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

BOSNIA AND HERZEGOVINA

NOVEMBER 2025

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ACRONYMS (a selection)

AVP	Agencija za vodnop područje
CZZS	*Centar za životnu sredinu* (Center for Environment).
ELV	*Emission Limit Values*.
EIAs	Environmental impact assessments
ESAP	Environmental Strategy and Action Plan
GFC/UNDP	Green Climate Fund (GCF) and the United Nations Development Programme (UNDP).
GWDEs	Groundwater-dependent ecosystems
GGDA	Groundwater governance diagnostic analysis
GWD	Groundwater Directive
UNECE-IHP	United Nations Educational, Scientific and Cultural Organization – International Hydrological Programme.
IECW	Inter-Entity Commission for Water
IFIs	international financial institutions
MoFTER	Ministry of Foreign Trade and Economic Relations
FBIH MoAWF	Ministry of Agriculture, Water Management and Forestry of the Federation of BiH
RS MoAFW	Ministry of Agriculture, Forestry and Water Management of the Republika Srpska
PI	Public Institution
RBM	River Basin managnet Plan
TBA	Transboundary Aquifer
WWF / Adriatic	WWF/ Adriatic region
WFD	Ewater Framework Directive
WIS	water information system
WWF Adria	World Wide Fund for Nature/Adriatic region

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1. Introduction

Project DIKTAS II requires development of Groundwater governance diagnostic analysis (GGDA) in all project countries, including a stocktaking of the governance situation — actors, legal framework, policies and plans, adherence to the EU WFD and GWD, available knowledge, enforcement capacity and an assessment of gaps and opportunities (output 2.1.).

To fulfil the objectives of the DIKTAS II project, groundwater governance diagnostic analysis needs to be carried out in two steps, as national GGDAs in all project countries and as a regional /transboundary GGDA. The items and questions to be addressed in the national GGDAs will be used to assess the state of the art of groundwater governance principles in all project countries. The outputs of the four national analyses, which will be carried out based on the common criteria, is to be used to indicate key pathways for developing an adequate and efficient groundwater governance in all TBA's, and come to a common set of indicators (for all TBA's) to be used to assess the implementation of enabling framework and guiding principles for effective groundwater management in respective TBA's in the future.

In accordance with the above, a GGDA for Bosnia and Herzegovina has been developed, encompassing legislative, political, hydrogeological, biodiversity, and socio-economic aspects.

The Constitution of Bosnia and Herzegovina, as part of the Dayton Peace Agreement, establishes the country as consisting of the Federation of BiH, the Republika Srpska and the Brčko District, each with broad autonomy in the water and environmental sectors managment.

2. Actors playing a role in groundwater governance and management

2.1 Groundwater governance in Bosnia and Herzegovina (BiH)

At the state level, Ministry of Foreign Trade and Economic Relations has jurisdiction on defining policy, and basic principles, coordinating activities, and harmonizing the plans of entity authorities and institutions on the international level, among others in the fields of agriculture, energy, environmental protection, development and use of natural resources (incl. Water) and tourism. The key actors are the entity ministries responsible for water management – the Ministry of Agriculture, Water Management and Forestry of the Federation of BiH and the Ministry of Agriculture, Forestry and Water Management of the Republika Srpska Thier tasks delegated to water management Sectors includes inter alia the strategic planning and implementation of water-related legislation, MoAWMF is also responsible for the supervision of the performance of the water management agencies/institutions. The entities Water Agencies/ Institution (Agency for watershed area of Adriatic Sea (AVP Jadran) and Agency for watershed area of Sava River (AVP Sava) and Public Institution "Vode Srpske" in RS (PI Vode Srpske) are responsible for overall water management including monitoring, issuing water permits, and planning groundwater protection measures. In the Federation of BiH, cantonal ministries play a role in implementing water legislation (issuing water permits permits for smaller water abstractions and inspections). Public water supply companies are responsible for the abstraction, treatment, and distribution of groundwater for drinking purposes and are also involved in the monitoring and protection of water sources within sanitary protection zones. Entities Geological Institutes contribute by collecting, analyzing, and interpreting hydrogeological data essential for assessing groundwater quantity and quality. The Hydrometeorological Institute focuses on meteorological and hydrological activities including monitoring and processing data. The Institute of Public Health is responsible for monitoring drinking water quality. Civil society organisations (CZZS, Aarhus Centres, WWF Adria) and research institutions (universities in Banja Luka, Tuzla, Mostar, Sarajevo) influence policy through advocacy and studies. Does institutional set-up integrate linkages and functions of groundwater management vertically between a national level and the local level and horizontally at each level with other sectors and agencies involved or impacting on groundwater;

2.2. Vertically and horizontal institutional cooperation impacting on groundwater

Vertical coordination is weak and often time consuming due to the fragmented constitutional setup. MOFTER provides coordination among entities but lacks executive power. It needs enhancement because its existing capacities are not sufficient to coordinate all activities related to the fulfilment of BiH's international obligations related to water resource management and environment. entities manage implementation with limited downward linkage to municipalities. Legally, in both entities, lower-level governmental and municipal authorities are obliged to submit relevant data to entities water authorities upon request. Entity-level institutions must also seek the opinion of local authorities in areas affected by proposed activities. However, in practice, administrative and resource-related constraints make this process slow and inefficient. Horizontal integration with sectors such as agriculture, energy and spatial planning is also modest. The Water Laws provides legal mechanisms for horizontal cooperation and environmental Laws for the development of strategic environmental impact assessment of plans; however, in practice, horizontal coordination is neither regular nor systematic. Groundwater protection measures are rarely incorporated into physical plans, irrigation or land-use policies. Coordination between entities water authorities specifically between water agencies, is referenced in the water laws through provisions related to joint water management planning for shared water bodies and administrative cooperation across boundaries. However, cooperation between entity-level water agencies during the development of river basin management plans is not practiced. Given that water management in Bosnia and Herzegovina is based on river basin units, and that the major river basins span both entities, but are implemented separately within each entity, the administrative division of these shared basins underscores the need for coordinated and integrated management. Coordination between the water sector and other sectors—such as energy, agriculture, physical planning, and health—is neither regular nor systematic in either entity. It mainly occurs through donor-driven projects (e.g., DIKTAS-2, GCF/UNDP, World Bank/UoF). No permanent inter-sectoral platform exists for aligning groundwater management with socio-economic development priorities.

2.3. Institutional capacity, budget support and knowledge

Since implementation is carried out at the entity level, MOFTER does not require specialized water management expertise, but rather broad knowledge of water resource principles aligned with international conventions and EU directives. The Water and Environment Sector may require a balanced staffing structure that reflects its jurisdiction related to entities coordination and development of plans and programs at the national level, ensuring an appropriate mix of environmental, and civil (hydro) engineers, legal and economic experts.

Institutional capacity remains limited at both entities, cantonal (in FBIH) and municipal levels. The entity water agencies/public institution have competent technical staff but, the number of qualified employees is significantly below the level required to meet the expected demands of implementing EU legislation and regulations, to which Bosnia and Herzegovina has committed through its candidate status. Financial resources for managing water resources are very limited, including groundwater monitoring or upgrading / modernisation of databases / Water information systems. Budget allocations have been consistently absent for many years so. Technical assistance projects and occasional capital investment projects are funded to the extent possible through agency resources, and partially by the EU and UNDP donations and other international financial institutions (IFIs). Geological surveys operate with outdated equipment and minimal staff dedicated to hydrogeology. Municipal utilities face lack of qualified technical staff, chronic under-financing and rely heavily on donor support or loans for capital investment and training. Overall, financial and human resources capacity constraints hinder the systematic integration of groundwater considerations into planning and decision-making (World Bank 2022b; UNESCO-IHP 2024).

2.4. Cooperation between different actors

Cooperation within projects such as DIKTAS has improved technical exchange among key institutions. However, outside these frameworks, communication is irregular and data sharing remains ad hoc. There is no national platform dedicated to groundwater governance, and cross-sectoral dialogue depends on personal or project-based initiatives rather than institutional arrangements.

.2.5. Awareness on: groundwater, GW governance and management among different groups of actors, including general public

Awareness varies significantly across actor groups. Technical agencies and research institutions possess relatively strong knowledge, while local governments and utilities often lack understanding of aquifer dynamics and pollution risks. Decision-makers at the policy level focus on surface-water infrastructure rather than groundwater protection. Civil-society organisations and media have recently increased attention to karst ecosystems, but public perception remains limited and reactive, driven mainly by pollution events or water shortages. Educational curricula still marginalise groundwater topics (UNECE 2023; WWF Adria & CZZS 2024).

3. Legal Framework

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

The legal regulation of groundwater is decentralized and governed separately by the three governmental entities in BIH: FBIH (FBiH), the Republika Srpska (RS) and in Brčko District BIH. Besides, 10 Cantonal Governments in FBIH and Herzegovina. Groundwater is not regulated by specific legislation rather is a subject to a robust legal framework that spans water management to the most extend but also multiple sectors, including water management, environmental protection, spatial planning, geology, and public health.

The entity-level Water Laws - FBIH Water Law (“Official Gazette of FBiH,” No. 70/06, 01/12, 70/20; and RS Water law (“Official Gazette of RS,” No. 50/06, 92/09, 121/12, 39/13, 44/15, 19/16, 1/20) are largely harmonized and define all waters, including groundwater, as public property. Among other, they regulate the abstraction, use, protection, and monitoring of groundwater, requiring water acts and permits for any activities that may affect the quantity or quality of water. Both laws require the development of River Basin Management Plans (RBMP) which incorporate principles of sustainable water use and protection of groundwater resources Groundwater monitoring is the responsibility of respective water agencies in FBIH (AVP Sava i AVP Jadran) and of PI “Vode Srpske” in RS, while inspection and enforcement are conducted by entity and cantonal water and environment inspectorates. Both entities also have Environmental Protection Laws (FBiH “Official Gazette,” No. 15/21; RS “Official Gazette,” No. 71/12, 79/15, 70/20) that integrate groundwater protection within broader environmental management, establishing requirements for environmental permits, pollution control, and remediation of contaminated sites.

