | Brezna - Maglić |
| 49 | Danube | Mateševo | Old borehole | ME_DB_GGW_K_7 | Komovi |
| 50 | Danube | Oko Bijele Spring | Natural Spring | ME_DB_GW_K_1 | Brezna - Maglić |
| 51 | Danube | Maoče | New borehole | ME_DB_GGW_C_1 | Maoče |
| 52 | Danube | Brezna | New borehole | ME_DB_GW_K_1 | Brezna - Maglić |
| 53 | Danube | Bukovica Spring | Natural Spring | ME_DB_GW_K_2 | Pivska Mountain |

| No. | RBD | Name | Type | Code of GWB/GGWB | GW Body |
|-----|--------|---------------------------|----------------|------------------|-------------------------------|
| 54 | Danube | Alipaša Spring | Natural Spring | ME_DB_GGW_K_6 | Prokletije |
| 55 | Danube | Gojakovića Spring | Tapped Spring | ME_DB_GW_K_3 | Sinjajevina |
| 56 | Danube | Šavnička Glava Spring | Tapped Spring | ME_DB_GW_K_2 | Pivska Mountain |
| 57 | Danube | Ibar Spring | Natural Spring | ME_DB_GGW_K_10 | Gornji Ibar |
| 58 | Danube | Manastirsko Spring | Tapped Spring | ME_DB_GGW_C_2 | Beranska Bistrica - Ljuboviđa |
| 59 | Danube | Bitrica Spring | Tapped Spring | ME_DB_GGW_C_2 | Beranska Bistrica - Ljuboviđa |
| 60 | Danube | Breznica Spring | Tapped Spring | ME_DB_GGW_I_1 | Pljevlja basin |
| 61 | Danube | Zmajevac Spring | Tapped Spring | ME_DB_GW_K_5 | Kosanica |
| 62 | Danube | Djurička River (alluvium) | Old borehole | ME_DB_GGW_K_6 | Prokletije |
| 63 | Danube | Dapsića Vrelo | Tapped spring | ME_DB_GGW_K_8 | Lješnica |
| 64 | Danube | Djalovića Cave | Natural spring | ME_DB_GGW_K_9 | Pešter |
| 65 | Danube | Žabljak (Crno Lake) | Old well | ME_DB_GGW_K_4 | Durmitor |
| 66 | Danube | Murinski springs | Natural spring | ME_DB_GGW_K_7 | Komovi |
| 67 | Danube | Rožaje (Županica) | Old borehole | ME_DB_GGW_K_10 | Gornji Ibar |

Table 10: Proposed groundwater monitoring of quality and quantity in Montenegro

| RBD | Code of GWB/GGWB | GWB name | Groundwater Monitoring | | | |
|----------|------------------|---------------------------------|---|-------------------------|--|-------------------------|
| | | | Quality | | Quantity | |
| | | | Existing | Proposed | Existing | Proposed |
| Adriatic | ME_AB_GGW_K_1 | Southern Rim of the Skadar Lake | Existing: Continual for water-source "Velje Oko" | Surveillance monitoring | Continual for water-source "Velje Oko" | Surveillance monitoring |
| Adriatic | ME_AB_GW_I_1 | Ulcinjско polje | Continual for water-source "Lisna Bori" | Operational monitoring | Continual for water-source "Lisna Bori" | Operational monitoring |
| Adriatic | ME_AB_GGW_K_2 | Možura - Paštrovići | Continual for the water sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, Buljarica, Lončar, Kaliman and Salč | Operational monitoring | Continual for the water sources: Gač, Klezna, Mide, Kaliman, Salč, Brca, Kajnak, Zaljevo, Turčini, Sustaš, Čanj, Reževića Spring, Buljarica, Lončar, Kaliman and Salč/ | Surveillance monitoring |
| Adriatic | ME_AB_GGW_K_3 | Grbalj - Luštica | Continual for the water sources: Topliš (Tivat), Grbaljsko polje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring (Budva) | Operational monitoring | Continual for the water sources: Topliš (Tivat), Grbaljsko polje, Spring under the Pyramid, Lončar, Zagradac, Topliš Spring (Budva) | Surveillance monitoring |
| Adriatic | ME_AB_GW_K_4 | Opačica - Morinj | Continual for the water sources: Opačica, Sutorinsko polje | Operational monitoring | Water sources: Opačica, Sutorinsko polje | Surveillance monitoring |
| Adriatic | ME_AB_GW_K_5 | Orjen | Continual for the water sources Risanska Spilja and Smokovac Spring | Surveillance monitoring | Water sources Risanska Spilja and Smokovac Spring | Surveillance monitoring |
| Adriatic | ME_AB_GW_K_6 | Lovćen (Njeguši) | Continual for the water sources: Plavda, Škurda and Tabaciņa, water sources Ercegovina | Operational monitoring | Water sources: Plavda, Škurda and Tabaciņa, water sources Ercegovina and | Surveillance monitoring |

