



**IMPLEMENTATION OF THE STRATEGIC ACTION PROGRAMME (SAP) OF THE  
DINARIC KARST AQUIFER SYSTEM: IMPROVING GROUNDWATER  
GOVERNANCE AND SUSTAINABILITY OF RELATED ECOSYSTEMS**

**OUTPUT 2.1.**

**NATIONAL GROUNDWATER GOVERNANCE  
DIAGNOSTIC ANALYSIS  
MONTENEGRO**

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## **ACRONYMS**

**EPA** - Environmental Protection Agency of Montenegro

**GGDA** - Groundwater Governance Diagnostic Analysis

**GGP** - Groundwater Governance Project

**GWDE** - Groundwater-dependent ecosystems

**GWDE** - Groundwater-Dependent Terrestrial Ecosystems

**GSM** - Geological survey of Montenegro

**IHMS** - Hydrometeorological and Seismological Institute

**MAR** - Managed Aquifer Recharge

**RBMP** - River Basin Management Plan

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## 1. Introduction

During the first year of the DICTAS II project implementation, national experts from the Socio-Economic and Legal-Policy Working Group (with support from other national specialists) are conducting a Groundwater Governance Diagnostic Analysis (GGDA) in all participating countries. The objective of the GGDA is to carry out a comprehensive assessment of the current state of groundwater governance, including a review of key stakeholders, the legal and institutional framework, existing policies and management plans, available knowledge and data, the level of implementation and enforcement, as well as the identification of major gaps and opportunities for improvement.

### **Methodological Framework**

The analysis is conducted following the recommendations of the GEF/FAO “Groundwater Governance Project (GGP)”, based on the document *Global Framework for Action to Achieve the Vision of Groundwater Management*. This framework defines four key components of groundwater governance:

1. Legal Framework – clear, enforceable, and adapted to the local context;
2. Knowledge and Awareness – reliable information on aquifer status and public awareness raising;
3. Institutional Framework – functional and coordinated institutions, with stakeholder engagement;
4. Policies and Plans – incentive measures and development plans aligned with sustainable development goals.

The GGDA provides a foundation for establishing an effective and sustainable groundwater management system, including protection, use, and conservation of resources.

### **Approach and Steps**

The analysis is carried out in two phases:

1. National GGDA – conducting a diagnostic assessment in each participating country, based on common criteria;
2. Regional (Transboundary) GGDA – integrating national results to assess the status of transboundary aquifers (TBAs) and identify shared challenges.

The process includes:

- Identification of stakeholders and their roles (government institutions, local communities, private sector, water users);
- Analysis of legal, institutional, and policy frameworks;
- Assessment of knowledge, information, and implementation capacity;
- Identification of gaps, challenges, and opportunities for improvement.

## Key Assumptions

Groundwater management largely depends on the local context—hydrogeological characteristics, level of economic development, institutional capacity, and political leadership. Beyond physical challenges (overexploitation, pollution), socio-economic and political factors also influence reforms and their effectiveness. The economic importance of groundwater use determines the level of interest, available financial resources, and stakeholders' willingness to cooperate and adapt to new management models.

## Expected Outcome

The results of the national GGDA assessments will be consolidated to:

- Define key directions for the development of groundwater management systems across all TBAs;
- Establish a common set of indicators to monitor the implementation of principles and frameworks for effective groundwater management in the future.

## 2. Actors in groundwater governance

Water management, including groundwater, falls under the jurisdiction of the Government of Montenegro and is implemented through several ministries and institutions, the most important being: **Ministry of Agriculture, Forestry and Water Management – Directorate for Water Management, Ministry of Ecology, Sustainable Development and Northern Region Development, Environmental Protection Agency, Ministry of Health, Ministry of Energy and Mining and Water Administration**, which hold key responsibilities for regulating, monitoring, and protecting groundwater. Local governments and public water supply and sewage companies are responsible for water supply and the establishment and maintenance of sanitary protection zones around water sources. The Hydrometeorological and Seismological Institute (IHMS) and the Geological survey of Montenegro (GSM) contribute through monitoring and scientific analyses. Non-governmental organizations and local initiatives often raise awareness on water protection, while international organizations and projects (e.g., GEF, UNECE) provide support and additional expertise.

### 2.1. Institutional Linkages (Vertical and Horizontal)

There is a basic vertical linkage between national institutions and local governments through legal frameworks and planning documents. However, coordination across governance levels is often weak due to limited capacity and underdeveloped data-sharing mechanisms. Horizontal collaboration with sectors such as spatial planning, agriculture, and energy exists formally but is often partial in practice. The lack of an integrated approach leads to overlapping responsibilities and gaps in management.

### 2.2. Institutional Capacities

The competent institutions possess basic professional capacities and a legal framework for their work, but available human resources and budgetary allocations are minimal relative to their responsibilities. Technical equipment for groundwater monitoring and analysis is limited, and there is a lack of

continuous training and development of specialized staff. International support is largely absent, leaving gaps unaddressed.

### 2.3. Collaboration Among Stakeholders

Collaboration among key national institutions and local governments can be considered reasonable, often relying on personal initiative and individual projects. Coordination with NGOs and the academic community is occasional and largely project-based. Regional cooperation on transboundary aquifers is still developing. Overall, collaboration is not fully institutionalized and depends on ad-hoc mechanisms.

### 2.4. Awareness of Groundwater

Awareness among professional institutions is solid, but the general public has a limited understanding of the importance of groundwater and the need for its protection. Local communities are better informed in areas facing water supply issues. However, broader societal awareness of groundwater significance remains low compared to surface water.

## 3. Legal Framework

### 3.1. Legal and regulatory setting at the state, regional and local level

Groundwater (and surface water) in Montenegro is regulated by the **Water Law** (“Official Gazette of the Republic of Montenegro”, no. 027/07; “Official Gazette of Montenegro”, nos. 073/10, 032/11, 047/11, 048/15, 052/16, 055/16, 002/17, 080/17, 084/18, 084/24), which governs the status of water, rules for use, protection, and monitoring. In practice, this law provides the basis for issuing permits/concessions for water use and monitoring obligations. The law stipulates that the status of water, including groundwater, is assessed through monitoring, covering the chemical and quantitative status of groundwater.

The **Law on Geological Research** (“Official Gazette of the Republic of Montenegro”, nos. 028/93, 027/94, 042/94, 026/07; “Official Gazette of Montenegro”, nos. 073/10, 028/11) (a new version is under preparation) regulates basic and detailed hydrogeological research to determine the status of groundwater, properties and characteristics of rocks and soils, as well as protection measures.

The **Environmental Protection Law** (“Official Gazette of Montenegro”, nos. 52/16, 59/18, 10/23) introduces principles of pollution prevention, the “polluter pays” principle, ensures public access to information, and provides mechanisms for environmental impact assessment. It is implemented through water protection measures that include preventing or limiting the introduction of hazardous, waste, and other harmful substances into water, monitoring and testing the quality of surface and groundwater, as well as wastewater treatment.

The **Nature Protection Law** (“Official Gazette of Montenegro”, nos. 054/16, 018/19, 084/24) protects biological and geological diversity, ensures the preservation of the quality, quantity, and availability of groundwater and surface water, protects habitats and ecosystems dependent on water, and regulates zoning and protection regimes in protected areas. Funding for water management in

Montenegro is provided under the **Law on Financing Water Management** (“Official Gazette of Montenegro”, nos. 065/08, 074/10, 040/11, 082/20), through fees for water use and discharge, watercourse regulation, and other sources, and is used for the protection, regulation, and maintenance of water resources.

### **3.2. National legislation and regulations implementing the WFD and GWD on groundwater and groundwater-dependent ecosystems.**

Montenegro has adopted a legal framework that largely aligns national legislation with the Water Framework Directive (2000/60/EC) and the Groundwater Directive (2006/118/EC), aiming at sustainable management and protection of water resources. The Water Law of Montenegro establishes principles of sustainable and integrated water management based on the river basin approach, with the aim of protecting aquatic ecosystems and preserving the quality of surface and groundwater. It defines surface and groundwater bodies, ecological objectives, monitoring, and criteria for assessing chemical and quantitative status (including Annexes II and V of the WFD and partially Annex I of the GWD), and prescribes planning, measures for rational use of water resources, pollution reduction, and mitigation of flood and drought impacts, through public participation and responsible concession management.

The supplementary legal framework includes the Environmental Protection Law (“Official Gazette of Montenegro”, nos. 52/16, 59/18, 10/23) and the Law on Environmental Liability (“Official Gazette of Montenegro”, nos. 27/14, 55/16), which ensure the implementation of Directives 2003/4/EC and 2004/35/EC. The Environmental Protection Law regulates the public’s right to information and participation in decision-making, while the environmental information system enables data collection and accessibility, including groundwater data. The Law on Environmental Liability introduces the general “polluter pays” principle, defining remediation obligations and liability for environmental damage.

The Nature Protection Law transposes key elements of the Habitats Directive (92/43/EEC), contributing to the preservation of biodiversity and water-dependent ecosystems. **The Rulebook on the Method and Deadlines for Determining Groundwater Status (“Official Gazette of Montenegro”, no. 052/2019)** regulates the methodology and criteria for assessing chemical and quantitative status of groundwater. This regulation partially implements Annex I of the Groundwater Directive 2006/118/EC, which defines quality standards and threshold concentrations of pollutants.

In key documents, such as the Water Law and the Water Management Strategy of Montenegro (2017), the term “groundwater-dependent ecosystems” is not used explicitly, but sustainable water management is addressed in a way that partially includes the protection of these ecosystems.

### **3.3. Legal provisions, which define the approach for assessing and monitoring the chemical and quantitative status of groundwater according to the requirements of the WFD and GWD, as well as the ecological status of associated surface waters and related ecosystems**

In Montenegro, regulations defining the approach to the assessment and monitoring of the chemical and quantitative status of groundwater, as well as the ecological status of related surface waters and ecosystems, are contained in the **Water Law** (“Official Gazette of the Republic of Montenegro”, no. 027/07; “Official Gazette of Montenegro”, nos. 073/10, 032/11, 047/11, 048/15, 052/16, 055/16,

002/17, 080/17, 084/18, 084/24), the **Rulebook on the Method and Deadlines for Determining Groundwater Status** (“Official Gazette of Montenegro”, no. 052/19), and the **Rulebook on the Method and Deadlines for Determining Surface Water Status** (“Official Gazette of Montenegro”, no. 025/19). These regulations establish obligations for monitoring the chemical and quantitative status of groundwater, determining status (good/poor), and reporting to competent authorities. The Government of Montenegro adopts and issues each year the **Monitoring Program for Surface and Groundwater** for the current year. Monitoring is conducted through various types—operational, surveillance, and investigative—to detect changes in status, identify pressures and risks, and ensure measures are taken if protection objectives are not met. For groundwater-dependent ecosystems, such as springs and certain watercourses, the regulations provide for the application of protection measures through **water source protection zones** and through programs of measures included in **Water Management Plans** (Capacity Building for the Implementation of the Water Framework Directive in Montenegro – **Danube Basin Water Management Plan (2021) – Adriatic Basin Water Management Plan (2021)**).

#### **3.4. Legal provisions that regulate issues of quantification, allocation and regulation of use rights and usage (of water/groundwater)**

The Water Law of Montenegro defines water as a public good and regulates its use through permits, concessions, and usage rights, taking into account environmentally acceptable flows and the water balance to preserve aquatic ecosystems and associated terrestrial ecosystems. The quantity, purpose, and duration of water use are determined through permits issued by the Water Administration of Montenegro, while long-term or commercial uses, such as hydropower projects, irrigation, bottling, or tourism activities, are granted through concessions with clearly defined conditions and financial obligations. The law also establishes priorities for water use, particularly for public water supply, and regulates procedures for resolving potential conflicts among users.