Groundwater associated with geological resources including mineral, thermal, and geothermal waters is regulated by the entities Laws on Geological Research (FBiH “Official Gazette,” No. 9/10; RS “Official Gazette,” Nos. 110/13 and 121/18) and the Mining Laws (FBiH “Official Gazette,” Nos. 26/10 and 103/15; RS “Official Gazette,” Nos. 1/16, 66/18, and 84/19). These laws govern the exploration and exploitation of geological resources, including hydrogeological investigations, and require prior approval from the competent ministries. Activities must comply with environmental and water protection regulations, as outlined in legislation. In both entities, inspections are conducted by authorized mining and environmental inspectorates to ensure that geological and mining operations do not compromise groundwater quality or availability.

The entities Laws on Spatial Planning and Land Use ("Official Gazette of FBiH," No. 2/06, 72/07, 32/08, 4/10, 13/10, 45/10, 26/14; "Official Gazette of RS," No. 84/02, 118/05, 101/11, 40/13, 106/15, 84/19) require the inclusion of protected areas and water protection zones in spatial planning documents.

Health Protection Laws ("Official Gazette of FBiH," No. 46/10; "Official Gazette of RS," No. 106/09, 44/15, 96/22). do not directly refer to groundwater but regulate public health, drinking water quality, and sanitary supervision of water supply systems, which are often based on groundwater sources.

Under the legal framework of FBIH, Cantonal authorities may adopt their own regulations in areas such as water management, environmental protection, spatial planning, geological research, and mining. However, not all cantons have enacted separate laws in each of these sectors, and may rely on the implementation of federal legislation.

3.2. Transposition of WFD and the GWD in national laws and regulations

The transposition of the EU WFD (WFD) into the legal framework of Bosnia and Herzegovina is uneven but relatively advanced at the entity level. The FBIH (FBiH) is estimated to have transposed over 95% of WFD provisions, while Republika Srpska (RS) has achieved approximately 75%. Both FBIH and RS have incorporated WFD principles into their respective Water Laws, including integrated river basin management, chemical and quantitative status assessment of groundwater, pollution prevention, and the maintenance of ecological flow. The Groundwater Directive (GWD) has been only partly transposed in both entities, not achieving more than 30%. There is no dedicated regulation equivalent to the GWD, and implementation remains fragmented. However its core elements such as chemical status assessment, pollution prevention, trend reversal, and threshold values are partially implemented through these legal instruments.

In FBiH, the Water Law reflects WFD objectives and provides the legal basis for groundwater protection. This is further elaborated through regulation such as the Rulebook on Monitoring of Surface and Groundwater ("Official Gazette of FBiH", No. 4/10), which defines parameters, frequency, and methods for monitoring chemical and quantitative status, and the Rulebook on Classification of Water Bodies ("Official Gazette of FBiH", No. 26/20), which sets criteria for status assessment and includes threshold values for pollutants, in line with GWD requirements. These regulations are relevant as well for defining the ecological status of associated surface waters. Rulebook on Classification of Water Bodies defines ecological status categories and includes biological, chemical, and hydro - morphological parameters, and the Rulebook on Monitoring of Surface and Groundwater sets out procedures for monitoring those elements

In RS, the Water Law similarly incorporates WFD principles and is supported by the Rulebook on Monitoring of Water Quality ("Official Gazette of RS", No. 106/06), which establishes procedures for sampling, analysis, and reporting and the Rulebook on Classification of Water Bodies ("Official Gazette of RS", No. 42/21), which defines groundwater status categories and includes threshold values for key pollutants relevant to GWD implementation. These regulations are relevant as well for defining the ecological status of associated surface waters. Rulebook on Classification of Water Bodies establishes criteria for status assessment and the Rulebook on Monitoring of Water Quality which defines sampling and analysis methods for relevant ecological indicators.

Groundwater-dependent ecosystems (GWDEs) are not explicitly defined in water legislation but are addressed through environmental protection laws. In FBiH, the Law on Environmental Protection recognizes the ecological value of groundwater-dependent ecosystems such as wetlands and springs, and requires environmental impact assessments (EIAs) to consider potential impacts on these systems. In RS, the Law on Environmental Protection includes provisions for the protection of sensitive ecosystems, and GWDEs are considered in planning and permitting procedures

3.3. Legal provisions for assessing and monitoring the chemical and quantitative status of groundwater according to the requirements of the WFD and GWD including ecological status of associated surface waters and related ecosystems

In the FBIH, the legal framework for assessing and monitoring the chemical and quantitative status of groundwater is defined by the Water Law supported by the Rulebook on Water Bodies Classification, the Rulebook on Monitoring of Surface and Groundwater ("Official Gazette of FBiH", No. 4/10), and the Decision on Characterization of Surface and Groundwater, Reference Conditions and Parameters for Status Assessment and Monitoring ("Official Gazette of FBiH", No. 1/14). These acts establish environmental objectives, monitoring obligations, and criteria for status classification, partially transposing the requirements of the WFD and GWD. This legal framework is applied in the RBMPs for the Sava and Adriatic Sea Basins (2022–2027), which include methodologies for groundwater status assessment. The plans define procedures for determining background concentrations and threshold values for pollutants, based on available monitoring data and expert judgment. In karst areas, where natural variability is high and data availability is limited, the plans recommend cautious interpretation and site-specific assessments. For groundwater-dependent ecosystems such as springs and wetlands, the plans emphasize integrated monitoring of groundwater and associated surface waters to support ecological integrity.

In the Republic of Srpska, the legal basis is provided by the Water Law, complemented by the Regulation on Classification and Categorization of Waters and the Rulebook on Monitoring of Water Quality. These acts define groundwater bodies, set environmental protection goals, and establish criteria for assessing chemical and quantitative status, including monitoring protocols. This framework is implemented through the RBMP for the Sava and Trebišnjica Basins (2017–2021), which apply the prescribed methodology for groundwater monitoring and classification. The plans include procedures for determining background concentrations and threshold values for pollutants, based on available data and expert evaluation. In karst regions, particularly in the Trebišnjica basin, the plans highlight the need for site-specific assessments and cautious interpretation. For groundwater-dependent ecosystems such as springs, wetlands, and riparian zones, the plans recommend integrated monitoring with associated surface waters and outline procedures for identifying saline intrusion, surface water interaction, and impacts on terrestrial ecosystems.

3.4. Legal provisions that regulate water quantification, allocation and usage

Water is defined as a public good under the entities' Water Laws. Both entities regulate water abstraction through their respective Water Laws in a way that it must not compromise ecological flow, water quality, or the rights of other users. Both entities regulate the quantification of groundwater use through their respective Water Laws and accompanying bylaws: FBIH Rulebook on Monitoring of Surface and Groundwater and RS Rulebook on Monitoring of Water Quality. The Laws require that any abstraction of groundwater be measured, recorded, and reported to competent authorities, ensuring transparency and sustainable resource management. Allocation is regulated through permits and, for economically significant or long-term uses, through the concessions. In the FBIH, the issuance of water permits is the responsibility of Water Agencies and cantonal authorities, while in the RS, it is handled by PI „Vode Srpske".. The second-instance bodies for resolving disputes are the respective entity-level Ministries of Water Management. Concessions are governed by the Laws on Concessions in each entity (FBiH: "Official Gazette," No. 2/02; RS: "Official Gazette," No. 59/09 and amendments), and are required for activities such as irrigation, hydropower, tourism, and industrial water use. Based on both sets of Laws applicants must obtain a valid water use permit prior to granting concession. Priority uses, such as public water supply, are legally defined. Water usage regulation is enforced through monitoring obligations, reporting requirements, and inspections, as prescribed by both entities Water Laws which define technical standards for abstraction points and require users to measure and report the volume of abstracted water. In both entities, groundwater exploration is also regulated through geological legislation which require permits for drilling and hydrogeological studies/explorations.

3.5. User/polluter pay principle and principle of cost recovery and integration of environmental and resource costs in pricing policies

The legal frameworks of both the FBIH and RS recognize the polluter pays and cost recovery principles, in line with the EU WFD These principles are embedded in the respective Water Laws and Environmental Protection Laws of both entities.

Water is defined as a public good, and users of water resources are required to contribute financially through water abstraction fees, discharge permits, and service charges. The Environmental Protection Laws reinforce the polluter pays principle by requiring polluters to bear the costs of environmental damage and restoration, and by promoting the integration of environmental costs into sectoral policies.

However, while these principles are legally recognized, neither entity has adopted methodology or dedicated by-law for integrating environmental and resource costs into water pricing structures.

In both entities water resource fees for abstraction and discharge are regulated by entity-level water laws and collected by the respective water management institutions (the Water Agencies in FBiH and the Public Institution "Waters of Srpska" in RS , entities environmental Funds as well as Cantonal administration in FBIH). However, water tariffs for water supply and sanitation services are under the jurisdiction of municipalities and public utilities, resulting in decentralized and fragmented implementation.

River Basin Management Plans developed by competent agencies in both entities acknowledge the obligation of cost recovery for water services. However, the integration of environmental and resource costs into pricing remains partial, with implementation varying across administrative levels and sectors.

3.6 Protective measures in sanitary protection zones in karst areas

In, both entities sanitary protection zones are defined by bylaws (regulations) adopted at the entity level, while the Brčko District currently has no specific regulation for establishing sanitary protection zones.