| RBD | Code of GWB/GGWB | GWB name | Groundwater Monitoring | | | |
|----------|---------------------|---------------------------------|--|-------------------------|--|-------------------------|
| | | | Quality | | Quantity | |
| | | | Existing | Proposed | Existing | Proposed |
| | | | and Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj | | Cicanova Kuća in Orahovac, Tunnel Vrmac, Simoš Spring, Gornji Grbalj | |
| Adriatic | ME_AB_GGW_C_1 | Orahovštica - Rijeka Crnojevića | Continual for Podgor, Uganjska springs, Obzovica springs, water-source "Orahovsko Polje" and water-source "Sjenokos" | Operational monitoring | Continual for Crnojevića spring and temporary for Podgor, Uganjska springs and Obzovica spring | Surveillance monitoring |
| Adriatic | ME_AB_GGW_K_7 | Karuč - Sinjac | Continual for Bolje Sestre Spring | Operational monitoring | Continual for Bolje Sestre Spring | Operational monitoring |
| Adriatic | ME_AB_GGW_I_2 | Zeta Valley | Continual for water-sources Čemovsko polje, Zagorič, Tuzi, Dinoši, Vuksan Lekić | Operational monitoring | Continual for water-sources Čemovsko polje, Zagorič, Tuzi, Dinoši, Vuksan Lekić | Operational monitoring |
| Adriatic | ME_AB_GGW_C_2 | Prekornica - Bjelopavlići | Continual for Mareza Springs, Slatina Spring, Žarića Jama, Brajovića Jama, Iverak, Viški Well | Operational monitoring | Continual for Mareza Spring | Operational monitoring |
| Adriatic | ME_AB_GGW_K_8 | Garač | Continual for "Oraska Jama" and "Milojevića Spring" | Surveillance monitoring | Continual for "Oraska Jama" and "Milojevića Spring" | Surveillance monitoring |
| Adriatic | ME_AB_GGW_K_9 | Vojnik | Continual for water source "Vidrovan" | Surveillance monitoring | Continual for water source "Vidrovan"/ | Surveillance monitoring |
| Adriatic | ME_AB_GGW_C_3 | Niškičko polje | Continual for water source "Poklonci" | Operational monitoring | Continual for water source "Poklonci"/ | Surveillance monitoring |
| Adriatic | ME_AB_GGW_K_10 | Trebišnjica (Bilečko Lake) | There are no monitoring points | Surveillance monitoring | There are no monitoring points | Surveillance monitoring |
| Adriatic | ME_AB_GGW_C_4 | Kuč | Continual for water sources "Miljes" and "Bioče" | Operational monitoring | Continual for water sources "Miljes" and "Bioče" | Surveillance monitoring |
| Adriatic | ME_AB_GGW_K_11 | Morača | There are no monitoring points | Surveillance monitoring | There are no monitoring points | Surveillance monitoring |
| Danube | ME_DB_GW_K_1 | Brezna - Maglić | Continual for water source "Sutulija" | Surveillance monitoring | Continual for water source "Sutulija" | Surveillance monitoring |
| Danube | ME_DB_GW_K_2 | Pivska Mountain | Continual for water source "Šavnička Glava" | Operational monitoring | Continual for water source "Šavnička Glava" | Surveillance monitoring |
| Danube | ME_DB_GW_K_3 | Sinjajevina | Continual for water sources "Ravnjak", "Gojakovića Spring" and "Ropušica" | Operational monitoring | Continual for water sources source "Ravnjak", "Gojakovića Spring" and | Surveillance monitoring |

| RBD | Code of GWB/GGWB | GWB name | Groundwater Monitoring | | | | |
|--------|---------------------|-------------------------------|---|-------------------------|---|------------|-------------------------|
| | | | Quality | | Quantity | | |
| | | | Existing | Proposed | Existing | Proposed | |
| | | | | | | "Ropušica" | |
| Danube | ME_DB_GGW_K_4 | Durmitor | Continual for water sources "Oko" and "Mlinski potok" | Operational monitoring | Continual for water sources "Oko" and "Mlinski potok" | | Surveillance monitoring |
| Danube | ME_DB_GW_K_5 | Kosanica | There are no existing monitoring points | Surveillance monitoring | There are no existing monitoring points | | Surveillance monitoring |
| Danube | ME_DB_GGW_C_1 | Maoče | Continual for water sources "Zmajevac", "Mandovac" and "Bezarska Vrela" | Operational monitoring | Continual for water sources "Zmajevac", "Mandovac" and "Bezarska Vrela" | | Surveillance monitoring |
| Danube | ME_DB_GGW_I_1 | Pljevlja basin | Continual for water sources "Breznica" and "Jogušnica" | Operational monitoring | Continual for water sources "Breznica" and "Jogušnica" | | Surveillance monitoring |
| Danube | ME_DB_GGW_K_6 | Prokletije | Continual for water source "Bajrovića Spring" | Operational monitoring | Continual for water source "Bajrovića Spring" | | Surveillance monitoring |
| Danube | ME_DB_GGW_K_7 | Komovi | Continual for water source "Krkori Spring" | Operational monitoring | Continual for water source "Krkori Spring" | | Surveillance monitoring |
| Danube | ME_DB_GGW_C_2 | Beranska Bistrica - Ljuboviđa | Continual for water sources: Vrelo (Mušovića Rijeka; Vrelo Bistrice (Majstorovina, Ljuboviđa), Manastirski Spring; Merića Vrelo; Daspičko Vrelo; Vinicka Spring, Bjelezi Spring, Trepča Spring, Komčar Spring | Operational monitoring | Continual for water sources: Vrelo (Mušovića Rijeka; Vrelo Bistrice (Majstorovina, Ljuboviđa), Manastirski Spring; Merića Vrelo; Daspičko Vrelo; Vinicka Spring, Bjelezi Spring, Trepča Spring, Komčar Spring | | Operational monitoring |
| Danube | ME_DB_GGW_K_8 | Lješnica | Continual for water sources "Popča", "Pusta Vrata" and "Jasenica" | Operational monitoring | Continual for water sources "Popča", "Pusta Vrata" and "Jasenica" | | Surveillance monitoring |
| Danube | ME_DB_GGW_K_9 | Pešter | There are no existing monitoring points | Surveillance monitoring | There are no existing monitoring points | | Surveillance monitoring |
| Danube | ME_DB_GGW_K_10 | Gornji Ibar | Continual for water sources "Vrelo Ibra" and "Grlja Spring" | Operational monitoring | Continual for water sources "Vrelo Ibra" and "Grlja Spring" | | Surveillance monitoring |