#### **3.5. Regulation of the Polluter Pays Principle and Cost Recovery in Water Pricing Policies.**

Montenegro has developed a legal framework for water resource management and environmental protection that combines ecological, economic, and legal aspects of sustainable development. The Water Law regulates water use through permits, concessions, and usage rights, taking into account environmentally acceptable flows and the preservation of aquatic and associated terrestrial ecosystems, while water pricing policy includes resource, infrastructure, operational, and environmental costs. The Law on Financing Water Management applies the principles of “**user pays**” and “**polluter pays**” through fees for resource use and infrastructure maintenance, with their allocation ensuring sustainable sector financing. The Environmental Protection Law defines an integrated approach to protection, coordination among authorities, public participation, and further supports the principles of economic and ecological responsibility of users and polluters. Additionally, the Law on Environmental Liability (“Official Gazette of Montenegro”, nos. 27/14 and 55/16) clearly establishes remediation obligations and liability for environmental damage.

### **3.6. Legal and Regulatory Framework for Sanitary Protection Zones and Protection and Monitoring of groundwater and GWDE.**

**Protection zones of water supply sources** are established by the **Rulebook on the Determination and Maintenance of Sanitary Protection Zones and Belts of Water Supply Sources and Restrictions within These Zones** (“Official Gazette of Montenegro”, nos. 066/09 and 013/24). Due to the specific characteristics of karst aquifers, zones and protection measures are determined using a selective approach to reduce the risk of groundwater contamination. When defining zones, factors such as pollutant transport time, recharge and discharge regime of the aquifer, and the hydrogeological structure of the catchment and aquifer system are taken into account.

For the sanitary protection of water supply sources for public water supply, three protection zones are defined: the wider protection zone (Zone III), the narrower protection zone (Zone II), and the immediate protection zone (Zone I). For potential regional water supply sources, sanitary protection zones are determined through the Strategy. Sanitary protection zones are defined in accordance with the hydrological, hydrogeological, and other characteristics of the land and catchment areas, as well as the intended use of the area. Protection zones established by a water source protection decision, as well as the areas designated for these zones, are incorporated into new Water Management Plans and spatial plans for special purposes. The regulation on the determination and maintenance of sanitary protection zones and belts of water supply sources, and the restrictions within these zones, is issued by the Ministry, with the consent of the Ministry responsible for health affairs and the Ministry responsible for environmental protection, and for groundwater sources, also with the consent of the Ministry responsible for geological affairs.

Monitoring of surface and groundwater includes chemical, physicochemical, and microbiological analyses, as well as monitoring of heavy metals and pesticides. Monitoring is carried out as surveillance, twice a year, in spring and autumn, to identify pressures and risks.

The monitoring network has been supplemented within the framework of the project “**Strengthening Administrative Capacities for the Implementation of the Water Framework Directive in Montenegro**”, including certain karst water sources.

Results are interpreted using multiple rulebooks, as there is no single unified rulebook, including the following: the Rulebook on the Method and Deadlines for Determining Groundwater Status (“Official Gazette of Montenegro”, 052/19), the Rulebook on the Method and Deadlines for Determining Surface Water Status (“Official Gazette of Montenegro”, 025/19), the **Rulebook on Parameters, Compliance Verification, Methods, Scope and Implementation of Monitoring of Water Quality for Human Use** (“Official Gazette of Montenegro”, 64/18, 101/21), as well as the Croatian Regulation on Water Quality Standards (96/19).

### **3.7. Current Status of Methodologies for Delineating Sanitary Protection Zones and Groundwater Monitoring in Karst Areas**

According to the **Rulebook on the Determination and Maintenance of Sanitary Protection Zones and Belts of Water Supply Sources and Restrictions within These Zones** (“Official Gazette of Montenegro”, nos. 066/09 and 013/24), sanitary protection zones are defined; however, there are no detailed national guidelines that precisely specify the methodology for their determination, particularly in karst areas. Groundwater monitoring is conducted in accordance with the principles of

the Water Framework Directive, including the assessment of the chemical and quantitative status of waters. Monitoring elements include basic physicochemical and microbiological parameters, as well as the monitoring of heavy metals and pesticides. Monitoring points are selected based on the hydrogeological representativeness of the site. Sampling is carried out twice a year, during the hydrological maximum and minimum. **Drinking Water Monitoring at Public Water Supply Sources:** Public health institutes regularly monitor water quality, with frequency depending on system size (monthly to quarterly). Results are reported nationally and support harmonisation with the EU Drinking Water Directive.

### **3.8. Overview of Legislative Provisions on Protective Measures in Sanitary Protection Zones in Karst Areas**

According to the Water Law, a legal entity engaged in water supply operations is obliged to install devices and ensure continuous and systematic recording of the quantities of extracted water and testing of water quality at the water intake (in accordance with regulations issued by the Ministry of Agriculture, Forestry and Water Management and the Ministry of Health – **Rulebook on Parameters, Compliance Verification, Methods, Scope and Implementation of Monitoring of Water Quality for Human Use** (“Official Gazette of RCG”, 64/18, 101/21)). Systematic water quality testing for water supply is carried out according to an annual program adopted by the competent Ministry of Agriculture, Forestry and Water Management, following prior opinions from the Ministry of Health and the Ministry responsible for environmental protection. In addition, under the annual program adopted by the **Government of Montenegro**, mandatory monitoring of surface and groundwater is carried out in accordance with the **Water Framework Directive**, supervised by the **Hydrometeorological and Seismological Institute (IHMS)**, for the use and protection of surface and groundwater.

For water sources in karst formations (with abstraction from the surface or underground), three sanitary protection zones are defined according to the Rulebook (“Official Gazette of Montenegro”, nos. 066/09 and 013/24).

The **first protection zone (Zone I)** protects the water source, water intake structures, and the immediate surroundings, allowing only facilities directly related to water supply. The boundary of Zone I must be at least 10 meters from water intake structures.

The **second protection zone (Zone II)** is determined based on the quantity and regime of exploitation, hydrogeological characteristics, and contamination risk. Activities that could compromise water quality are strictly prohibited within Zone II, including untreated wastewater discharge, industrial construction, mining activities, use of fertilizers and pesticides, intensive livestock farming, and the construction or expansion of cemeteries.

The **third protection zone (Zone III)** covers the area from the outer boundary of Zone II to the hydrogeological watershed and the broader recharge area of the aquifer. Activities that disrupt the natural recharge regime are prohibited in Zone III, including waste disposal, untreated wastewater discharge, industrial development with pollution risk, storage of hazardous substances, and the construction or expansion of cemeteries.

For the protection of groundwater (GW) and groundwater-dependent ecosystems (GWDE), there is a legal basis in the **Water Law** (preventing deterioration, protecting and improving the status of aquatic

ecosystems as well as terrestrial and wetland ecosystems directly dependent on water systems) and regulations on wastewater discharge. However, no specific guidelines exist for groundwater, and consequently for karst areas.

The **Rulebook on the Quality and Sanitary-Technical Conditions for Wastewater Discharge, the Method and Procedure for Testing Wastewater Quality, and the Content of Reports on Determined Wastewater Quality** (“Official Gazette of Montenegro”, 056/19) prescribes maximum allowable concentrations of hazardous and harmful substances in wastewater discharged into recipients (surface waters) or sewerage systems. Direct discharge of pollutants into groundwater is prohibited except in prescribed cases, as is the disposal of municipal or other waste on water bodies, high river banks, cliffs and canyon sides, natural pits, dolines, and other locations from which pollutants could reach surface or groundwater or lead to deterioration of water quality.

### **3.9. Legal basis for artificial aquifer recharge and treated wastewater discharges into the underground (soil, aquifer, GW)**

Currently, no legal regulation in Montenegro defines the conditions for the discharge of treated wastewater or treated clean water into groundwater aquifers for the purpose of groundwater replenishment within Managed Aquifer Recharge (MAR) technologies, i.e., “artificial aquifer recharge.” Existing laws and subordinate regulations govern the discharge of wastewater into surface waters or public sewerage systems, establish sanitary protection zones and restrictions, and prescribe wastewater quality, pollutant concentrations, minimum number of tests, monitoring, reporting, and permit issuance. However, there are no specific requirements for aquifer recharge in the MAR style or for the infiltration of treated wastewater into underground layers, while the law prohibits the introduction of pollutants into groundwater except in exceptional cases that are specifically defined.

Although Montenegro has an obligation to align with EU water directives, there is currently no system for assessing risks and benefits of MAR technologies. There are initiatives and professional dialogues on integrated management of surface and groundwater, but these are still in the planning and strategic development stage. The lack of clear guidelines and standards indicates that the application of MAR technologies without adequate regulations may pose a risk to groundwater quality.

### **3.10. Legislation that defines remediation measures of contaminated soil and/or groundwater, especially in karst areas**

Currently, Montenegro does not have a specific law that directly regulates the remediation of the geological environment (soil, rocks, and sediments), contaminated land, and groundwater, with clearly defined remediation standards, mandatory methods, or special provisions for karst areas, where the hydrogeological situation is more complex and sensitive. The main regulations in force, including the Water Law and the Environmental Protection Law, establish general principles for the protection of water, soil, and ecosystems but do not provide detailed remediation procedures in cases of contamination. Strategic documents, such as the Water Management Plan of Montenegro and the **National Waste Management Plan for 2024–2028**, mention remediation as part of measures for pollution prevention and reduction, but without established technical criteria, procedures, or responsibilities of competent authorities.

Existing measures mostly concern the closure, reclamation, and remediation of illegal and inadequate landfills and disposal sites, which represent a significant source of contamination for the geological environment, soil, and groundwater. The water quality monitoring system covers surface and groundwater, but it is not focused on the identification and tracking of contaminated areas requiring remediation. Remediation activities are currently carried out mainly through local projects and programs supported by the European Union and international organizations, focusing on landfill rehabilitation and the control of pollution from historical industrial sites.

Therefore, it is necessary to develop national technical guidelines, standards, and a regulatory framework that clearly define priorities, responsible entities, financial instruments, and remediation procedures, in accordance with the requirements of European directives and the principles of sustainable water resource management.

### **3.11. Legal obligation to include sanitary protection zones in spatial planning documents**

According to Article 57 of the Water Law (“Official Gazette of the Republic of Montenegro”, no. 027/07; “Official Gazette of Montenegro”, nos. 073/10, 032/11, 047/11, 048/15, 052/16, 055/16, 002/17, 080/17, 084/18, 084/24), sanitary protection zones of water supply sources, as well as the areas designated for these zones, must be incorporated into Water Management Plans and spatial plans for special purposes.

This legal provision clearly establishes the legal obligation to include sanitary protection zones in spatial planning documents, thereby ensuring integrated protection of sources used for public water supply. However, the practice of implementing these obligations in Montenegro remains far below the required level. A large number of water supply sources still do not have formally established sanitary protection zones or corresponding water acts prescribed by law, indicating the need for further actions to fully implement the legal provisions.