In the Federation of BiH, the key legislation is the Water Law which prescribes measures for water management, protection, and monitoring. The main bylaw is the Regulation on the Method for Determining Zones and area of Sanitary Protection of Water Sources, and on Protection Measures for Sources Used for Public Water Supply in the FBIH ("Official Gazette of FBiH", 88/12), which establishes three zones of sanitary protection, criteria for their delineation, and protection measures. The fourth protection zone might be defined as well for the karst environment. The Regulation treats distinct methodological criteria for defining karst protection zones. Additional relevant acts in FBiH include the Regulation on Protection Measures, Health Safety of Drinking Water (36/10), defining the scope and parameters of monitoring and the Decision on Characterization and Assessment Parameters for Surface and Groundwater Monitoring ("Official Gazette FBiH", No. 1/14), aligning monitoring with the EU WFD-

In the RS, the Water Law serves as the main legal instrument. The Regulation on Protection Measures, Designation, Maintenance, and Marking of Sanitary Protection Zones ("Official Gazette RS", No. 76/16) defines three zones of sanitary protection, their spatial extent, and protection measures. Under the current Regulation in the RS, there are no specific criteria for delineating zones in karst areas i.e it does not differentiate between karst and non-karst hydrogeological conditions. In other words, different hydrogeological conditions are not recognized (except in terms of defining minimal criteria). Minimum criteria are prescribed, and the authors of Sanitary Protection Programmes must comply with them. Additional RS bylaws include the Regulation on the Health Safety of Drinking Water (54/15) and the Regulation on Ecological and Chemical Parameters of Surface and Groundwater ("Official Gazette RS", No. 74/11), which define monitoring requirements and parameters..

The following is general procedure for designation of sanitary protection zones in RS and FBIH: Sanitary Protection Programmes/Studies are to be developed in accordance with the relevant Regulations, which define the extent of sanitary protection zones and the protection measures within them,

including preventive actions. Based on these Programmes, Decisions on the protection of specific areas are adopted (by municipality, entity or Canton in FBIH.etc). In FBIH the decision is made by the municipal council, or if the zones extend beyond the boundaries of two or more municipalities or cantons—by the cantonal or federal government, respectively. The decision on the protection of water sources whose sanitary protection zones span the FBIH or BDBIH is made jointly by their respective governments. If the zones extend into a neighboring country, the decision must comply with an international agreement signed by Bosnia and Herzegovina. In RS, the decision on the protection of water sources is made by the assembly of the local government unit. If the protection zones extend across multiple units, their assemblies decide individually, or the Ministry may decide instead. For zones spanning two entities or neighboring countries, the decision is made jointly by the competent entity ministries, in accordance with international agreements.

In the RS, the Regulation on Protection Measures, Methods of Designation, Maintenance and Marking of Sanitary Protection Zones defines three zones: immediate, inner, and outer. The delineation is based on groundwater flow travel times (7, 90, and 180 days respectively) and minimum distance criteria (50 m, 250 m, and 200 m). The Regulation does not distinguish karst aquifers, applying the same criteria to all hydrogeological settings. It lists prohibited activities by zone (e.g., construction, excavation, waste disposal) and requires preparation of a Sanitary Protection Programme and an Elaboration on groundwater quality and reserves. Monitoring plans are part of the Programme and must comply with the Regulation on the Health Safety of Drinking Water (Official Gazette RS 54/15). The Water Law (Articles 44, 154, 212) assigns responsibility for water monitoring to the Water Agency and establishes penalties for non-compliance.

In FBIH regulation outlines different technical criteria for determining the boundaries of sanitary protection zones based on the type of aquifer including 1. Karstic Environment 2. Intergranular Environment 3. Fissured Environment (e.g. fractured rock). In karst terrains, sanitary protection zones are determined based on detailed hydrogeological investigations, which must include geological, hydrogeological, and hydrological analyses. Chemical analyses may also be included where relevant. Vulnerability assessment is explicitly required and forms an integral part of the hydrogeological Program / study that underpins the definition and spatial extent of sanitary protection zones. Program assess the type of aquifer (e.g., fractured or karstic), recharge mechanisms, groundwater flow velocity, direction and continuity, natural filtration capacity, and vulnerability to pollution. The Rulebook requires that the Program / Study also include an inventory of existing and potential pollution sources, erosion processes, vegetation cover, and water quality data at the source and within the catchment. Zone boundaries are defined based on groundwater flow times – karst specifically: Zone II is delineated by a minimum groundwater travel time of 1 day, Zone III by a minimum of 10 days, and Zone IV (optional) may extend to the hydrogeological catchment boundary if justified by vulnerability and risk analysis. In exceptional cases, zones may also be defined based on apparent flow velocity, with thresholds of >2.5 km/day for Zone II and 1.0–2.5 km/day for Zone III under high-flow conditions. Hydrogeological connectivity and special features such as sinkholes, ponors, and caves are considered critical in delineating Zone I. Zone I must be physically fenced, with a minimum distance of 25 meters from the intake structure; exceptionally, reduced to 10 meters. Zone I prohibits all activities except maintenance by operators. Zone II restricts agriculture, waste disposal, and construction. Zone III regulates broader land use and may encompass the entire hydrogeological catchment. Zone IV, where applied includes passive protection measures. The Regulation also allows inclusion of additional risk areas (e.g., roads, industrial corridors) within protection zones. In karst areas of FBiH, the The Rulebook mandates continuous monitoring of water quality and implementation of protection measures within all zones, but does not prescribe a detailed monitoring methodology. Instead, monitoring requirements are defined within the Program / Study and implemented by water utilities.

3.7. Methodology (ies) for determining sanitary protection zones and/or GW monitoring

Beyond what is prescribed in the respective laws and rulebooks in FBIH and RS, there are no other guidelines for determining sanitary protection zones or groundwater (GW) monitoring in karst areas.

The actual Regulation in FBIH provides comprehensive methodology for defining protection zones in FBIH, however lacking monitoring methodology. Rulebooks in RS require preparation of a Sanitary Protection Programme and an Elaboration on groundwater quality and reserves. Monitoring plans are part of the Programme and must comply with the Regulation on the Health Safety of Drinking Water (Official Gazette RS 54/15). The Water Law (Articles 44, 154, 212) assigns responsibility for water monitoring to the Water Agency and establishes penalties for non-compliance. However, Regulation defines protection zones not distinguishing karst aquifers, applying the same criteria to all hydrogeological settings.

None of the two entities regulation prescribe a detailed methodology for groundwater monitoring (absence of: criteria for conceptual model development, guidance on representativeness of monitoring points, defined parameter list or sampling frequency). Based on regulations monitoring is defined considering factors such as: number of consumers, the status of water bodies, distance from the water intake, presence of pollution risk, infrastructural pressures etc., which determine the number and frequency of analyses to be carried out.

RBMs in FBIH i RS address groundwater monitoring, but the methodology is not fully standardized or elaborated in detail, defining specific technical elements such as: (density of monitoring points, sampling frequency set of parameters). Monitoring is gradually developed through studies and plans prepared by water agencies, but it is still not fully aligned with EU directives. Decision on the Characterization of Surface and Groundwater Bodies (FBiH) and its equivalent provisions in RS provide partial elements of the methodology for groundwater monitoring.

3.8. Protective measures in sanitary protection zones in karst areas

In RS the Regulation on Protection Measures, Methods of Designation, Maintenance and Marking of Sanitary Protection Zones defines three zones: immediate, inner, and outer The Regulation does not distinguish karst aquifers, applying the same criteria to all hydrogeological settings. It lists prohibited activities by zone (e.g., construction, excavation, waste disposal) and requires preparation of a Sanitary Protection Programme and an Elaboration on groundwater quality and reserves. Monitoring plans are part of the Programme and must comply with the Regulation on the Health Safety of Drinking Water (Official Gazette RS 54/15). The Water Law (Articles 44, 154, 212) assigns responsibility for water monitoring to the Water Agency and establishes penalties for non-compliance.

FBIH Regulation regulate for karst environment that Zone I must be physically fenced, with a minimum distance of 25 meters from the intake structure; exceptionally, reduced to 10 meters, provided that enhanced monitoring is implemented and no risk to the source is identified. The Regulation also allows inclusion of additional risk areas (e.g., roads, industrial corridors) within protection zones. In karst areas of FBiH, the Rulebook defines protective measures based on hydrogeological vulnerability. It establishes up to four zones of protection: Zone I prohibits all activities except maintenance and includes the spring, intake structure, and vulnerable karst features. Zone II restricts agriculture, waste disposal, and construction involving hazardous substances. Zone III regulates broader land use, requires environmental impact assessments, and may encompass the entire hydrogeological catchment. Zone IV, where applied, serves for long-term monitoring and planning in highly sensitive karst systems and includes passive protection measures such as land-use control and spatial planning.

Overall, karst-specific protective measures are explicitly defined only in the FBH Regulation, while RS applies general groundwater protection criteria.

Additional groundwater protection measures are embedded in the entities Water Laws which prohibits direct or indirect discharge of pollutants into groundwater. The law also requires permits for activities that may affect water quality. Environmental laws in both entities include provisions that prohibit or restrict the discharge of pollutants into groundwater, through environmental permitting and impact assessment mechanisms.

3.9. Legal basis for artificial aquifer recharge and treated wastewater discharges into the underground

Artificial aquifer recharge can be legally addressed through provisions in the water laws of both entities but it is necessary to prepare a detailed Environmental Impact Assessment and obtain the appropriate permits from the competent authorities proving that it does not have adverse effect to water resources.

The Water Laws (RS, FBiH) specify that direct discharge of wastewater into groundwater is prohibited. However, indirect discharge is allowed only under the conditions and in the manner determined by law and by-laws. There are corresponding Regulations on the conditions for discharging wastewater into public sewage systems and surface waters in RS ((Official Gazette of Republika Srpska No. 44/01), as well as regulation Rulebook on the Conditions for Discharging Wastewater into the Environment and Public Sewage Systems ("Official Gazette of FBiH", 26/20, 96/20), defining technical and sanitary requirements for discharging wastewater, maximum allowable pollutant concentrations, monitoring and reporting requirements. For Brčko District – the Law on Water Protection prohibits the direct discharge of wastewater into groundwater. Indirect discharge, as well as the release or absorption of heat into groundwater, is allowed only in accordance with the provisions defined by the Water Protection Law.

3.10. Legislation (laws/bylaws) that defines remediation measures of contaminated soil and/or groundwater/ karst area

Remediation of contaminated soil and/or groundwater is legally regulated in the legislation of both the FBIH and RS and not through a separate law dedicated solely to remediation. The legal basis is found in the entity Water Laws, which provide the framework for water protection and management, and the Law on Environmental Protection, which mandates the prevention, elimination, and remediation of environmental damage. Key legal principles include implementing programs for soil management, protecting agricultural land, and creating action plans for environmental protection that include improving waste and wastewater management, as these impact groundwater quality.

In both entities, remediation is triggered when pollutant levels exceed permitted limits, and competent authorities may impose remediation measures, monitoring obligations, and penalties.

In FBIH the relevant regulation is Regulation on the Conditions for Discharging Wastewater into the Environment and Public Sewage Systems ("Official Gazette of FBiH", 26/20, 96/20).

In RS, relevant regulation defines discharges into surface waters and public sewage systems. These acts define the limit values of parameters, the conditions under which discharge is permitted, and mandatory monitoring.

The regulations and decisions also define mandatory remediation measures to reduce pollution to permissible limits (i.e., to ensure that all parameter values comply with the prescribed limits), as well as supervision and penalties.

The Law on Environmental Protection of RS (“Official Gazette of RS”, No. 71/12) prescribes measures for the remediation of contaminated soil and water, including mandatory cleanup and the liability of polluters. The Law on Environmental Protection of FBiH (“Official Gazette of FBiH”, No. 33/03 and 38/09) also mandates the remediation of contaminated areas, including soil and water, and allows for the adoption of specific remediation plans.

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

In Bosnia and Herzegovina, the obligation to include drinking water protection zones (sanitary protection zones) in spatial planning documents is defined through the Water Laws and Spatial Planning Laws at the entity and district levels.

Entities Water Law prescribed that Spatial plans and other sector/ planning documents that affect water protection, management, and use shall include data on protected and endangered areas

In RS, the Law on Spatial Planning and Construction (Article 18) defines special areas, including springs, reservoirs, and other water sources. Further, the Rulebook on the Method, Content, and Form of Spatial Planning Documents specifies that protective and restrictive measures must be included in spatial plans, covering all areas defined by the Decision on Source Protection.

Water Law of FBiH (Articles 66, 67, 68) defines drinking water protection areas and their inclusion in water management plans. The Law on Spatial Planning and Land Use at the FBiH level requires that protective zones and measures of protection be incorporated into spatial and urban plans.

The Water Protection Law of Brčko District (Article 17, Official Gazette 17/04) defines that spatial planning authorities must, when preparing planning documents, take into account all restrictions and conditions defined in water protection plans.

3.12. Effectiveness of legal framework on sanitary protection zones

Eventhou protection zones must be incorporated into the corresponding spatial planning documents. it is legally required in practice, the incorporation of these zones into planning documents occurs with varying speed and consistency across cantons, often influenced by administrative capacity and local priorities. Implementation dynamics differ significantly across localities. In the Federation of BiH, both the River Basin Management Plans and the Water Management Strategy 2022–2032 identify major gaps in the implementation of sanitary protection zones. Many municipalities have not adopted formal decisions or developed protection programs for water sources, despite legal obligations. The strategy includes a summary table showing that hydrogeological studies and zoning documentation are often missing or incomplete.

In RS, both the River Basin Management Plans and the Environmental Protection Strategy 2022–2032 highlight significant gaps in the implementation of sanitary protection zones. Many municipalities have not adopted formal decisions or developed protection programs for water sources, despite legal requirements. Enforcement is hindered by limited technical capacity, weak coordination, and delays in integrating zones into spatial plans.

3.13. Enforcement capacity of the water legislation:

FBiH legislation demonstrates enforcement capacity through a combination of legal provisions and institutional structures. However it is decentralized among different levels of authorities so some overlapping and gaps occur. The Water Law provides the legal framework for managing water quality and quantity, monitoring compliance, procedure for issuing water permits, and implementing protective measures. Enforcement responsibilities are shared between cantonal ministries and the Water Agencies for the Sava and Adriatic Sea Basins, which are tasked with permitting, developing RBMPs and overseeing compliance. Technical support is provided through regulations which outline standards for water quality assessment and monitoring procedures. FBIH Water law provides provisions that authorize competent inspectorates to conduct inspections, issue enforcement orders, initiate administrative proceedings, and impose penalties for violations such as unauthorized water use or pollution.

RS has a more centralized enforcement structure under the Water Law and defines procedures for water permitting, monitoring, and protection. The PI Vode Srpske serves as the central implementing body, responsible for issuing permits, developing RBMPs, and enforcing water management measures. .Water-related fees, penalties, and funding mechanisms are regulated through entity-level financial provisions. Technical support is provided through regulations which outline standards for water quality assessment and monitoring procedures. Enforcement in RS are responsibility of PI “Vode Srpske” and the Republic Water Inspectorate including monitoring compliance, conducting inspections, issuing enforcement orders, and initiating penalties for violations.

3.14. Operational capacity - availability of human and financial resources for the implementation of policies and regulations

Water legislation in both entities of BIH provides a legal framework for operational capacity, particularly regarding institutional responsibilities and basic financial mechanisms. FBIH Water Law assigns key responsibilities to the Sava River Basin Agency and the Adriatic Sea Basin Agency, which are tasked with issuing permits, conducting monitoring, preparing RBMPs and enforcing water regulations. The Federal Ministry of Agriculture, Water Management and Forestry plays a coordinating role, aligning water policy with environmental, health, and agricultural sectors. While the legal framework supports cost recovery and polluter pays principles, the implementation of large-scale investment programs is challenged by limited financial resources and institutional fragmentation. RBMPs acknowledge these constraints and propose measures such as stakeholder engagement, socio-economic assessments, and improved data collection to support investment planning. Human resource capacity is fragmented, with responsibilities spread across entity, cantonal and municipal levels. Training programs are sporadic mostly project based. Financial capacity is very limited, no budget fund are not provided for a long time for the implementation of regulations (e.g. monitoring). It is supported by Water Agencies through water abstraction, usage and discharge fees which are determined through entities decisions. However, funding under this framework is significantly inadequate in relation to the needs for implementing water sector regulations."

RS Water Law delegates operational responsibilities to the PI Vode Srpske, which manages water resources, issues permit, monitors water quality, and prepares RBMPs. The Agriculture, Water Management and Forestry Ministry oversee water policy coordination and integration with other sectors. RBMPs recognize the need for enhanced financial planning and propose measures to improve cost recovery, including more quality data on water use and pollution loads. Human resource capacity is concentrated within PI Vode Srpske and local utilities, but formal training for water professionals are limited, and project based mostly. Legal framework supports cost recovery and polluter pays principles but implementation of large-scale investment programs is challenged by limited budgetary funds. Financial capacity is supported through fees for water abstraction, discharge, and use which are determined through decisions and institutional agreements. However, this is significantly inadequate comparing to the needs for implementing water sector regulations. Environmental and resource costs are not systematically integrated into pricing structures.

3.15 Supervision and sanctions: compliance monitoring and application of penal provisions of regulations;

Supervision and enforcement in FBIH are regulated through Water law provisions that authorize competent inspectorates to conduct inspections, issue enforcement orders, initiate administrative proceedings, and impose penalties for violations such as unauthorized water use or pollution. In cases of environmental emergencies, remediation and damage control measures are applied. Financial penalties and water-related fees are regulated through entity-level decisions and cantonal bylaws. Compliance monitoring including tracking adherence to water permit conditions, pollution loads, and water quality standards is carried out by: Sava River Basin Agency and the Adriatic Sea Basin Agency Enforcement tools include the Rulebook on Wastewater Discharge Standards which sets emission limits and monitoring protocols for industrial and municipal wastewater. RBMPs emphasize the need for enhanced monitoring and enforcement, particularly in areas with high water abstraction pressure or pollution risk.

The Supervision and enforcement in RS are responsibility of PI “Vode Srpske” and the Republic Water Inspectorate including monitoring compliance, conducting inspections, issuing enforcement orders, and initiating penalties for violations. Enforcement procedures include field inspections, administrative measures, and sanctions. The Law on Environmental Protection (“Official Gazette of RS”, No. 71/12) complements water legislation by establishing environmental liability and compliance mechanisms. Compliance monitoring including tracking adherence to water permit conditions, pollution

loads, and water quality standards is carried out by PI Vode Srpske. Enforcement tools include the Rulebook on Wastewater Discharge Standards which sets emission limits and monitoring protocols for industrial and municipal wastewater.

Further enforcement tools are provided by entity-level regulations on wastewater discharge, which set specific emission limit values for pollutants in municipal and industrial wastewater. These regulations define conditions for wastewater collection, treatment, and discharge into the environment or public sewerage systems. They include provisions for sampling, monitoring, reporting, and deadlines for achieving compliance with prescribed thresholds which are mandatory for permit holders. However, in practice**,** environmental permits may include specific compliance timelines and technical conditions that allow gradual alignment with the prescribed ELVs. These arrangements are typically applied in cases where existing infrastructure does not yet meet regulatory standards or where significant investments are required to achieve compliance. River Basin Management Plans (RBMPs) emphasize the role of water permits as key legal instruments for regulating wastewater-related activities and ensuring alignment with environmental objectives.

3.16. International conventions and bilateral agreements related to water management;

Bosnia and Herzegovina has ratified several key international conventions relevant to the water sector, including transboundary water cooperation, public health protection, and marine environment preservation.

- United Nations Framework Convention on Climate Change (UNFCCC) *on 10 May 2000* and acceded to the Paris Agreement *on March 22, 2017.*
- Protocol on Water and Health (UNECE/WHO) *Acceded in September 2010; entered into force in BiH in November 2012*
- UNECE Water Convention – Helsinki Convention *Ratified on 3 September 2009; entered into force on 3 March 2010*
- Danube River Protection Convention (ICPDR) *Ratified in December 2004*.
- Framework Agreement on the Sava River Basin *Ratified in June 2003*
- Barcelona Convention and Protocols *Succession in 1994; formally ratified on 10 June 1995; amendments ratified on 24 August 2020*
- Aarhus Convention on Access to Information, Public Participation and Access to Justice in Environmental Matters *Ratified in 2008*
- BIH has ratified bilateral agreement related to the water management Croatia – "Agreement between the Government of the Republic of Croatia and the Government of Bosnia and Herzegovina on Water Management Relations (Dubrovnik, July, 1996);
- Draft agreement between BIH and Montenegro has beed prepared but not yet signed.