Although some progress has been observed in recent years, it is evident that there is significant room for improvement in aligning spatial planning with the legal requirements concerning the sanitary protection of water supply sources. Under the new Law on Spatial Planning (“Zakon o uređenju prostora”, Official Gazette No. 19/2025), plans must be aligned with all relevant laws and bylaws, including those defining sanitary protection zones. The accompanying Law on Construction (“Zakon o izgradnji objekata”, Official Gazette No. 19/2025) further reinforces that urbanistic and spatial planning documents must comply with legal obligations stemming from sectoral regulations. In practice, this means that national, regional, and local spatial and urban plans are required to integrate and respect the constraints and protections established by the sanitary zone regulation hierarchy.

### **3.12. How effective is this legal framework in practice**

The Water Law (“Official Gazette of the Republic of Montenegro”, no. 027/07; “Official Gazette of Montenegro”, nos. 073/10, 032/11, 047/11, 048/15, 052/16, 055/16, 002/17, 080/17, 084/18, 084/24) clearly stipulates the obligation to include sanitary protection zones of water supply sources in Water Management Plans and spatial plans for special purposes, but its practical implementation is limited.

Although the legal provisions are precisely defined, a large number of municipalities still do not have formally established sanitary protection zones for their water sources, nor the corresponding water acts, while available data (Water Administration) show that only about half of the water sources in Montenegro have designated protection zones. Even where zones have been established, there are often problems with the lack of data, particularly in defining the wider protection zone covering the entire catchment area of the water source. These shortcomings indicate the need to strengthen institutional capacities, improve the database, and ensure more consistent enforcement of legal obligations. To achieve the full effectiveness of the legal framework, it is necessary to accelerate the procedures for establishing and updating sanitary zones and to integrate them into spatial planning for the long-term protection of water sources and the security of public water supply.

### **3.13. Enforcement capacity of the water legislation**

#### **i) legal mechanisms - ability to enact and apply regulations**

The Montenegrin legal framework for water management provides the basic legal mechanisms for implementing regulations, but its effectiveness in practice is limited due to insufficient institutional capacities and uneven enforcement. The **Water Law** ("Official Gazette of Montenegro", nos. 27/07, 73/10, 32/11, 47/11, 48/15, 52/16, 55/16, 2/17, 80/17, 84/18, 84/24) establishes a framework for managing water quantity and quality, protection against the harmful effects of water, and alignment with relevant EU directives, such as the **Water Framework Directive (2000/60/EC)** and the **Urban Wastewater Treatment Directive (91/271/EEC)**. Implementation of the law is carried out by the **Water Administration**, which issues water permits, monitors compliance with regulations, and coordinates activities related to water protection. The financial aspect of implementation is regulated by the **Law on Financing Water Management**, which defines fees, contributions, and penalties for non-compliance, while providing funds for infrastructure, remediation, and monitoring. Subordinate regulations, such as the **Rulebook on the Quality and Sanitary-Technical Conditions for Wastewater Discharge, the Method and Procedure for Testing Wastewater Quality, and the Content of Reports on Determined Wastewater Quality** ("Official Gazette of Montenegro", no. 056/19), prescribe technical standards and conditions for discharge, as well as obligations for sampling, reporting, and sanctioning violators.

However, supervision and inspection enforcement are often limited due to a lack of personnel, equipment, and financial resources. Although institutional mechanisms exist, such as permit issuance and maintaining the **Register of Water Acts**, their application in practice is not fully consistent. To improve the implementation of water legislation, it is necessary to further strengthen inspection services, digitize records, and enhance coordination between state and local authorities.

#### **ii) operational capacity - availability of human and financial resources for the implementation of policies and regulations;**

The operational capacity for implementing water policy in Montenegro is based on the legislative framework established by the **Water Law** ("Official Gazette of Montenegro", nos. 27/07, 73/10, 32/11, 47/11, 48/15, 52/16, 55/16, 2/17, 80/17, 84/18, 84/24), which defines the competencies of the **Ministry of Agriculture, Forestry and Water Management – Directorate for Water Management**, the **Ministry of Ecology, Sustainable Development and Northern Region Development**, the

**Environmental Protection Agency**, the **Ministry of Health**, the **Ministry of Energy and Mining**, and the **Water Administration**, i.e., the authority responsible for water management. The Water Administration plays a key role in issuing water acts, supervising the use and protection of water, implementing water management plans, and maintaining records. However, operational capacity is limited due to a lack of skilled personnel, equipment, and financial resources at both the state and local levels. Most institutions and municipalities do not have a sufficient number of trained water management engineers, nor stable budgetary sources for the maintenance and development of water infrastructure.

Financial mechanisms, such as water use and protection fees, exist, but their collection and reinvestment in the sector are often inconsistently implemented. Through **IPA projects** and other international programs, Montenegro receives support to strengthen administrative and technical capacities, modernize equipment, and develop strategic plans, including the **Water Management Plans for the Danube and Adriatic River Basins (2021)**.

It is necessary to further strengthen inter-institutional cooperation, implement systems for continuous training and professional certification, and ensure stable financing of the water sector in accordance with the EU principle of full cost recovery.

**iii) supervision and sanctions: compliance monitoring and application of penal provisions of regulations;**

Supervision of the implementation of the **Water Law** ("Official Gazette of Montenegro", nos. 27/07, 73/10, 32/11, 47/11, 48/15, 52/16, 55/16, 2/17, 80/17, 84/18, 84/24) is carried out by the **Water Administration**, the inspection bodies within the **Inspectorate**, as well as the competent ministries. These authorities have the powers to conduct inspections, issue orders to remedy irregularities, temporarily suspend activities, and initiate misdemeanor proceedings in cases of non-compliance with regulations. The misdemeanor provisions of the Water Law provide for fines for legal entities and individuals who do not comply with water permits, violate wastewater discharge limits, use water resources without authorization, or fail to implement prescribed protective measures.

The punitive provisions are supplemented by provisions of the **Law on Inspection Supervision** and the **Environmental Protection Law**, which allow for the application of additional sanctions in cases that endanger water quality and the environment. The supervision system also includes monitoring the implementation of the **Water Management Plans (2021)**; however, in practice, there is a noticeable lack of personnel and technical capacity for comprehensive monitoring and control. Therefore, it is necessary to improve cooperation between state and local authorities, increase the number of inspectors, and ensure continuous financing of water monitoring and control activities.

**3.14. International conventions and bilateral agreements related to water management;**

Montenegro's cooperation with neighboring countries and the broader international community in water management is regulated by interstate treaties and signed conventions and agreements in the field of water, which form part of Montenegro's legal framework for water management.

Montenegro has acceded to international multilateral water conventions, including:

- The Convention on the Law of Non-Navigational Uses of International Watercourses – Watercourses Convention (New York, 1997),

- The Convention on the Protection and Use of Transboundary Watercourses and International Lakes – Water Convention (Helsinki, 1992),
- The Convention for the Protection of the Mediterranean Sea against Pollution – Barcelona Convention (Barcelona, 1995) and its five protocols.

Given the importance of Lake Skadar, which Montenegro shares with Albania, and the fact that almost all major rivers in Montenegro are international watercourses, the ratification of these conventions is clearly of great significance for the country.

Montenegro became a candidate country for European Union membership in December 2010, and the negotiation process between Montenegro and the EU officially began in June 2012. In Montenegro's path towards EU accession, Chapter 27 – Environment and Climate Change, under which the sub-area of Water Quality falls, is one of the most demanding.

Since 2008, Montenegro has been a member of the International Commission for the Protection of the Danube River (ICPDR). A Memorandum of Cooperation between the International Sava River Basin Commission (ISRBC) and Montenegro was signed in December 2013, establishing the basis for cross-border cooperation projects, water management, and environmental protection in the field of water.

A Memorandum of Understanding for the Drin Basin – Drin Declaration was signed in November 2011 by the countries of the Drin Basin (Montenegro, Albania, North Macedonia, Greece, and Kosovo). The aim of the Drin Declaration is to strengthen cross-border cooperation in integrated water management and sustainable development of the region, in accordance with the Water Convention and the Water Framework Directive. This project is of particular importance for Montenegro in terms of its impact on the Bojana River and the coastal sea.

Since 2008, Montenegro has also been a member of the World Water Council, the largest international organization dealing with global water management issues.

In addition to international cooperation, due to the transboundary nature of most rivers, cooperation with neighboring countries in the management of transboundary water resources is of great importance for Montenegro.

Montenegro's interstate relations in the field of water with neighboring Albania and Croatia are regulated by treaties between the states:

- Treaty between the Government of Montenegro and the Government of the Republic of Albania on Water Issues, concluded on 31 October 2001 in Podgorica,
- Treaty between the Government of Montenegro and the Government of the Republic of Croatia on Mutual Relations in Water Management, drafted and signed on 4 September 2007 in Zagreb.

The first treaty Montenegro concluded was with the Republic of Albania in 2001. In addition to the bilateral treaty on water management, the following were signed:

- Statute and Protocol on Cooperation in the Field of Water Management in 2003, adopted by both governments,
- Treaty between the Academies of Sciences and Arts of Montenegro and Albania, 2005,

- Memorandum of Understanding between the Council of Ministers of the Republic of Albania and Montenegro for the “Cross-Border Development of Lake Skadar”,
- Memorandum of Understanding between the Ministry of Agriculture and Rural Development of Montenegro and the Ministry of Environment, Forestry and Water of Albania, 14 December 2010,
- Agreement on Transboundary Water Resources Management between Montenegro and Albania, 2018,
- Cross-border cooperation on the Cijevna/Cem River – supported by the Water Convention’s Implementation Committee as part of the advisory procedure on the Cijevna/Cem River (2023).

### **3.15. Assessment of Gaps and Areas for Improvement in the Legal Framework for Groundwater and GWDE**

Montenegro has established a foundational legal framework for water resources management through the Water Law, which is largely harmonized with European Union directives, notably the Water Framework Directive (WFD, 2000/60/EC) and the Groundwater Directive (GWD, 2006/118/EC). Despite this alignment, significant gaps remain in both practical and legal implementation, particularly with regard to karst aquifers and groundwater-dependent ecosystems (GWDE). Montenegro currently lacks a regulation on the classification and categorization of groundwater reserves, which would enable precise registration, assessment, and control of abstraction capacities, thereby preventing overexploitation and conflicts of interest among water users.

The interactions between surface and groundwater in karst environments are insufficiently addressed in national legislation, although these interactions are critical for ecosystem preservation and water balance. The Water Law does not provide explicit provisions regarding hydraulic connections between surface and groundwater, nor does it require assessment of their combined impacts. In coastal karst areas, such as the Buna-Bojana coastal aquifer, Tivat Bay, and Boka Kotorska Bay, issues of salinization are observed due to excessive water abstraction, yet the legal framework does not stipulate measures to restrict abstraction during drought periods.

Although Montenegro has signed a bilateral agreement with Albania on transboundary water management, including shared aquifers, its implementation is limited and does not cover joint monitoring, data sharing, or coordinated risk assessment procedures.

Monitoring of groundwater and surface waters is conducted by the Institute of Hydrometeorology and Seismology of Montenegro (IHMS), which maintains the national database on groundwater quality and surface water regimes. The Geological Survey of Montenegro (GSM) collects and analyzes data on groundwater regimes within hydrogeological projects; however, these data are not systematically integrated into the national database nor coordinated with IHMS.

The legal framework does not establish clear criteria for the recharge of aquifers with treated wastewater or Managed Aquifer Recharge (MAR) applications, which is particularly concerning in karst areas, where contamination can rapidly propagate through karst channels and fractures. Although certain ecological quality standards (e.g., nitrates, ammonia, heavy metals) exist, these are limited in

scope and do not incorporate biological or ecosystem indicators, as comprehensive groundwater quality and ecological indicators have yet to be developed in Montenegro.