3.17. Gaps in the legal framework related to groundwater or groundwater dependent ecosystems

Bosnia and Herzegovina has no dedicated legislation for groundwater management, nor specifically addressing karst systems, despite their dominance in the national hydrogeological setting. The existing entity Water Laws provide a general framework for water protection but do not distinguish groundwater as a distinct subsystem requiring specific management instruments. Consequently, groundwater protection in both entities is treated only as a subset of surface water regulation, without recognition of the particular vulnerabilities of karstic aquifers or their ecological and quantitative dynamics.

The major gaps stem from the absence of legal provisions that are explicitly required under the EU Water Framework Directive (WFD) and the Groundwater Directive (GWD).

Neither FBIH nor RS Water laws define explicitly groundwater-dependent ecosystems.

Although monitoring is defined by the relevant laws and by-law acts, in practice it is often not fully implemented. It is necessary to establish additional acts that will oblige the implementation of monitoring both at the water source level and at the catchment management level (qualitative and quantitative monitoring).

All parameters should be harmonized with the EU Water Framework Directive.

Conditions and procedures for discharge and artificial recharge should be defined and regulated by the corresponding legislation, along with appropriate remediation measures.

Regarding the sanitary protection zones, it is necessary to define mandatory methodologies (e.g. modelling) and analyses (e.g. vulnerability assessment) that must be carried out during the preparation of technical documentation (such as the Study on Water Quality and Reserves, as an integral part of the Sanitary Protection Programme).

4. Policy, plans and principles

4.1. Goals and requirements of national water management strategy related to GW and GWDE

Although strategic documents in both entities include priorities and measures related to the transposition of EU groundwater standards, they do not specify dedicated legal instruments for regulating groundwater or addressing specifically vulnerabilities of karst systems.

The Water Management Strategy of FBIH (2022–2032), establishes high-level strategic objectives including the protection of water quality, sustainable use of water resources, ensuring access to drinking water, risk management of extreme water events, and adaptation to climate change. Strategy identifies specific measures aimed at improving monitoring systems for both quantity and quality, safeguarding recharge zones and sanitary protection areas, and aligning management practices with EU directives. The strategy also calls for reducing pollution from agriculture and industry and promoting integrated water resource management that includes groundwater. However, strategy does not define GWDE or propose ecological criteria for their protection, nor does it mandate the use of hydrogeological modeling or vulnerability mapping in groundwater assessments.

RS Water Management Strategy up to (2014 -2025) establishes general goals for sustainable management and protection of water resources. It emphasizes the strategic importance of groundwater, proposing actions to enhance monitoring, protect infiltration zones, and establish a centralized groundwater database. It also includes measures to strengthen inspection and control of wastewater discharges into subsurface systems. However, it does not clearly define groundwater-dependent ecosystems or provide specific measures for their protection. While the strategy references alignment with EU directives, concrete measures to ensure compliance with WFD and GWD for groundwater and karst aquifers are absent. It does not address GWDE as a distinct management concern and lacks provisions for ecological modelling or site-specific protection of sensitive aquifers, particularly karst systems.

Similarly, the RS Environmental Strategy and Action Plan (ESAP) 2022–2032 reinforces the importance of groundwater within its broader environmental objectives. It sets goals to preserve groundwater quality and availability, establish monitoring systems, build institutional capacity, and harmonize practices with EU standards. Public awareness and education on groundwater protection are also included as strategic actions. Nevertheless, GWDE are not explicitly mentioned, and the ecological role of groundwater is acknowledged only in general terms without operational detail or legal recognition.

4.2. Alignment of water management strategy with other sectoral strategies/policies

Alignment between the entity Water Management Strategies and other sectoral strategies in BiH remains partial and largely declarative, evethou both FBIH and RS have legal and strategic frameworks that promote alignment of water management strategies with other sectoral policies. The Water Laws

provides legal mechanisms for horizontal cooperation particularly with phusical planning sector. Environmental Laws require development of strategic environmental impact assessment of plans. However, in practice, horizontal coordination is neither regular nor systematic.

Horizontal integration with sectors such as agriculture, energy and spatial planning is also modest. (more details in Chapter 2.2.).

Groundwater protection measures are rarely incorporated into physical plans, irrigation or land-use policies.

Groundwater and groundwater-dependent ecosystems (GWDE) are mentioned in environmental and energy strategies but without measurable targets or budgetary commitments.

The Agricultural Development Strategies (2019–2027) promote irrigation expansion without integrating groundwater-sustainability criteria, risking over-abstraction in semi-arid karst zones such as Popovo Polje.

Tourism and spatial-planning strategies recognize karst landscapes as valuable natural assets but lack explicit mechanisms for aquifer-protection or water-balance monitoring.

Recent updates to the Entity Environmental Protection Strategies (RS 2022; FBiH 2023) introduce integrated-resource-management principles yet omit groundwater indicators.

Transport-infrastructure policies consider hydrological impacts only through project-level EIAs, not as strategic safeguards.

Overall, sectoral alignment is moderate, constrained by administrative fragmentation and the absence of a unified national framework linking water, agriculture, environment, and spatial planning (World Bank 2022b; UNESCO-IHP 2024).

4.3. Current and potential impacts on groundwater from other sectors being mainstreamed into the policies of those sectors

In Bosnia and Herzegovina, the integration of groundwater concerns into other sectoral policies is limited and largely indirect. While some environmental and land-use policies touch on groundwater protection, there is no systematic mainstreaming of groundwater or groundwater-dependent ecosystems (GWDE) into sectoral planning frameworks. While BiH does not have a dedicated GWDE policy, several frameworks indirectly support groundwater and ecosystem protection: Environmental Protection Strategies (entity-level) aim to reduce pollution and protect natural resources, including water bodies. Nature conservation laws protect certain karst springs and wetlands, which may be GWDEs, but without explicit linkage to groundwater status. Climate adaptation plans recognize water scarcity and drought risks, but do not yet include aquifer resilience or GWDE vulnerability.

Generally, groundwater impacts are only partially addressed in other sector's policies:

Environmental-impact procedures formally require assessment of aquifer effects, but enforcement is inconsistent. Environmental permitting (in both entities) requires impact assessments for activities that may affect water resources - sectors like mining, energy, and infrastructure. Industrial and mining permits rarely incorporate recharge-zone protection; pollution incidents revealed institutional gaps.

Spatial planning laws consider water protection zones, but groundwater vulnerability is not consistently mapped or integrated into land-use decisions. Urban planning introduces groundwater considerations mainly through water-source-protection zones, which cover limited municipal areas and are often unenforced

Agricultural policy includes some measures for nutrient management and pesticide control, but lacks targeted groundwater protection strategies. In agriculture, neither fertilizer-use policies nor irrigation subsidies are linked to groundwater-quality monitoring.

Public health regulations focus on drinking water quality at the source, but do not extend to broader aquifer protection.

Hydropower-licensing frameworks address groundwater only when seepage affects dam stability rather than aquifer dynamics.

Tourism-development plans in karst areas (Trebinje, Mostar, Livno) include sustainability principles but lack hydrogeological data.

Consequently, the mainstreaming of groundwater concerns remains low, relying primarily on donor-driven cross-sectoral projects (DIKTAS-2; UNDP-GCF 2023).

4.4. GW and GWDE elaboration by the River Basin Management Plan

In FBiH, III cycle of RBMP is in preparation (2027-2032) by the Water Agencies for the Sava and Adriatic Sea Basins in accordance with the Water Law. In RS, (II cycle) of RBMPs are prepared by the PI Vode Srpske under RBMPs the Water Law

In both entities, RBMPs for the current cycles include detailed elaboration on groundwater management. The plans define and delineate groundwater bodies. All four RBMP include groundwater monitoring, but implementation varies significantly in scope and effectiveness. While some plans, such as the FBIH Sava RBMP conduct structured monitoring on several delineated groundwater bodies using piezometers and public water supply wells, others focus almost exclusively on drinking water sources. The Adriatic RBMP in FBIH and both RS RBMPs mention groundwater monitoring, but in practice they do not assess the chemical and quantitative status of groundwater bodies comprehensively. Across all plans, efforts are needed to expand coverage, improve data quality, and integrate ecological considerations, particularly in vulnerable karst areas.

While the plans reflect core principles of the EU Water Framework Directive (WFD) and partially align with the Groundwater Directive, they do not explicitly define groundwater-dependent ecosystems (GWDE) or include targeted legal instruments for their protection. Karst systems are acknowledged in the context of vulnerability and monitoring, but no specific ecological modeling or GWDE-related measures are provided.

4.5. GW challenges and measures addressed by RBM

In both entities, the plans explicitly address pollution from point and diffuse sources, over-abstraction for public supply and agriculture, and pressures on drinking water sources. Karst aquifers are acknowledged as particularly vulnerable due to their hydrogeological characteristics, including rapid flow and limited natural filtration.

However, neither plan explicitly define groundwater-dependent ecosystems (GWDE) and no targeted measures for karst systems are provided beyond general monitoring and pollution control in karst areas. While karst vulnerability is mentioned, there are no specific ecological connectivity tests or modelling tools applied to assess impacts on surface water or terrestrial ecosystems dependent on groundwater.

In FBIH, pollution from urban wastewater, industrial and agriculture, activities is identified as a major pressure. However, local challenges such as cumulative impacts from tourism-related water use in coastal karst zones and diffuse agricultural pollution are not comprehensively addressed.

In RS, the RBMP similarly outlines groundwater pressures, including nitrate contamination and abstraction stress. The plan includes threshold values and background concentrations for pollutants, and identifies protected zones around drinking water sources.