Furthermore, the concept of groundwater-dependent ecosystems (GWDE) is not legally defined, and no formal procedures exist for their identification, protection, or monitoring. Consequently, these ecosystems remain outside the institutional framework despite their critical importance for biodiversity, hydrology, hydrogeology, and climate resilience in karst regions.

Overall, Montenegro's legal framework establishes the basic principles for water protection, but it does not provide detailed, standardized, and ecologically-based mechanisms for managing complex karst systems. Key gaps include: limitation of abstraction during droughts, protection of coastal aquifers from salinization, practical implementation of bilateral agreements, standardized mapping of vulnerability, enhancement of monitoring systems, establishment of comprehensive ecological quality thresholds, and formal recognition and protection of groundwater-dependent ecosystems.

## **4. Policy, plans and principles**

### **4.1. Goals and requirements of national water management strategy related to GW and GWDE, especially in karst areas**

In Montenegro, the Water Management Strategy (2017) defines long-term management of water resources, including groundwater, based on the principles of sustainable development. The strategy foresees the strengthening of institutional and professional capacities for water management, with a particular focus on monitoring and protection. Although it does not explicitly mention "karst aquifers" in every provision, the document recognizes the vulnerability of water resources and the need to protect springs and aquifers throughout Montenegro.

Among the objectives is the reduction of water pollution—both surface and groundwater—through better control of pollution sources and pressures, as well as water use. The strategy emphasizes the rational use of water resources and the improvement of water supply systems, which indirectly contributes to the protection of groundwater. It also calls for an integrated approach to surface and groundwater management, which is particularly important for groundwater-dependent ecosystems (GWDEs).

The strategy stipulates that spatial planning documents and other sectoral plans must align with water protection objectives, which includes the protection of groundwater. The introduction of a monitoring system, financing mechanisms, and institutional reforms is foreseen as a key step towards achieving the objectives related to groundwater management.

### **4.2. To what extent is water management strategy aligned with other sectoral strategies/policies (agriculture, environment, tourism, traffic etc..)**

The Water Management Strategy (2017) in Montenegro states that its framework must be considered in the preparation of spatial planning strategies, environmental protection strategies, and other sectoral policies. The document foresees that the water sector should be coordinated with other sectors, but in practice, many sectoral documents were adopted later or have not yet been fully harmonized.

For example, water management must be aligned with agricultural policies, as irrigation and the use of chemicals also affect groundwater—but concrete mechanisms for this alignment are not clearly specified in the available strategy. In the tourism and infrastructure sectors, the implementation of water supply and wastewater projects (especially in coastal areas) shows that water is placed in the context of other sectors, but not necessarily with a strong focus on groundwater in karst areas.

The strategy foresees that sectoral document must take water resources and protection into account, but no clear, explicit framework has been identified that would set mandatory groundwater-related objectives for other sectors. Therefore, while there is a formal obligation for alignment and some practical steps have been taken, the integration between the water strategy and other sectors remains partial and is still under development.

#### **4.3. Review of Sectoral Policies Relevant to Groundwater and GWDE**

In Montenegro, the impacts of sectors such as agriculture, tourism, energy, and transport on groundwater are not systematically integrated into all sectoral strategies, although formal protection mechanisms exist through the Water Law and EIA/SEA procedures. The Montenegro Environmental Protection Strategy recognizes the importance of integrated water protection but does not include specific measures for karst aquifers or groundwater-dependent ecosystems (GWDE).

The Agriculture and Rural Development Strategy 2023–2028 incorporates sustainable irrigation and responsible use of fertilizers and pesticides, which indirectly protects groundwater, but groundwater is not treated as a specifically vulnerable resource. In the tourism sector, the main challenges arise from seasonal pressure on resources in karst and coastal areas; integration of wastewater management is improving but is not yet uniform.

The Energy Strategy and the development of hydropower in Montenegro do not sufficiently consider potential impacts on groundwater and springs, particularly in the Dinaric karst. The Spatial Plan of Montenegro (PPPCG) contains provisions requiring the protection of sanitary protection zones for water intakes and sources, but operational tools for implementing these provisions are often weak.

Waste management and old landfill remediation plans include objectives to reduce leakage of harmful substances that could contaminate groundwater, particularly in source catchment areas. Although water protection and cross-sectoral cooperation are present in strategies, the specific integration of groundwater and GWDEs into sectoral policies remains underdeveloped and requires further strengthening of the institutional and legal framework.

#### **4.4. Overview of Groundwater and GWDE Provisions in the River Basin Management Plan**

The Water Management Plan of Montenegro (2021) was developed in accordance with the EU Water Framework Directive (WFD) and includes basic guidelines for the protection of groundwater. Groundwater bodies have been defined, but cartographic coverage and detailed hydrogeological elaboration, especially in karst areas, remain limited. Groundwater monitoring is functional, but it primarily relies on qualitative parameters (annual Water Quality Reports by IHMS).

The Plan foresees measures for the protection of water sources and sanitary protection zones, but the protection of Groundwater-Dependent Terrestrial Ecosystems (GWDTE) has not yet been systematically integrated as a separate component of management. Direct discharges into

groundwater are prohibited by the Water Law, yet monitoring of impacts in vulnerable karst aquifer zones is rarely implemented (except in a few hand-dug wells in the Zeta Plain).

In the catchment areas of Lake Skadar and the Zeta–Bjelopavlić Plain, increased vulnerability has been identified, but this is seldom translated into concrete protective measures in the River Basin Management Plan (RBMP). To align with EU standards, Montenegro needs to integrate GWDEs into the next generation of RBMPs and strengthen institutional capacities for implementing protection measures.

#### **4.5. Groundwater Challenges, Local Gaps, and Protective Measures in Karst Areas**

The River Basin Management Plan of Montenegro (2021) identifies the main groundwater challenges, such as over-abstraction and localized pollution, but lacks a detailed elaboration of karst-specific features. Karst terrains cover more than 70% of the territory, yet there are no specific guidelines or measures exclusively addressing their protection. Monitoring does not include key indicators of karst vulnerability, such as sudden increases in turbidity, short retention times, and rapid infiltration. Diffuse pollution from agriculture, including mineral fertilizers and manure, is still not systematically included as a pressure in the RBMP. Although the law formally prohibits direct discharges into groundwater, field controls and sanctions for illegal activities are rare.

To improve the RBMP in Montenegro, it is necessary to develop karst-specific methodologies, integrate Groundwater-Dependent Ecosystems (GWDE), and better incorporate data on surface–groundwater interactions.

#### **4.6. Integration of Groundwater and Surface Water in Relevant Strategies and Policies**

Montenegro, through the Water Law and the Water Management Plan, has formally recognized the interconnection between groundwater and surface waters, but this integration is not operational. Monitoring systems for groundwater and surface waters function separately, using different indicators and timeframes. In karst areas, where surface and groundwater are directly connected (e.g., the Skadar Lake basin, Cijevna River), there is no integrated system for monitoring the mutual impacts of one on the other.

The Wastewater Management Strategy and the Environmental Protection Strategy do not contain specific mechanisms for joint risk assessment between these water types. Systematic comparisons of groundwater and surface water regimes do not exist. Some protective measures in river basins, such as discharge prohibitions near water intakes, indirectly protect groundwater as well, but this is not part of a broader integrated policy.

For the integration of these systems, it is necessary to develop unified sampling methodologies, common indicators, and harmonized monitoring stations, which has not yet been implemented. In order to fully harmonize with the EU Water Framework Directive, Montenegro must establish the legal and technical basis for integrated management of all water resources, particularly in karst regions.

#### **4.7. Role of Public Finance in Supporting Sustainable Groundwater Use**

Public finances in Montenegro partially support the sustainable use of groundwater through investments in infrastructure and source protection. However, subsidies are often not tied to environmental conditions, and oversight is weak, which can lead to overuse and pollution, particularly in karst areas. Improved control and alignment of funding with water protection objectives are needed.

## **5. Adherence to the WFD and GWD**

### **5.1. How water management strategy complies with the requirements set in the Water Framework Directive (WFD) and Groundwater Directive (GWD)**

Montenegro's Water Law transposes the main WFD principles: integrated river basin management, combined approach to pollution control, and the goal of achieving "good" water status. River Basin Management Plans (RBMPs) are prepared for the Adriatic and Danube basins, with programs of measures addressing groundwater pressures and risks, as required by the WFD.

The law explicitly protects aquatic ecosystems and groundwater-dependent terrestrial ecosystems (GWDEs), consistent with Art. 4 WFD. It establishes monitoring networks and classification of ecological and chemical status, including for groundwater. The prohibition of direct discharges into groundwater (with limited exceptions) reflects GWD Art. 6.

Sanitary protection zones and restrictions in karst aquifers are defined by by-law, aligning with WFD Annex V obligations to prevent deterioration. The framework also integrates economic instruments (water fees, "polluter pays" principle). Environmental Impact Assessment and liability laws complement water legislation, supporting preventive/remedial measures. Full alignment with WFD Annexes and GWD provisions is gradual but embedded in the strategic/legal framework. However, the main challenge remains the effective implementation of these provisions, particularly in strengthening groundwater monitoring networks, ensuring consistent enforcement, and improving protection of vulnerable karst aquifers.

### **5.2. How is the determination of GW and GWDE quality standards and threshold values, defined by the GWD and Directive on Environmental Quality Standards, regulated by respective law**

The Water Law requires adoption of environmental quality standards (EQS) for surface water and quality standards and threshold values for groundwater, in line with the GWD and the Directive on EQS. A by-law on water classification and monitoring (under preparation or partially adopted) sets general parameters, while effluent standards are already defined in a rulebook on wastewater discharge quality. For groundwater, Montenegro uses EU-recommended parameters (nitrates, pesticides, conductivity, chloride, sulphate, etc.), but a comprehensive national methodology for deriving site-specific threshold values (as per Annex II GWD) is not yet fully developed. In practice, RBMPs identify pollutants of concern and set preliminary thresholds, but systematic GWDE-specific standards are still pending. Karst areas are prioritized through the Rulebook on sanitary protection zones, which requires hydrogeological studies, tracer tests, and risk-based delineation, indirectly guiding threshold-setting in sensitive karst aquifers. Harmonization with the GWD methodology (intercalibration, trend assessment, significant upward trend criteria) is in progress but not complete.

### **Summary:**

1. Montenegro's Water Law largely transposes the key principles of the EU directives (WFD and GWD): river basin management, protection of aquatic and groundwater ecosystems, quality monitoring, prohibition of direct discharges, and special measures for karst areas;

2. Economic instruments have also been introduced, as well as horizontal alignment with laws on environmental impact assessment and liability;

3. The main challenge remains practical implementation, including strengthening the monitoring network, ensuring consistent enforcement, and improving the protection of vulnerable karst aquifers. This includes the operationalization of national methodologies and the full development of GWDE-specific standards, particularly in karst areas.

### **5.3. How do national regulations define areas designated for the abstraction of water intended for human consumption**

In Montenegro, areas designated for the abstraction of water intended for human consumption are primarily defined through sanitary protection zones of drinking water sources, rather than as separate groundwater bodies. These zones are established in accordance with the Law on Waters and accompanying Rulebook on the manner of determining and maintaining sanitary protection zones ("Official Gazette of Montenegro", No. 066/09 of 02 October 2009, 013/24 of 16 February 2024). The protection zones are divided into three levels (I, II, and III), depending on the degree of restriction and proximity to the water source. Their purpose is to safeguard both groundwater and surface water sources used for public water supply from pollution and overexploitation.

Groundwater bodies are identified separately in the River Basin Management Plans for the Adriatic and Danube River Basins (2021), where they are classified based on hydrogeological characteristics and monitoring results. However, the designation of water abstraction areas for drinking water is operationally and legally linked to sanitary protection zones. The establishment and maintenance of these zones are under the competence of the Ministry of Agriculture, Forestry and Water Management in cooperation with the Ministry of Health- Institute for Public Health and local water utilities.

## **6. Knowledge, information and awareness**

### **6.1. Assessment of the Dinaric Karst Groundwater System in Relation to WFD and GWD Requirements**

The groundwater system of the Dinaric karst within Montenegro has been only partially assessed in accordance with the requirements of the EU Water Framework Directive (WFD) and the Groundwater Directive (GWD). Due to the highly complex hydrogeological structure of the karst, characterized by strong heterogeneity, rapid infiltration, and limited natural protection, the delineation of groundwater bodies was challenging. The initial delineation and characterization were carried out during the preparation of the River Basin Management Plans (RBMPs) for the Adriatic and Danube River Basins, adopted in 2021. These plans provided the first official framework for groundwater body definition, status assessment, and risk identification.

According to the River Basin Management Plans (RBMPs) for the Adriatic and Danube River Basins, adopted in 2021, Montenegro has delineated 89 surface water bodies (48 for Danube and 41 for Adriatic, including rivers, lakes, and transitional waters) and 30 groundwater bodies (13 for Danube and 17 for Adriatic) across both river basin districts. The delineation was based on hydrographic, geomorphological, and hydrogeological criteria in line with the requirements of the EU Water Framework Directive. For groundwater, special consideration was given to the hydrogeological characteristics of the Dinaric karst system, which dominates the Adriatic basin.

However, systematic quantitative and chemical status assessments remain limited due to insufficient monitoring data and the lack of continuous groundwater quality networks. The existing monitoring is mostly focused on public water supply sources and does not fully represent the variability of karst systems. Groundwater-dependent ecosystems have not yet been comprehensively mapped or assessed, as required by the WFD.

## **6.2. Groundwater Monitoring: Available Data and Current Programmes**

The national water monitoring programme is implemented by the Institute of Hydrometeorology and Seismology of Montenegro (IHMS), in cooperation with the Environmental Protection Agency (EPA) and the Geological Survey of Montenegro (GSM). The monitoring includes regular assessment of surface and groundwater quality and quantity, following national regulations and partially harmonized with EU directives. The network covers key river sections, reservoirs, and selected groundwater sources used for public water supply. However, the frequency and spatial coverage of monitoring are still limited due to financial and technical constraints, and further strengthening of the network is planned to achieve full compliance with the WFD.

In conclusion, while Montenegro has made initial steps toward implementing WFD and GWD principles in the Dinaric karst groundwater system, further work is required to achieve full compliance, particularly in monitoring, classification, and integration of ecosystem-related assessments.

### **Monitoring**

The monitoring of water quality is carried out by the state administration body responsible for hydrometeorological affairs — the Institute of Hydrometeorology and Seismology of Montenegro (IHMS) — in accordance with the annual Monitoring Programme for Surface and Groundwater, adopted by the Ministry, following prior opinions from the state authorities responsible for health and environmental protection.

Continuous monitoring of surface water quality in Montenegro is conducted to assess water quality, track pollution trends, and preserve water resources. The testing of water quality at springs and water supply sources serves to evaluate the suitability of water for drinking and recreational use, with the goal of protecting both water sources and public health.

Water testing aims to determine the status of water bodies:

- Surface waters are classified by chemical and ecological status,
- Groundwater by chemical and quantitative status. Each status is categorized as high, good, moderate, poor, or bad, while for artificial or heavily modified water bodies, classification is based on ecological potential (good, moderate, poor, bad).

## Water Quality monitoring

In line with the EU Water Framework Directive (WFD), surface water monitoring in Montenegro should include:

- Biological monitoring covering five biological quality elements: phytoplankton, phytobenthos, macrophytes, benthic invertebrate fauna, and fish;
- General physico-chemical parameters supporting biological monitoring (such as pH, temperature, dissolved oxygen, alkalinity, salinity, and nutrients);
- Monitoring of specific pollutants;
- Hydromorphological elements (flow quantity and dynamics, connectivity with groundwater, river continuity, river width and depth variations, riverbed structure, and bank composition);
- Chemical monitoring including the analysis of 45 priority substances.

The physico-chemical parameters included:

pH value, temperature, turbidity, electrical conductivity, total dissolved solids, suspended matter, oxygen concentration, oxygen saturation (%O<sub>2</sub>), BOD<sub>5</sub> (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand, with KMnO<sub>4</sub>), alkalinity, total hardness (°dH), bicarbonates (HCO<sub>3</sub><sup>-</sup>), chlorides (Cl<sup>-</sup>), sulfates (SO<sub>4</sub><sup>2-</sup>), nitrates (NO<sub>3</sub><sup>-</sup>), nitrites (NO<sub>2</sub><sup>-</sup>), ammonium (NH<sub>4</sub><sup>+</sup>), total nitrogen (TN), orthophosphates (o-PO<sub>4</sub><sup>3-</sup>), total phosphates (u-PO<sub>4</sub><sup>3-</sup>), total organic carbon (TOC), calcium (Ca<sup>2+</sup>), magnesium (Mg<sup>2+</sup>), total iron (u-Fe), sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), and salinity.

During 2023, **surface water** testing in Montenegro was conducted through 3 to 4 measurement series for basic physico-chemical parameters, covering both low-flow periods (when pollution levels are highest) and high-flow periods, one series for priority and specific pollutants, one series of biological assessments (for phytobenthos, macrophytes, and macrozoobenthos), and two series for phytoplankton monitoring.

The monitoring covered 20 watercourses at 27 sites (table 1.1). Out of the 27 monitored river sites, the overall water status met the required “good” status at 4 locations (14.8%) — Ibar (upstream of Rožaje), Vrbnica (downstream of the camp), Tara (downstream of Mojkovac), and Tara (Šćepan Polje). The remaining 23 sites (85.2%) did not meet the satisfactory status, as follows:

Moderate water quality status was recorded at 12 locations (44.4%) — Lim (Dobrakovo); Bistrica Bjelopljaska (upstream of Bistrica settlement); Ljuboviđa (Kovren); Popča (downstream of Petnjica); Bistrica Beranska (downstream of Lubnice); Kutska Rijeka (Kuti); Peročica (Jošanica); Grlja (upstream of Vusanje); Ibar (Bać); Bijela (Gornja Bijela); Bukovica (upstream of Timar); and Čehotina (Rabitlje).

Poor water quality status was recorded at 9 locations (33.3%) — Crnojevića Rijeka (Brodsko Njiva); Morača (Zlatica); Morača (downstream of Vukovci); Cijevna (Dinoša); Zeta (Dukla Bridge); Zeta (Danilovgrad); Zeta (Vranjske Njive); Lim (Marsenića Rijeka, upstream of the bridge); and Čehotina (downstream of the collector).

Very poor water quality status was observed at 2 sites (7.4%) — Bojana (Fraskanjel) and Crmnica (upstream of the Bojana confluence).

**Table 1.1** Overview of the assessment of ecological status / chemical status, and potential of surface waters, overall status as well as status by quality elements of general physicochemical parameters, pollutants and priority substances and biological parameters in 2023.

2023.g.	Nazivi vodnih tijela	Površinsko VT	Tip VT	Redni broj	Naziv mjernog mjesta	Hemijski i Ekološki status kvaliteta voda									
						Prioritetne i zagađujuće supstance	Opšti fizičko hemijski parametri	Specifične zagađujuće supstance	Fitoplankton	Fitobentos	Makrofite	Makrozoobentos	Ukupni ES / EP i HS na osnovu 6 elemenata	Ukupni ES / EP i HS bez makrozoobentonske zajednice	
1.	Bojana	1	R9	1.	Fraskanjel	vdD	d	d	u	d	l	vl	VL	L	
2.	Crmnica	1	R3	2.	Iznad ušća	vdD	u	d	-	vd	vl	vl	VL	VL	
3.	Crnojevića R.	1	R3	3.	Brodsko Njiva	vdD	d	d	-	vd	-	l	L	D	
4.	Morača	4	R6	4.	Zlatica	-	u	-	-	vd	-	l	L	U	
		7	R8	5.	Ispod Vukovaca	vdD	u	d	-	vd	l	l	L	L	
5.	Cijevna	1	R6	6.	Dinoša	-	d	-	-	vd	-	l	L	D	
6.	Zeta	1	R5	7.	Duklov most	-	u	-	-	vd	l	u	L	L	
		4	R8	8.	Danilovgrad	-	d	-	-	d	d	l	L	D	
		4	R8	9.	Vranjske njive	vdD	d	d	d	vd	u	l	L	U	
7.	Lim	2	R4	10.	Marsenića rijeka	-	d	-	-	vd	-	l	L	D	
		3	R7	11.	Dobrakovo	vdD	u	d	-	d	-	-	U	U	
8.	Bistrica Bjelop.	1	R2	12.	Iznad Bistrice	-	d	-	-	u	d	u	U	U	
9.	Ljuboviđa	1	R1	13.	Kovren	-	u	-	-	d	-	u	U	U	
10.	Popča	1	R2	14.	Ispod Petnjice	-	d	-	-	d	-	u	U	D	
11.	Bistrica Ber.	2	R4	15.	Ispod Lubnica	-	d	-	-	vd	-	u	U	D	
12.	Kutska rijeka	1	R1	16.	Kuti	-	d	-	-	d	d	u	U	D	
13.	Peročića	1	R1	17.	Jošanica	-	d	-	-	vd	-	u	U	U	
14.	Grlja	1	R10	18.	Iznad Vusanja	-	d	-	-	vd	-	u	U	U	
15.	Ibar	1	R1	19.	Izn. Rozaja	-	d	-	-	vd	-	-	D	D	
		2	R4	20.	Bać	vdD	u	d	-	d	-	u	U	U	
16.	Vrbnica	2	R2	21.	Kod kampa	-	vd	-	-	d	d	d	D	D	
17.	Bijela	1	R1	22.	Gornja Bijela	-	u	-	-	d	d	u	U	U	
18.	Bukovica	1	R1	23.	Iznad Timara	-	d	-	-	vd	vd	u	U	D	
19.	Tara	3	R4	24.	Ispod Mojkovca	-	d	-	-	vd	-	-	D	D	
		5	R7	25.	Šćepan Polje	vdD	d	vdD	-	vd	-	-	D	D	
20.	Čehotina	2	R5	26.	Rabitlja	-	u	-	-	vd	u	d	U	U	
		5	R5	27.	Ispod kolektora	vdD	u	d	-	d	l	l	L	L	
1.	Šasko j.	1	L4	28.	Kod splava	vdD	u	d	d	d	u	-	U	U	
2.	Skadarsko jezero	WB1	L4	29.	Kamenik	-	d	-	d	vd	vl	-	VL	VL	
		WB 3	L5	30.	Moračnik	vdD	vd	d	d	vd	u	-	U	U	
		WB4	L5	31.	Centar	-	vd	-	u	-	-	-	U	U	
		WB2	L4	32.	Podhumski kanal	-	d	-	u	vd	u	-	U	U	
3.	Plavsko j.	1	L1	33.	Kod splava	vdD	vd	vdD	ul	vd	u	-	UL	UL	
4.	Crno j.	1	L1	34.	Kod splava	-	vd	-	d	vd	u	-	U	U	
1.	Pivsko j.	VVT	N/A	35.	Kod splava	dbP	dbP	dbP	ul	vd	-	-	UL	UL	
1.	Hercegn.i Z.	TW 4	T3	36.	Ušće Sutorine	-	u	-	-	-	-	-	U	U	
2.	Risanski Z.	TW 2	T1	37.	Ušće Risanske rijeke	-	d	-	-	-	-	-	D	D	
3.	Kotorski Z.	TW 1	T1	38.	Ušće Škudre	-	d	-	-	-	-	-	D	D	
4.	Tivatski Z.	TW 3	T2	39.	Ušće Rijeke kod Opatova	-	u	-	-	-	-	-	U	U	
5.	Bojana-more	TW 5	T4	40.	Ušće Bojane desni ruk.	-	d	-	-	-	-	-	D	D	

**Groundwater** - The monitoring network in 2023 included 32 groundwater locations, consisting of 6 springs/aquifers, 3 dug wells, and 23 boreholes. Some of these are currently used or planned for drinking water abstraction.