4.6. Integration of groundwater and surface water within the relevant strategies and policies

In the strategic documents in BIH, including the Water Management Strategy of the Federation of BiH (2010–2022), the Water Management Strategy of Republika Srpska (2015–2024), and the

Environmental Protection Strategy of Republika Srpska (2022–2032) , the importance of both groundwater and surface water is acknowledged, but their integration is not clearly defined as a strategic objective. While all three strategies emphasize the need to improve monitoring, protect water sources, control pollution, and align with EU directives, none of them propose measures that explicitly aim to manage groundwater and surface water as interconnected systems. Strategies address groundwater in the context of drinking water protection, while surface water is discussed in relation to floods and ecological status without reference to their mutual interaction.

In summary, while the strategies do not ignore the significance of groundwater, they do not establish its integration with surface water as a strategic priority, nor do they foresee measures that would enable joint planning, monitoring, or protection of connected ecosystems.

4.7. Public finance, including subsidies in relation to groundwater use

Bosnia and Herzegovina's public finance system includes various subsidies and investments across sectors that impact groundwater, but groundwater-specific funding is almost negligible. Public-finance instruments in BiH are not yet designed to promote sustainable groundwater management.

Entity environmental and water funds provide some grants for wastewater treatment, flood protection and communal infrastructure but allocate minimal resources to groundwater.

No performance-based incentives exist for utilities or industries to reduce leakage or improve groundwater-efficiency.

Limited cost-recovery from abstraction fees constrains investment in monitoring.

Agricultural subsidies often promote irrigation and fertilizer use without strong environmental conditionality, which can lead to nitrate pollution and over-abstraction of groundwater. Thay may unintentionally encourage over-extraction by financing irrigation equipment without abstraction control or metering.

Lack of funds for groundwater-dependent ecosystems (GWDE) means these sensitive areas are not actively protected or restored.

At the same time, donor projects (World Bank, UNDP, EU IPA) occasionally fill this gap by funding studies, pilot recharge schemes and monitoring wells, but such support is non-systemic and short-term.

Overall, public finance neither explicitly supports nor strategically undermines sustainable groundwater use—it remains neutral but fragmented, lacking long-term planning or conditional funding linked to groundwater outcomes (UNDP 2023a; World Bank 2024b)

5. Adherence to the WFD and GWD

5.1. Compliment of water management strategy with the requirements of WFD and GWD

The FBIH Water Strategy (2022–2032) strategy is largely aligned with WFD principles through its focus on water quality protection, sustainable use, and basin-based planning. It explicitly refers to ecological status for surface waters and includes measures for pollution control, monitoring, and intersectoral coordination. Groundwater protection is addressed through recharge zone management and sanitary protection areas. However, ecological criteria for groundwater are not defined, and groundwater-dependent ecosystems (GWDE) are not mentioned. Economic instruments are referenced but not operationalized.

RS Water Management Strategy (2014–2025) supports WFD objectives through goals related to pollution reduction, water quality improvement, and monitoring. It promotes institutional strengthening and legal harmonization with EU directives. Ecological status is mentioned but not methodologically defined, and there is no classification system for water bodies. GWDE are not

addressed, and integrated basin planning is underdeveloped. Economic and adaptive planning tools are not fully incorporated.

RS Environmental Protection Strategy (2022–2032) The strategy reflects WFD principles conceptually, emphasizing water quality, monitoring, and cross-sectoral integration. It links water with biodiversity, land use, and climate policy, and promotes public awareness. Implementation tools such as economic instruments are absent.

As explained in Chapter 4.6. the Strategies does consider groundwater significance but they do not establish its integration with surface water as a strategic priority, nor do they foresee measures that would enable joint planning, monitoring, or protection of connected ecosystems.

5.2. Regulation GW and GWDE quality standards and threshold including national methodology for determining GW and GWDE quality standards and threshold values

The laws in BIH recognize the importance of groundwater and is developing frameworks to address their protection (including karst aquifers and groundwater dependent ecosystems). However, the country has not yet fully established the detailed threshold value system for groundwater (as per GWD requirements) with full implementation, monitoring, and publicly published criteria comparable to EU Member.

Quality standards and threshold values for groundwater is addressed in few of key documents and legal acts. This includes standards for chemical status as mandated by the GWD, setting EU-wide pollutant limits with provisions for substances of national concern.

Bosnia and Herzegovina has developed a national methodology for determining groundwater (GW) and groundwater-dependent ecosystems (GWDE) quality standards, which incorporates the unique characteristics of karst terrains. This methodology is embedded in various legal acts and regulations, supported by scientific research and monitoring efforts. The implementation of groundwater quality standards and monitoring in BiH is supported by various institutions (ministries, agencies, institutes and academia).

5.3. Defining of areas designated for the abstraction of water intended for human consumption in national regulation

In both FBiH and RS, national regulations define areas for drinking water abstraction primarily through sanitary protection zones around water sources, rather than by designating entire groundwater bodies as protected areas. This approach creates a conceptual gap between EU WFD requirements and local practice.

As explained in Chapter 3. relevant regulation in FBIH governs the delineation of areas used for public water supply. Sanitary protection zones in karst might be defined in three or four levels based on proximity to the source and vulnerability to pollution. The regulation does not require designation of the entire groundwater bodies as protected areas for drinking water abstraction, but sanitary protection zone may encompass an entire groundwater body or catchment area, if necessary for the protection of drinking water sources.

In RS, the Water Law and relevant bylaws also define sanitary protection zones as the primary tool for safeguarding drinking water sources. Sanitary protection zone are established around individual abstraction points, with protective measures based on hydrogeological assessments.

In both entities no legal obligation exists to link sanitary protection zone with groundwater body boundaries, nor to assess chemical status across entire bodies for drinking water purposes. Strategic groundwater reserves are not formally defined or protected under a unified framework.

Both entities rely on sanitary protection zones as the main regulatory tool, but do not designate groundwater bodies as drinking water protected areas, nor do they fully align with the WFD's

conceptual framework. A national methodology is needed to bridge this gap and ensure robust, EU-compliant protection of drinking water resources.

6. Knowledge, information and awareness

6.1. Assessment of Dinaric karst groundwater system according to the requirements of the WFD and GWD;

The Dinaric karst groundwater system in Bosnia and Herzegovina has been partially assessed in line with the requirements of the EU Water Framework Directive (WFD) and the Groundwater Directive (GWD).

Groundwater bodies within the Dinaric karst have been delineated and characterized as part of the river basin management planning process conducted separately by the FBIH, RS and BDBIH. Both entities water laws require mutual consultation and coordination between entities when preparing river basin management plans and implementing upstream-downstream activities in shared catchments. However, the assessment is not yet fully harmonized at the national level due to the decentralized institutional framework and differences in methodologies used by the entities.

Basic characterization including hydrogeological boundaries, recharge areas, and general qualitative and quantitative status has been carried out, but comprehensive risk assessment and status classification according to WFD/GWD criteria are still ongoing.

The transboundary nature of the Dinaric karst aquifers, which extend across several neighboring countries, presents an additional challenge for full compliance with WFD/GWD requirements, and further coordination and data harmonization are needed to achieve consistent assessment and monitoring.

6.2. Monitoring data exist and key ecological indicators

Information on water monitoring data in Bosnia and Herzegovina include qualitative and quantitative aspects (water quality, abstraction, spring discharge, ecological flow, and ecological indicators).

Existing monitoring data and the aspects covered (quality, abstraction volumes, spring discharge capacity, ecological flow, ecological indicators). Ongoing monitoring programs including variables monitored, their frequency, and spatial coverage.

Water quality data cover chemical and ecological status of surface and groundwater, with surveillance, operational, and research monitoring programs established to assess long-term trends, risks, and pollution incidents.

Data on water abstraction monitor volumes from surface waters and groundwater by sector (agriculture, public supply, industry), though some gaps exist for unauthorized abstraction.

Spring discharge capacity is monitored especially in karst regions with historic waterworks.

Ecological flow monitoring aims to maintain or restore freshwater ecosystems following EU biodiversity strategies and WFD ecological flow requirements (periodical)

Key ecological indicators include species conservation status, habitat condition, and ecosystem service indicators, with partial data coverage for forests, agricultural ecosystems, and wetlands.

RBM for Trebišnjica River Basin (district) – 2017-2021 proposed monitoring in accordance with WFD, but no activities occurred up to 2025

In the territory of the RS, monitoring has been established primarily at the level of public water supply utilities, focusing mainly on water quality, in accordance with the relevant Regulation and the developed Programme of Sanitary Protection Zones. In addition, several companies carry out

monitoring activities for their own operational purposes (e.g. HPP Trebišnjica – provide complex groundwater monitoring).

Systematic, state-level monitoring is foreseen by the RBM, but in practice it has been only partially implemented.

In the FBIH, the Sava River Basin Water Agency and the Adriatic Sea Basin Water Agency have established their own monitoring networks, which include observations depending on the monitoring station: of water quality, groundwater level, quantity, and temperature. The majority of the network is related to alluvial aquifers.

In karst areas, most monitoring stations fall under the responsibility of the Adriatic Sea Basin Water Agency and local public water supply utilities, which are legally obliged to conduct regular monitoring.

The status of monitoring activities in the FBIH is generally good and shows continuous improvement; however, there is still significant room for further development.

In the Trebišnjica River Basin (RS), a UNDP project is currently being implemented, which aims to enhance the level of public monitoring and improve data coverage. Monitoring within the Trebišnjica Basin, Bileća Reservoir, and Cetina River Basin is largely well covered through the existing monitoring networks operated by the electricity production companies.