Groundwaters from the first aquifer of the Zeta Plain were sampled from three wells as part of monitoring vulnerable zones under the EU Nitrates Directive. These wells are privately owned - water was pumped from two wells and collected manually from one (in Vranj). The Gostilj well is still used today for drinking water without any treatment. Groundwater investigations were conducted in 2023 through two sampling campaigns, representing characteristic hydrological conditions, specifically during periods of low and high water levels.

Based on the values of basic physico-chemical quality elements and specific pollutants tested in 32 groundwater sites (23 new boreholes, 3 dug wells, and 6 springs/aquifers), the overall groundwater status was assessed as good at 19 sites (59.4%) - Kajnak, Sjenokos, Podgorska Vrela, Budva, Kaluđerovo Oko, Ribnica, Vučji Studenac, Cijevna (right bank near the confluence), Bolje Sestre (borehole), Bolje Sestre (aquifer), Trgaj, Čevo, Riječani, Glava Šavnika (aquifer), Šavnik (near the school), Mateševo, Ravnjak, Manastirsko Vrelo-Berane, and Ali Paša's Springs.

A poor status was recorded at 13 sites (40.6%) - Sveti Đorđe, Popovići, Jaz, Risanska Špilja, Goljemadi, Radovče, Plantaže, Gostilj, Vranj, Drešaj, Zaljutnica, Bijelo Polje, and Pljevlja.

The physico-chemical parameters that contributed to the unsatisfactory groundwater quality were: electrical conductivity (8 sites), alkalinity (1 site), BOD<sub>5</sub> (1 site), ammonium (NH<sub>4</sub><sup>+</sup>) (4 sites), nitrite (NO<sub>2</sub><sup>-</sup>) (4 sites), total nitrogen (TN) (4 sites), total phosphorus (TP) (3 sites), orthophosphate (o-PO<sub>4</sub><sup>3-</sup>) (1 site), sulfates (SO<sub>4</sub><sup>2-</sup>) (2 sites), and total organic carbon (TOC) (2 sites). The parameters pH and nitrate (NO<sub>3</sub><sup>-</sup>) were within the satisfactory range at all locations.

Among polluting substances, cadmium (Cd), mercury (Hg), and pesticides were not detected (below the limit of quantification - LOQ), while lead (Pb) and arsenic (As) were detected in trace amounts, but below threshold values - As detected at 4 sites (range 0.24-1.5 µg/L) and Pb at 4 sites (range 0.21-0.24 µg/L).

### **Additional Notes**

#### **Bathing water status data**

EPA monitors bathing water quality at marine and freshwater sites during the bathing season.

Parameters: microbiological indicators (*E. coli*, intestinal enterococci) and supporting physico-chemical indicators.

Frequency: typically every two weeks during the summer season.

Data are published annually and reported to the EU Bathing Water Directive framework (for coastal sites).

#### **Drinking water monitoring**

Public health institutes regularly monitor drinking water quality from supply systems.

Parameters: microbiological safety (coliforms, *E. coli*, enterococci), physico-chemical indicators (nitrate, chloride, metals, hardness, conductivity), and residual chlorine.

Frequency: varies by system size, but generally monthly to quarterly.

Results are reported in National Public health reports and form part of EU Drinking Water Directive harmonisation.

**Table 1.2** Assessment of the chemical status of groundwater for 2023 based on general physicochemical parameters and pollutants (shown in colors in accordance with WFD recommendations)

2023.g.	Opština	KOD vodnog tijela podzemnih voda ili grupe vodnih tijela podzemnih voda	Naziv vodnog tijela podzemnih voda ili grupe vodnih tijela podzemnih voda	Redni broj mjernog mjesta	Naziv mjernog mjesta	Status vode - opšti fizičko hemijski elementi kvaliteta i zagađujuće supstance
1.	Ulcinj	ME_A_GVTPV_I_2	Ulcinjско polje	1.	Sveti Đorđe	L
2.	Bar	ME_A_GVTPV_K_3	Možura-Paštrovići	2.	Kajnak	D
		ME_A_GVTPV_K_3	Možura-Paštrovići	3.	Popovići	L
		ME_A_GVTPV_C_8	Orahovštica-R.Cmojevića	4.	Sjenokos	D
		ME_A_GVTPV_C_8	Orahovštica-R.Cmojevića	5.	Podgorska vrela	D
3.	Budva	ME_A_GVTPV_K_4	Grbalj-Luštica	6.	Budva kod škole	D
		ME_A_GVTPV_K_4	Grbalj-Luštica	7.	Jaz	L
4.	Risan	ME_A_VTPV_K_6	Orijen	8.	Risanska špilja	L
5.	Podgorica	ME_A_GVTPV_K_9	Karuč-Sinjac	9.	Goljemadi	L
		ME_A_GVTPV_K_9	Karuč-Sinjac	10.	Kaluđerovo oko	D
		ME_A_GVTPV_C_16	Kući	11.	Ribnička vrela	D
		ME_A_GVTPV_C_11	Prekornica-Bjelopavlići	12.	Radovče	L
		ME_A_GVTPV_K_12	Garač	13.	Vučji studenac	D
6.	Zeta	ME_A_GVTPV_I_10	Zetska ravnica	14.	Plantaže	L
		ME_A_GVTPV_I_10	Zetska ravnica	15.	Ušće Cijevne	D
		ME_A_GVTPV_K_9	Karuč-Sinjac	16.	Bolje sestre-bušot.	D
		ME_A_GVTPV_K_9	Karuč-Sinjac	17.	Bolje sestre-izdan	D
		ME_A_GVTPV_I_10	Zetska ravnica	18.	Gostilj	L
7.	Tuzi	ME_A_GVTPV_I_10	Zetska ravnica	19.	Vranj	L
		ME_A_GVTPV_I_10	Zetska ravnica	20.	Drešaj	L
		ME_A_GVTPV_C_16	Kući	21.	Trgaj	D
8.	Cetinje	ME_A_GVTPV_K_12	Garač	22.	Čevo	D
9.	Nikšić	ME_A_GVTPV_K_15	Trebišnjica	23.	Riječani	D
		ME_DB_VTPV_K_18	Brezna-Maglič	24.	Zaljutnica	L
10.	Šavnik	ME_DB_VTPV_K_18	Brezna-Maglič	25.	Glava Šavnika	D
		ME_DB_VTPV_K_19	Pivska planina	26.	Šavnik kod škole	D
11.	Kolašin	ME_DB_GVTPV_K_26	Komovi	27.	Mateševo	D
12.	Mojkovac	ME_DB_VTPV_K_20	Sinjajevina	28.	Ravnjak	D
13.	Bijelo Polje	ME_DB_GVTPV_C_27	Beranska Bistrica-Ljuboviđa	29.	Bijelo Polje	L
14.	Berane	ME_DB_GVTPV_C_27	Beranska Bistrica-Ljuboviđa	30.	Manastirsko vrela	D
15.	Gusinje	ME_DB_GVTPV_K_25	Prokletije	31.	Alipašini izvori	D
16.	Pljevlja	ME_DB_GVTPV_I_24	Basen Pljevlja	32.	Pljevlja	L

### Hydromorphological and ecological flow monitoring

Hydromorphological assessments include river morphology, riparian zone, and connectivity, carried out in WFD status assessments.

Ecological flow monitoring is pilot-based, focused on rivers with hydropower or groundwater interaction.

Data coverage is still limited, but gauging stations (Institute of Hydrometeorology and Seismology) provide continuous hydrological records to support ecological flow estimation.

Full methodology for ecological flow assessment is under development in line with WFD guidance.

**Important note:** In the Montenegrin legislation, there is no direct provision stating that karst springs and groundwater are habitats of special importance for biodiversity and that they should be protected as such. All protections are indirect, through: sanitary protection zones (for public water supply); the

general protection of ecosystems (Environmental Protection Act); and European obligations (WFD, GWD, Natura 2000, Habitats Directive).

### **6.3. Institutional Responsibilities and Capacity for Groundwater Data Collection, Management, and Dissemination**

In Montenegro, three main institutions are responsible for collecting, managing, and disseminating groundwater data: the Institute of Hydrometeorology and Seismology of Montenegro (IHMS), the Environmental Protection Agency (EPA), and the Geological Survey of Montenegro (GSM). The IHMS leads the national monitoring program for surface and groundwater, including the collection and processing of data on water quality and quantity. The EPA is responsible for processing, archiving, and reporting on the state of waters in accordance with EU directives and international project obligations. The GSM conducts hydrogeological investigations and collects data on groundwater regimes as part of research and investment projects.

Data are stored in institutional databases (IHMS and EPA) and are partially integrated into the national water information system, which is still under development. Although basic capacities exist, the organizations face limitations in human resources, technical equipment, and funding for continuous monitoring and database improvement. The number of trained specialists in hydrogeological and ecological monitoring is limited, especially in the analysis and interpretation of trends in karst areas. IHMS laboratory capacities are functional but require modernization and expansion of the set of accredited methods in accordance with EU directive requirements.

Coordination among institutions occurs through interdepartmental working groups and projects but is not systematically regulated by formal data exchange protocols. A unified platform for accessing, verifying, and utilizing data by different sectors (water management, ecology, health, energy) is lacking.

Despite these limitations, the institutions have solid basic capacities and professional staff, and progress in strengthening technical and organizational capabilities is achieved through international projects (GEF/UNDP and IPA programs). In the long term, it is necessary to ensure stable financing, systematic staff training, and modernization of information systems to enable efficient and integrated management of groundwater data.

### **6.4. Public Access to Groundwater and GWDE Information**

In Montenegro, data and information on groundwater are partially publicly available through institutions responsible for water monitoring and management. The Institute of Hydrometeorology and Seismology of Montenegro (IHMS) implements the national monitoring program for surface and groundwater and maintains a database with the results of regular water quality and quantity monitoring. Some of this data is published in annual reports and public statements (<https://www.meteo.co.me/page.php?id=57>).

In addition to IHMS, the Geological Survey of Montenegro (GSM) collects groundwater data as part of hydrogeological surveys and projects related to water supply and source protection. These data are primarily used for technical and project purposes and are not integrated into a unified national database.

Water quality data are also submitted to the Environmental Protection Agency (EPA) (<https://epa.org.me/informacije-o-stanju-zivotne-sredine/>), but most information remains within institutional or project-specific frameworks, without public access to raw data. Currently, there is no unified, publicly accessible information system that includes integrated data on groundwater and groundwater-dependent ecosystems (GDE), particularly in karst areas.

In conclusion, although certain data are available through institutional reports, there is a lack of a systematized, transparent, and comprehensive database on groundwater in karst regions. Improving inter-institutional cooperation, standardization, and public accessibility of information is necessary for better water management and sectoral planning.

### **6.5. Status of Groundwater Information Sharing Between Public and Private Sectors**

In Montenegro, the exchange of groundwater information between state institutions exists but is limited and unstructured. The Institute of Hydrometeorology and Seismology (IHMS), the Environmental Protection Agency (EPA), and the Geological Survey of Montenegro (GSM) possess significant databases on groundwater quality, quantity, and geological characteristics. However, this information is most often exchanged on request and within individual project frameworks.

There is no unified national information system that enables automatic data exchange and integration between institutions. Instead, communication takes place through formal letters, reports, and periodic meetings, which limits efficiency and timeliness in decision-making.

Collaboration with the private sector (e.g., water supply companies, industry, tourism, and hydropower enterprises) occurs sporadically, mainly through water permit procedures, environmental impact assessments, and consultancy projects. The private sector rarely has access to complete databases, while obligations to share data from private studies are poorly defined. The lack of standardized protocols for information exchange and differing data formats further complicate the integration of information among institutions. In practice, this leads to duplication of research and inconsistent data quality.

Although there are positive examples of cooperation through international projects (e.g., IPA and GEF projects within the Dinaric karst), data exchange has not yet been systemically addressed. Establishing a centralized database and formal mechanisms for information sharing, along with strengthening transparency and communication between the public and private sectors, is necessary.

## **7. Socio-economic setting and challenges**

### **7.1. Identified Groundwater Management Challenges in Karst Areas and Potential Triggers for Governance Improvement**

At the national level, numerous challenges have been identified in the management of groundwater in karst areas. Karst aquifers exhibit high vulnerability to pollution due to the direct connectivity between surface and groundwater flows, which allows contaminants to rapidly reach water sources. Pronounced spatial and temporal variability of flow, as well as limited retention capacity, complicate the planning and sustainable use of resources, particularly during dry periods. Additional challenges include diffuse pollution from agriculture and inadequate septic systems, as well as unregulated

private wells (used as unmonitored septic drains). Seasonal tourism pressures contribute to increased water consumption and stress on wastewater systems. The lack of detailed hydrogeological monitoring and groundwater reserve assessments, combined with weak inter-institutional cooperation, further hampers effective management.

As priority “triggers” for improving management, the following are recommended: the establishment of a centralized database on water occurrences and infrastructure, the expansion and standardization of the monitoring network, the preparation of mandatory groundwater reserve reports, and the consistent implementation of sanitary protection zones for water sources. In addition, the use of financial incentives and the implementation of small-scale pilot projects employing nature-based solutions—such as afforestation, protection of springs, geological environment, and soil—can help ensure the long-term conservation and sustainable use of groundwater in karst areas.

## **7.2. Role and Significance of Groundwater and GWDE for the Economy and Well-being in the Dinaric Karst**

Groundwater plays a crucial role in the natural and socio-economic systems of Montenegro, particularly within the Dinaric karst region, which covers most of the country’s territory. It represents the primary source of drinking water, with approximately 92% of the population supplied by groundwater—significantly above the European average of around 75%. Public water supply relies on roughly 80 springs, with the largest reserves located in karst formations as well as in intergranular porous aquifers. These formations are practically the only source of drinking water, except in Herceg Novi and Pljevlja, which also exploit some surface waters (Otilovičko and Bilečko Lakes). Groundwater supports key economic sectors, including industry, energy, agriculture, and mineral water exploitation. In rural areas, local extractions enable agricultural production, while stable supply enhances community resilience during dry periods. Ecosystems dependent on groundwater play a significant role in human health, as the quality of groundwater directly determines the quality of drinking water. The Dinaric karst also has high potential for geotourism and recreational activities, contributing to local development and the preservation of natural heritage (Prokletije, Durmitor, Cijevna Canyon).

However, these resources face pressures from overexploitation, pollution, and climate change. Preserving the quality and quantity of groundwater and its dependent ecosystems is essential for the long-term wellbeing of the population and sustainable development in Montenegro. Sustainable management of these resources requires an integrated approach that combines protection, monitoring, and rational use in accordance with national and international standards.

## **7.3. Degree of development of water supply and sanitation infrastructure, wastewater and waste treatment and management**

The water supply infrastructure and wastewater collection and treatment systems in Montenegro show a significant degree of development in urban centers, whereas rural areas remain poorly covered. Access to water supply is considerably better in coastal and central towns and larger settlements, while remote mountainous and karst regions (central and northern Montenegro) often rely on local springs and individual wells. In these areas, access to safe water quantities and quality remains limited, especially during dry periods.

Sewer systems and wastewater treatment plants exist in larger cities, but their coverage and operational functionality remain uneven. Many settlements, particularly in rural and tourist areas, still rely on unmanaged septic tanks or improvised solutions, which increases the risk of groundwater contamination. In tourist regions, seasonal overloading of existing treatment plants during the summer further deteriorates the quality of surface and groundwater.

Solid waste management varies across municipalities, with some local governments still lacking standardized services for collection, transport, and disposal. Inadequate waste management, particularly at unmanaged landfills in karst areas, increases the risk of groundwater contamination.

Although water supply infrastructure is relatively developed in major urban areas, key challenges remain in improving wastewater treatment and effective solid waste management. These sectors represent priority areas for future investments and require an integrated approach to the protection and sustainable use of water resources in Montenegro's Dinaric karst region.

#### **7.4. Socio-Economic Context and Macroeconomic Policies in the Dinaric Karst and Their Impact on Groundwater and GWDE**

The economy of Montenegro in the Dinaric karst region is characterized by dominant tourism along the coast, agriculture in the northern and central areas, and industrial and service sectors in urban centers. Seasonal fluctuations in population in tourist destinations increase water consumption during the summer months. Rural economies largely rely on traditional agriculture, which depends on local groundwater sources. Infrastructure disparities between urban and rural areas affect access to water supply and wastewater collection and treatment systems. The main drivers (pressures) affecting the status of groundwater and dependent ecosystems include increased seasonal loads from tourism and coastal urbanization, diffuse pollution from agriculture, inadequate waste management, overexploitation of groundwater, and climate change. Macroeconomic policies provide the framework for state strategies and measures that shape economic development and directly or indirectly influence the protection and sustainable use of groundwater and dependent ecosystems. Prioritizing public water supply supports the protection of springs if implemented effectively, whereas tourism and infrastructure development without integrated protection can exacerbate the pressures on groundwater and groundwater-dependent ecosystems (GWDE).

The Water Management Strategy (2017) and River Basin Management Plans (2021) establish the framework for integrated water resources management, but their effective implementation and financing are crucial. Aligning macroeconomic policies with water protection measures-including investments, regulation, monitoring, and education-is essential to safeguard the services that groundwater and GWDE provide to society and the economy.

#### **7.5. Diversity of interest of groundwater users and stage of development of groundwater exploitation and management**

The strategic objective of water management in Montenegro is to ensure sufficient quantities of water of appropriate quality for public water supply and various economic needs, in a way that does not endanger the environment (Water Management Strategy of Montenegro, 2017).

Water supply for the population has priority over all other types of water use (Article 47 of the Water Law, “Official Gazette of Montenegro”, Nos. 27/07, 73/10, 32/11, 47/11, 48/15, and 52/16).

Main users of groundwater in Montenegro:

- Water supply for settlements and industries connected to public water supply systems
- Supply of industry and energy sectors with groundwater for technological purposes
- Irrigation of agricultural land
- Tourism and recreational uses
- Use of geothermal and mineral waters, including water for commercial purposes
- Groundwater-dependent ecosystems

The majority of the population in Montenegro is supplied by groundwater, while only two municipalities (Pljevlja and Herceg Novi) rely partially on surface water sources.

Since the area covered by registered irrigation systems is very limited, it can be assumed that most irrigation in Montenegro is carried out in an unorganized and traditional manner.

The exploitation and management of groundwater in Montenegro are partially regulated by the Water Law, as well as by the Water Management Plans for the Adriatic and Danube River Basins (2021) and the Water Management Strategy of Montenegro (2017).

## **7.6. Governance and Political Leadership in Support of Groundwater Management**

Montenegro has established a basic institutional and legal framework for water management, defined through the Water Law, the Water Management Strategy (2017), River Basin Management Plans for the Adriatic and Danube basins (2021), and accompanying subordinate regulations. Institutional responsibility is distributed among several ministries and agencies, including the Ministry of Agriculture, Forestry and Water Management, the Ministry of Ecology, the Environmental Protection Agency, the Ministry of Health, the Ministry of Energy and Mining, the Water Administration, local governments, and public water supply companies.

The legal framework is aligned with the principles of the EU Water Framework Directive (WFD), but practical implementation and inter-institutional coordination remain limited, especially in karst areas. Insufficient cross-sector coordination hampers communication between institutions, and frequent reorganizations and leadership changes slow the execution of strategies. Financial and human resources for monitoring, inspection, and water status analysis are limited, affecting the protection of groundwater sources. Public participation and the involvement of local governments in water resource decision-making are insufficient.

Nevertheless, progress is visible through the strengthening of integrated water management and the development of updated plans in line with EU standards. Political and institutional support for groundwater protection is gradually increasing. Institutional leadership and governance provide partial incentives for sound groundwater management. For full effectiveness, stronger coordination, enhanced political commitment, and long-term investment in monitoring and protective measures—particularly in karst areas—are necessary.

### 7.7. Broader Economic Trends and Their Potential Impact on Groundwater in the Dinaric Karst

In Montenegro, development processes are observed that directly or indirectly affect the status of groundwater, particularly in the Dinaric karst, where aquifers are highly vulnerable. Intensive tourism development in coastal and karst areas increases water consumption and pressure on springs, while inadequate wastewater treatment can lead to aquifer pollution. Urbanization and spatial expansion of settlements—often uncontrolled in source protection zones—raise the risk of reduced infiltration and contamination.

Agricultural activities, especially the use of fertilizers and pesticides, contribute to diffuse pollution, while unregulated irrigation causes uncontrolled groundwater abstraction. Energy and infrastructure development, including roads, tunnels, and hydropower projects, alters natural groundwater flows. Climate change results in longer dry periods and reduced available water, increasing the risk of salinization in coastal sources. Seasonal population growth during summer further stresses water resources and infrastructure.

Sustainable development planning and the integration of water policy into spatial and sectoral plans are crucial for groundwater protection. Strengthening monitoring systems and improving wastewater treatment are necessary. Stricter controls over land use in sanitary protection zones around water sources are essential. Future investments must be aligned with water and environmental standards to ensure long-term protection and sustainable use of groundwater.

## 8. National SWOT analysis

Detailed SWOT analysis of groundwater management in the Dinaric karst of Montenegro (Table 1.3).

### Strengths

#### 1. Legal and Strategic Framework

- The Water Law and accompanying by-laws regulate the use, protection, and monitoring of groundwater and surface waters.
- The Water Management Strategy (2017) and River Basin Management Plans (2021) implement the principles of EU directives (WFD, GWD).
- Institutional responsibility is distributed across multiple ministries and institutions, enabling multi-layered oversight (water management, health, environment, energy, agriculture).