The following are existing monitoring locations related to DIKTAS II:

- Bilećko lake:
- Waterworks monitoring: ''Dejanova pećina'', Bileća (quality)
- Other: Energy company/ HPP Trebinje system''HET'': 10 monitoring stations (piezometers)
- Trebišnjica:
- Waterworks monitoring: ''Oko'', watter suply for Trebinje (quality)
- Other: IAEA project/Geological Survey of the RS: 2 monitoring stations (ph-ch paramteres, quality, isotopes)
- According to FBIH RBMP for Adriatic Basin in FB&H: groundwater quality monitoring is regularly carried out twice a year at 30 springs/sources of groundwater (of which at several locations from wells in alluvial deposits)
- According to FBIH RBMP for Sava River Basin: 12 automatic monitoring stations (groundwater level and temperature); Without monitoring in transboundary karst aquifers
- Waterwork monitoring: in Klokot

6.3. Monitoring programmes and variables monitored

The Ongoing monitoring programs: are as following:

- Surveillance Monitoring: Focuses on assessing long-term natural and anthropogenic changes; includes chemical and ecological analyses of waters; temporal resolution is long-term, spatially distributed in river basin districts. The surveillance monitoring concept exists in documentation but practical nationwide implementation is incomplete.
- Operational Monitoring: Targets surface waters and groundwater bodies at risk; monitors priority substances and pollutant trends; higher temporal resolution for detecting changes due to measures. For groundwater the operational monitoring is very limited, especially in terms of pollutant trends, high temporal resolution, and coverage of bodies at risk.
- Research Monitoring: Used for identifying unknown pollution causes, sudden Pollution events; more intensive temporal and spatial resolutions during investigations. In Bosnia and Herzegovina they are very rare.
- Water Watch List Monitoring: Tracks emerging pollutants as mandated by EU directives over periods of at least one year at selected stations.

Variables monitored include physical-chemical parameters (nutrients, heavy metals, pesticides), biological indicators (macroinvertebrates, fish, ecological status), hydrological variables (discharge, water levels), and abstractions by sector. Specific monitoring networks supply comprehensive data for river basin management plans and status assessments.

In Bosnia and Herzegovina, Sava River Basin Agency, Adriatic Sea Watershed Agency and Public Institution „Vode Srpske "conduct water quality monitoring of surface water (including chemical and biological status).

Regarding bathing water, Bosnia and Herzegovina do not have officially declared bathing places in accordance with Ordinances on the quality of bathing water. Monitoring is usually carried out in accordance with financial possibilities.

Monitoring of drinking water should be carried out suppliers of water supply services in accordance with Ordinance on the quality of drinking water. The Food Safety Agency reports on this at the Bosnia and Herzegovina level.

Regarding on key ecological indicators monitoring, areas intended for the protection of the habitats of plant and animal species have still not been officially declared. However, as part of water monitoring of certain protected areas is carried out.

Data on water monitoring are shown in the following Tables:

Table 1Water Quality Monitoring

Monitoring Aspect	Data Available	Monitoring Program	Variables Monitored	Time Resolution	Spatial Coverage
Surface and Groundwater	Chemical and biological status	Surveillance, Operational Monitoring	Physical and chemical, nutrients, heavy metals, priority substance	Seasonal to annual	River basin districts, coastal and inland
	chemical status	Monitoring	Physical and chemical, microbiological		Sampling stations

Table 2 Water Abstraction Monitoring

Aspect	Data Available	Monitoring Program	Variables Monitored	Time Resolution	Spatial Coverage
Abstraction Volumes	By sector (agriculture, Hydro poweindustry other industry)	Water Use Monitoring	Volume abstracted (m^3/year/season)	Seasonal to annual	Surface and groundwater bodies
Illegal Abstraction	Partial data, ongoing improvement	Enforcement and Compliance	Reported incidents, estimated volumes	Ad hoc	National and local scales

Table 3 Spring Discharge Capacity Monitoring

Aspect	Data Available	Monitoring Program	Variables Monitored	Time Resolution	Spatial Coverage
Karst Springs	Discharge rates, flow permanence	Hydrological Monitoring	Discharge volume (l/s), flow timing and variability	Continuous or periodic	Key karst springs

Table 4. Ecological Flow Monitoring

Aspect	Data Available	Monitoring Program	Variables Monitored	Time Resolution	Spatial Coverage
Ecological Flows	Minimum flows, regime	Ecological Flow Monitoring	Flow volumes, water temperature	Continuous or event-based	Selected rivers, protected areas

Table 5 Key Ecological Indicators Monitoring

Aspect	Data Available	Monitoring Program	Variables Monitored	Time Resolution	Spatial Coverage
Biodiversity and Habitat	Species richness, habitat status	Ecosystem and biodiversity monitoring	Vegetation types, species abundance	Periodic, as part of the monitoring	Protected area

6.4 Data acquisition, data management and dissemination

The following are institutions responsible for data acquisition and dissemination:

Federation Bosnia and Herzegovina

- Sava River Basin Water Agency
- Adriatic Sea Basin Water Agency
- FBIH Hydro meteorological Institute FBIH

Republika Srpska

- PI Vode Srpske
- RS Hydro meteorological Institute

Although the responsible institutions have qualified staff and basic technical capacities for data acquisition, management, and dissemination, the available human and material resources are generally insufficient to ensure systematic, high-quality, and continuous implementation of all monitoring and data management activities.

There is a clear need for additional qualified personnel, particularly hydro- geologists, hydrologists, GIS and database specialists, and water quality experts — as well as for regular professional training of existing staff.

In addition, many institutions lack modern equipment, adequate software tools for data processing and integration, and particularly stable financial support for maintenance and field activities.

Strengthening institutional capacities through targeted training programs, improved inter-agency coordination, and investment in modern monitoring and data management infrastructure is therefore essential for ensuring reliable and sustainable operation of the system.

6.5. Public availability of data, information and knowledge on groundwater and groundwater dependent ecosystems in karst

Public access to groundwater and GWDE data in Bosnia and Herzegovina (BiH) remains limited, fragmented, and inconsistent across institutions.

The entity water agencies (Vode Srpske and Hydro-Meteorological Institute) collect hydrological and water-quality data, but public dissemination is irregular and often restricted to summary reports or project outputs in RS. Raw data on groundwater levels, abstraction volumes, or water chemistry are rarely accessible online and typically require formal requests. RS Hydrometeorological Institutes maintain groundwater-level time series but do not publish open datasets.

FBIH Water Agencies for Sava and Adriatic River Basin provide on line data at their web sites including: Water levels: current and historical data from hydrological stations, Water quality: chemical and biological monitoring of surface and groundwater, Monitoring network: station locations, sampling frequency, parameters Groundwater cadaster: GIS visualizations of springs, boreholes, and protection zones, Spatial (GIS) maps: interactive maps of water bodies, catchments, and protection zones. Most of these datasets are interactive and regularly updated, and some can be downloaded in PDF or Excel format. FBIH Hydro meteorological Institute publishes reports covering meteorological, hydrological, and climate data, with frequencies ranging from daily bulletins to annual analyses.

The Geological Surveys (Zvornik in RS; Sarajevo in FBiH) hold valuable archives on aquifer stratigraphy, springs, and karst morphology—most of which exist only in analogue or unpublished formats.

A few datasets have been digitized under donor-funded initiatives, yet their continuity is uncertain once projects end.

No unified water information system (WIS) currently aggregates groundwater data across entities and sectors, despite previous plans under the Water Management Strategies.

Academic research and NGOs occasionally publish thematic studies (e.g. karst spring vulnerability, pollution hotspots), but these outputs are scattered and lack interoperability.

Thus, while knowledge exists, it is institutionally largely inaccessible to the public, limiting its use for planning, investment, and awareness-raising (UNESCO-IHP 2024; World Bank 2022b).

6.6 Information on groundwater sharing among public agencies and between the public and private sectors

Information exchange on groundwater among agencies and sectors in BiH is ad hoc and project-driven.

The Inter-Entity Commission for Water (IECW) enables limited coordination, mostly concerning surface-water management and reporting to international bodies.

Entity water agencies, geological surveys, and hydrometeorological institutes have weak mechanism for data sharing; cooperation depends on informal professional networks or specific project mandates.

Municipal utilities rarely report abstraction data consistently to entity databases, while industries using groundwater (e.g. beverage and bottling plants) are not systematically integrated into reporting frameworks.

Private-sector access to hydrogeological information is often constrained by administrative procedures or non-digitized archives.

Donor and research projects (DIKTAS-2, GCF/UNDP) temporarily improve cooperation through joint datasets and working groups, but institutionalization after project completion is rare.

Public–private information flow is weak: utilities and local authorities often lack the technical capacity to interpret hydrogeological data or translate it into actionable management decisions.

Awareness and communication with the public are limited to specific campaigns (World Water Day, project dissemination events), without a permanent outreach mechanism.

Overall, data exchange and knowledge-sharing frameworks remain fragmented, preventing an integrated understanding of karst-aquifer systems and groundwater-dependent ecosystems across BiH (UNECE 2023; WWF Adria 2024).

7. Socio-economic setting and challenges

7.1. Groundwater management challenges in karst areas

Key challenges include fragmented competencies between entities and Brčko District, under-funded monitoring, and limited interoperability of groundwater datasets. Karst specificity (rapid conduit flow, low natural attenuation, episodic pollution) is insufficiently reflected in permitting and spatial planning. Source-protection zones are unevenly designated and enforced; abstraction metering and leakage control remain weak in many utilities. Agricultural pressures (nutrients, pesticide use) and tourism growth in Herzegovina increase diffuse risks with scarce preventive monitoring. Private datasets (hydropower, bottling) are not systematically shared with public authorities. Triggers for reform include RBMP updates, DIKTAS-2 working groups, EU Green Agenda/WFD alignment, and performance-based financing for utilities. Formalising inter-entity groundwater working groups and digitising geological archives would catalyse quick wins. *(Refs: World Bank 2022a,b; DIKTAS 2012; UNESCO-IHP 2024.)*

7.2 Role, services and significance of groundwater and groundwater dependent ecosystems to the economy, to human and environmental well-being of the Dinaric karst area

Groundwater is the primary drinking-water source for many settlements in Herzegovina and parts of RS and FBiH, underpinning public health and resilience in drought years. Karst springs and GWDE sustain high-value tourism/nature assets (Neretva, Trebišnjica, protected landscapes) and support hydropower operations via groundwater–surface water connectivity. Reliable groundwater enables food-processing and beverage industries and buffers seasonal demand in tourism hubs. Ecosystem services include base flow maintenance, thermal regulation, and biodiversity support; degradation would raise treatment costs and harm local livelihoods. Safeguarding GW/GWDE therefore carries direct welfare and competitiveness benefits. *(Refs: DIKTAS 2012; UNESCO-IHP 2024; World Bank 2022a.)*

7.3. Development of water supply and sanitation infrastructure and wastewater and waste treatment and management

Most urban to public water supply, but non-revenue water is high and rural connections remain uneven. Wastewater collection and areas are connected treatment lag behind EU norms; many agglomerations discharge partially treated or untreated effluent, elevating risk to karst aquifers. Asset registers and SCADA are improving in a subset of utilities, yet metering/pressure management are not universal. Sanitary landfills and leachate control are inconsistent, with legacy dumpsites persisting near vulnerable recharge zones. Investment is dominated by donor/state grants; cost-recovery and lifecycle planning are weak, constraining maintenance and upgrades. (Refs: World Bank 2022a, b; UNDP 2023a.)