#### 2. Existing Monitoring Network

- The national monitoring program covers surface and groundwater, including:
  - Quality (physico-chemical parameters, priority and specific substances, biological elements) and quantity,
  - Hydromorphological elements and ecological flows.
- Monitoring is partially harmonized with EU requirements and covers public drinking water sources and key rivers and aquifers.

### **3. Quality and Importance of Groundwater**

- The Dinaric karst provides high-quality drinking water (around 92% of Montenegro's population is supplied by groundwater).
- Groundwater supports key economic sectors:
  - Tourism: coastal areas, geotourism attractions (Durmitor, Prokletije, Cijevna canyon).
  - Agriculture: irrigation, livestock, and local production.
  - Industry and energy: technological needs and hydropower.
- Groundwater-dependent ecosystems (GWDE) contribute to biodiversity conservation and ecosystem stability, although they are not yet formally defined in legislation.

### **4. International Cooperation**

- Implemented international projects (GEF/UNDP, IPA projects) provide knowledge transfer, experience, technology, methodologies, and financial support for monitoring and protection.
- There is experience in applying WFD and GWD principles, including chemical status assessment and identification of at-risk aquifers.

## **Weaknesses**

### **1. Limited Monitoring and Data Gaps**

- The monitoring network is insufficiently spatially covered, especially in karst areas, where heterogeneity and fast flow dynamics require a dense network.
- The status of water regimes has not yet been assessed.
- Data are stored across different institutions (IHMS, EPA, GSM), complicating integration and trend analysis.

### **2. Institutional Challenges**

- Weak coordination between sectors and institutions; information exchange is neither standardized nor automated.
- Cooperation with the private sector is sporadic and unregulated; private monitoring is often not integrated into the national system.
- Insufficient involvement of local communities and the public in water management decisions.

### **3. Regulatory and Legal Gaps**

- Karst aquifers and GWDE are not explicitly recognized in legislation as special resources for biodiversity protection.
- Control over sanitary protection zones of water sources is inconsistent.
- Integration of water protection into spatial and sectoral planning is limited.

#### **4. Resource and Infrastructure Issues**

- Land-use changes.
- Urbanization processes.
- Rural and mountainous areas rely on local sources and individual wells, often without supervision.
- Lack of adequate wastewater treatment and solid waste management facilities in rural and tourist areas.
- Limited human resources and finances for continuous monitoring and analysis.

#### **5. Socio-Economic Pressures**

- Seasonal tourism and urbanization increase pressure on water sources.
- Agriculture and the use of fertilizers/pesticides lead to diffuse pollution.
- Climate change: longer dry periods, increased risk of salinization, and reduced water yield.

### **Opportunities**

#### **1. Modernization of Monitoring Systems**

- Centralized database for integrated management of groundwater and surface water.
- Expansion of the monitoring network, including indicators for GWDE, ecological flows, and hydrogeological assessments.
- Application of GIS and remote sensing technologies can significantly improve monitoring of karst aquifer dynamics and enable more precise planning for groundwater protection and use.
- Strengthening institutional capacities.
- Enhancing transboundary cooperation.
- Standardization of data exchange procedures between public and private sectors.
- Training of water professionals (hydrogeology, hydrology), monitoring, and ecological management.
- Active involvement of local communities and the public in source and GDE protection.

#### **2. Regulatory Opportunities**

- Introduction of regulations for the preparation of hydrogeological reports on groundwater reserves.
- Amendment of legislation for the special protection of karst aquifers and GWDE.
- Consistent implementation of sanitary protection zones and control of exploitation.
- Integration of water protection into tourism, agriculture, and urban planning.

- Implementation of NATURA 2000.

### **3. Economic and Ecological Initiatives**

- Application of nature-based solutions for water protection (afforestation, soil protection, source revitalization).
- Development of sustainable tourism and agriculture that reduce pressure on groundwater.
- Alignment of macroeconomic policies with water protection and sustainable development goals.

## **Threats**

### **1. Intensive Anthropogenic Pressures**

- Seasonal tourism, urbanization, and inadequate infrastructure increase the risk of pollution.
- Agriculture (fertilizers and pesticides) and unregulated irrigation threaten the quantity and quality of aquifers.
- Unregulated wastewater and solid waste systems contribute to contamination.

### **2. Natural and Climatic Factors**

- Heterogeneity of karst aquifers and high spatial variability complicate planning.
- Droughts and climate change reduce available resources and increase the risk of salinization in coastal springs.

### **3. Institutional and Regulatory Uncertainty**

- Insufficient implementation of the legal framework and management plans in practice.
- Weak coordination among institutions leads to duplication of research and inefficient management.

### **4. Socio-Economic Risks**

- Uncontrolled development of infrastructure, energy, and tourism without integrated water protection threatens the long-term status of aquifers.
- Lack of investment in rural and karst areas reduces the resilience of local communities and ecosystems.

Table 1.3. Detailed SWOT analysis of groundwater management in the Dinaric Karst of Montenegro

<b>Detailed SWOT analysis of groundwater management in the Dinaric Karst of Montenegro</b>	
<b>STRENGTHS</b>	<b>WEAKNESSES</b>
<b>1. Legal and strategic framework</b>	<b>1. Limited monitoring and lack of data</b>
There is a Water Law and accompanying subordinate regulations governing the use, protection, and monitoring of groundwater and surface waters. The Water Management Strategy (2017) and River Basin Management Plans (2021) apply the principles of EU directives (WFD, GWD). Institutional responsibility is distributed across multiple ministries and agencies, enabling multi-layered oversight.	The monitoring network is insufficiently spatially covered. The water regime and the status of GWDE have not yet been assessed. Data are stored across different institutions (IHMS, EPA, GSM), making integration and trend analysis difficult.
<b>2. Existing monitoring network</b>	<b>2. Institutional challenges</b>
The national monitoring program covers surface and groundwater. The monitoring is partially harmonized with EU requirements and covers public drinking water sources as well as key rivers and aquifers.	Weak coordination between sectors and institutions. Collaboration with the private sector is sporadic and unregulated. Insufficient involvement of local communities and the public in water management decisions.
<b>3. Quality and significance of groundwater</b>	<b>3. Regulatory and legal gaps</b>
The Dinaric karst provides high-quality drinking water. Groundwater supports key economic sectors: tourism, agriculture, industry, and energy. Groundwater-dependent ecosystems (GWDE) contribute to biodiversity conservation and ecosystem stability.	Karst aquifers and GWDE are not explicitly recognized in legislation. Control of sanitary protection zones of water sources is inconsistent. Integration of water protection into spatial and sectoral plans is limited.
<b>4. International cooperation</b>	<b>4. Resource and infrastructure challenges</b>
Implemented international projects (GEF/UNDP, IPA projects). Experience exists in applying WFD and GWD principles, including chemical status assessment and identification of at-risk aquifers.	Land-use changes. Urbanization processes. Rural and mountainous areas rely on local springs and individual wells. Lack of adequate wastewater and solid waste treatment facilities in rural and tourist areas. Limited human resources and funding for continuous monitoring and analysis.
	<b>5. Socio-economic pressures</b>
	Seasonal tourism and urbanization increase pressure on water sources. Agriculture and the use of fertilizers/pesticides lead to diffuse pollution. Climate change.
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<b>1. Modernization of the monitoring system</b>	<b>1. Intensive anthropogenic pressures</b>
Centralized database for integrated management of groundwater and surface waters.	Seasonal tourism, urbanization, and inadequate infrastructure increase the risk of pollution.

<p>Expansion of the monitoring network, including indicators for GWDE, ecological flows, and hydrogeological assessments. Implementation of GIS and remote sensing technologies to assess the dynamics of karst aquifers. Strengthening transboundary cooperation.</p>	<p>Agriculture (fertilizers and pesticides) and unregulated irrigation threaten the quantity and quality of aquifers. Unmanaged wastewater and solid waste systems contribute to contamination.</p>
<p><b>2. Regulatory opportunities</b></p>	<p><b>2. Natural and climatic factors</b></p>
<p>Introduction of regulations for the preparation of hydrogeological reports on groundwater reserves. Amendment of legislation for the special protection of karst aquifers and GWDE. Consistent application of sanitary protection zones and control of water abstraction. Integration of water protection into tourism, agriculture, and urban planning. Implementation of NATURA 2000.</p>	<p>The heterogeneity of karst aquifers and high spatial variability complicate planning. Droughts and climate change reduce available resources and increase the risk of salinization in coastal springs.</p>
<p><b>3. Economic and ecological initiatives</b></p>	<p><b>3. Institutional and regulatory uncertainty</b></p>
<p>Application of nature-based solutions for water protection (afforestation, land conservation, spring revitalization). Development of sustainable tourism and agriculture to reduce pressure on groundwater. Alignment of macroeconomic policies with water protection and sustainable development goals.</p>	<p>Insufficient implementation of the legal framework and plans in practice. Weak coordination among institutions leads to duplication of research and inefficient management.</p> <p><b>4. Socio-economic risks</b></p> <p>Uncontrolled development of infrastructure, energy, and tourism without integrated water protection threatens the long-term status of aquifers. Lack of investments in rural and karst areas reduces the resilience of local communities and ecosystems.</p>

## 9. Gaps and opportunities

### **Gaps / Weaknesses in Groundwater Management**

#### **1. Monitoring and Data**

- Insufficient spatial and temporal coverage of monitoring, especially in karst aquifers.
- Limited data on quantity status, and Groundwater-Dependent Ecosystems (GWDE).
- Non-integrated databases - data are stored across multiple institutions without a centralized platform.
- Lack of standardization and automated data exchange among public institutions and the private sector.

#### **2. Institutional and Regulatory Weaknesses**

- Inadequate coordination among responsible institutions and sectors (water management, health, environment, agriculture, energy).
- Karst aquifers and GWDE are not explicitly recognized and protected in legislation.
- Weak implementation and control of sanitary protection zones for water sources.

#### **3. Infrastructure and Resources**

- Insufficient coverage of water supply and sewerage systems in rural and mountainous areas.
- Inadequate wastewater treatment and solid waste management systems.
- Limited human, technical, and financial resources for continuous monitoring and analysis.

#### **4. Socio-Economic Pressures**

- Seasonal tourism and urbanization increase exploitation and pollution risk.
- Diffuse pollution from agriculture and inadequate septic systems.
- Climate change – longer dry seasons and increased risk of salinization of coastal water sources.

### **Opportunities for Improvement**

#### **1. Modernization and Integration of Monitoring Systems**

- Centralized database integrating surface and groundwater, including GWDE.
- Expansion of monitoring networks and introduction of GIS, remote sensing, and automated sensors for better karst aquifer monitoring.

#### **2. Strengthening Institutional Capacities**

- Standardization of procedures for data exchange between public and private sectors.
- Training of specialists in hydrogeology, ecology, and data analysis.

- Engagement of local communities and public participation in water management and source protection.

### **3. Regulatory and Legal Opportunities**

- Amendment of legislation for explicit protection of karst aquifers and GWDE.
- Consistent application and control of sanitary protection zones.
- Integration of groundwater protection into spatial and sectoral plans (tourism, agriculture, urbanization).

### **4. Economic and Ecological Initiatives**

- Development of sustainable tourism, agriculture, and nature-based solutions (afforestation, land and source protection).
- Alignment of macroeconomic policies and investments with groundwater and GWDE conservation.
- Pilot projects and financial incentives for local initiatives to preserve water resources and ecosystems.