7.4. Overall socio-economic characteristics and macro-economic objectives and policy related to the Dinaric karst area and their impact on GW and GWDE

Demographics show ageing and out-migration in many karst municipalities, reducing local fiscal capacity yet concentrating demand seasonally via tourism. Macro-objectives prioritise growth, energy security, and connectivity; without safeguards, these can increase hydro-technical pressures on karst systems. Agricultural modernisation and irrigation expansion, if decoupled from abstraction control,

may heighten quantitative stress. Climate variability amplifies drought/flood extremes, altering recharge and contaminant transport in conduits. Spatial-planning reforms and green-transition agendas offer alignment opportunities if groundwater safeguards and vulnerability maps are embedded. *(Refs: World Bank 2022b; UNECE 2023; UNESCO-IHP 2024.)*

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

The diversity of groundwater users in Bosnia and Herzegovina includes:

- Public water supply companies providing drinking water to urban and rural populations.
- Industrial users, including energy production, food processing and manufacturing.
- Agricultural users, mainly for irrigation purposes.
- Individual or private users, such as small-scale wells for households or local businesses.

The stage of development of groundwater exploitation and management varies. Most public water supply relies on groundwater sources in urban areas, with formal Sanitary Protection Programmes for major sources, but exploitation and monitoring in rural areas remain limited.

The management of these groundwater bodies is regulated at a broader scale through the corresponding River Basin Management Plans, which define the framework for integrated water resource management in line with the EU WFD.

However, the practical implementation of these plans is still at an early stage, particularly regarding coordination between different user sectors and administrative levels. Institutional fragmentation and varying capacities among responsible agencies often limit effective groundwater governance.

Further harmonization of data collection, monitoring, and decision-making procedures is required to ensure sustainable and balanced groundwater exploitation across all basins.

7.6. Overall governance and political leadership conducivnes to groundwater governance

Leadership signals are mixed: strategies acknowledge groundwater importance, but operational mandates, budgets, and indicators remain weak. IECW provides a platform yet lacks technical sub-groups, binding protocols, or a shared information system. Periodic donor projects demonstrate strong cooperation when convening power exists, but continuity fades post-project. Political attention gravitates to visible surface-water infrastructure, not invisible aquifer protection. A shift toward performance-based finance and transparent reporting could realign incentives. *(Refs: World Bank 2022b; UNDP 2023a; UNESCO-IHP 2024.)*

7.7. Impact of developments in the broader economy on groundwater in Dinaric karst area

Tourism growth (accommodation, recreation, second homes) raises seasonal water demand and wastewater volumes in karst municipalities. Energy developments (hydropower optimisation, potential new storage) can alter groundwater–surface water exchanges and require enhanced seepage/recharge monitoring. Agricultural value-chain upgrades and irrigation pilots may increase abstractions without robust metering. Urban expansion and logistics corridors intensify land-use pressures near recharge zones. Conversely, EU decarbonisation and green funding can finance leakage reduction, metering, and digital monitoring if groundwater targets are embedded. *(Refs: World Bank 2022a,b; UNESCO-IHP 2024.)*

8. National SWOT analysis

Human resources

Strength (S): Entity-level institutions have a core group of qualified professionals with experience in water management and EU alignment processes.

Weakness (W): There is a shortage of staff in both numbers and expertise, especially at local and operational levels. No systematic training programs or staffing structures exist to meet the specific demands of WFD/GWD implementation.

Opportunity (O): Establish targeted capacity-building programs, technical certification and institutional workforce planning aligned with EU directives and karst-specific needs.

Threat (T): Without strategic investment in human resources, fragmented expertise and limited field-level capacity may delay compliance, reduce monitoring quality, and hinder protection of groundwater-dependent ecosystems.

Fragmented Governance and Limited Institutional Coordination

Strength (S): Formal frameworks such as the Inter-Entity Commission for Water (IECW) and River Basin Management Plans provide basic coordination mechanisms.

Weakness (W): Responsibilities are divided between entities and Brčko District, binding protocols, or shared information systems.

Opportunity (O): Establishing unified data-sharing system could rapidly improve governance

Threat (T): Lack of institutional cooperation and technical capacity may lead to uncoordinated measures, duplicated efforts, and ineffective protection of karst aquifers.

Financial Resources

Strength (S): The legal framework supports cost recovery and the polluter pays principle, enabling fee-based water management.

Weakness (W): Environmental and resource costs are not reflected in current fee structures, and tariffs remain too low.

Opportunity (O): Introducing a standardized methodology for calculating fees to reflect real costs for environment and resources

Threat (T): Budgetary limitations and weak enforcement capacity may prevent effective implementation of revised fee systems.

Methodology for Establishment of Protection Zones

Strength (S): Existing methodology for delineating protection zones in karst aquifers, incorporating vulnerability assessments and hydrogeological analysis.

Weakness (W): Despite legal obligations, lack of developed hydrogeological studies or adopted formal decisions on source protection, leading to widespread gaps in implementation.

Opportunity (O): Establishing a unified, risk-based methodology for protection zone delineation across whole country could improve consistency and ecological safety.

Threat (T): The absence of standardized methodologies and karst-specific criteria across entities may lead to inconsistent protection measures, increasing the risk of legal disputes, planning conflicts, and ecological degradation in vulnerable groundwater areas

Groundwater Monitoring (GW)

Strength (S): Basic groundwater characterization has been completed, and entity-level agencies have established monitoring networks covering water quality, quantity, and temperature — especially in alluvial aquifers.

Weakness (W): Monitoring in karst areas is fragmented and lacks ecological indicators; GWDE and ecological flow are not systematically assessed

Opportunity (O): Strengthen karst-specific and transboundary monitoring through harmonized methodologies, integration of ecological parameters, and expansion of monitoring programs

Threat (T): Limited coordination between entities and neighboring countries, combined with partial implementation of RBMPs, risks inconsistent data, and delayed compliance with EU directives.

Law Enforcement for preserving GW and Sanitary Protection Zones

Strength (S): Inspectorates are authorized to conduct inspections and impose penalties.

Weakness (W): Enforcement is mostly reactive, triggered by complaints or visible violations

Opportunity (O): RBMPs emphasize the need for proactive enforcement strategies.

Threat (T): Limited number of qualified inspectors and insufficient financial resources for recruitment and training hinder effective enforcement. Weak coordination between inspectorates and water agencies further reduces the ability to monitor and respond to violations in protection zones

Groundwater and GWDE in Karst Areas

Strength (S): Karst aquifers are recognized as highly vulnerable in strategic documents and RBMPs.

Weakness (W): No specific ecological tools, modeling, or GWDE definitions are included in plans or strategies.

Opportunity (O): Future RBMPs and strategies can integrate karst-specific protection measures and ecological connectivity assessments.

Threat (T): Protection is indirect and fragmented across sectors without targeted action, karst systems remain exposed to cumulative pressures from tourism, agriculture, and abstraction.

Water Strategies and River Basin Management Plans

Strength (S): Groundwater protection is recognized as a strategic priority, and RBMPs include delineation and monitoring of groundwater bodies.

Weakness (W): GWDE are not defined, and karst-specific measures are missing in both strategies and RBMPs.

Opportunity (O): Future planning cycles can integrate ecological modeling, vulnerability mapping, and GWDE protection aligned with EU directives.

Threat (T): Without operational tools and ecological criteria, sensitive karst aquifers remain exposed to degradation and regulatory gaps.

Sectoral Integration and Policy Mainstreaming

Strength (S): Legal frameworks support horizontal cooperation and require environmental impact assessments for water-related activities.

Weakness (W): Groundwater concerns are weakly integrated into agriculture, tourism, and spatial planning policies.

Opportunity (O): Cross-sectoral strategies can embed groundwater sustainability criteria, especially in irrigation, land use, and tourism development.

Threat (T): Continued sectoral fragmentation and lack of hydrogeological data risk over-abstraction and pollution in vulnerable areas.

Groundwater Sustainability

Strength (S): Environmental / water funds exist and occasionally support water-related infrastructure.

Weakness (W): Groundwater-specific funding is negligible, and cost-recovery mechanisms are weak.

Opportunity (O): Introduce performance-based incentives and conditional subsidies tied to groundwater protection outcomes.

Threat (T): Public subsidies and investments across sectors—such as agriculture, tourism, infrastructure, and energy—often lack environmental safeguards, which may unintentionally contribute to groundwater over-abstraction, pollution, and degradation of sensitive recharge zones and ecosystems.

Groundwater and GWDE Data Availability and Sharing in BiH

Strength (S): Operational online access to hydrological, water quality, and GIS-based groundwater data, with regular updates and downloadable formats.

Weakness (W): Data availability is fragmented and inconsistent across entities; datasets are mostly inaccessible, and many archives remain analogue or unpublished.

Opportunity (O): Establish a unified Water Information System (WIS) to digitize, and harmonize groundwater and GWDE data across institutions and sectors.

Threat (T): Weak coordination, limited technical capacity, and lack of institutionalized data-sharing mechanisms hinder integrated management and public awareness, especially in karst regions.