EU4Environment in Eastern Partner Countries:
Water Resources and Environmental Data (ENI/2021/425-550)

GROUNDWATER MONITORING DEVELOPMENT PLAN 2024

Georgia

Funded by the European Union

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ABOUT THIS REPORT

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ABOUT EU4ENVIRONMENT – WATER RESOURCES AND ENVIRONMENTAL DATA

This Programme aims at improving people's wellbeing in EU's Eastern Partner Countries and enabling their green transformation in line with the European Green Deal and the Sustainable Development Goals (SDGs). The programme's activities are clustered around two specific objectives: 1) support a more sustainable use of water resources and 2) improve the use of sound environmental data and their availability for policy-makers and citizens. It ensures continuity of the Shared Environmental Information System Phase II and the EU Water Initiative Plus for Eastern Partnership programmes.

The programme is implemented by five Partner organisations: Environment Agency Austria (UBA), Austrian Development Agency (ADA), International Office for Water (OiEau) (France), Organisation for Economic Co-operation and Development (OECD), United Nations Economic Commission for Europe (UNECE). The programme is principally funded by the European Union and co-funded by the Austrian Development Cooperation and the French Artois-Picardie Water Agency based on a budget of EUR 12,75 million (EUR 12 million EU contribution). The implementation period is 2021-2024.

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CONTENTS

List of abbreviations

AM ..... Armenia
GE ..... Georgia
CIS ..... Common Implementation Strategy
EaP ..... Eastern Partners
EC ..... European Commission
EPIRB ..... Environmental Protection of International River Basins
EU ..... European Union
EU4WD ..... EU4Environment in Eastern Partner Countries: Water Resources and Environmental Data
EUWI+ ..... European Union Water Initiative Plus
GEF ..... Global Environmental Fund
GW ..... Groundwater
GWB ..... Groundwater Body
RBD ..... River Basin District
RBMP ..... River Basin Management Plan
UBA ..... Umweltbundesamt GmbH, Environment Agency Austria
UNDP ..... United Nations Development Programme
UNECE ..... United Nations Economic Commission for Europe
WFD ..... Water Framework Directive
UNECE ..... United Nations Economic Commission for Europe
WFD ..... Water Framework Directive

Country Specific Abbreviations Georgia

MEPA ..... Ministry of Environmental Protection and Agriculture of Georgia
NEA ..... National Environmental Agency
NWP ..... National Water Partnership
SEMS ..... State Environment Monitoring System

Executive Summary

This Groundwater Monitoring Development Plan 2024 (GW-MDP) is an update of the first plan which was prepared in 2021 within the EUWI+ project. It provides recommendations for the improvement of Georgia's groundwater (quantity and chemical) monitoring infrastructure and activities to further converge to the requirements of the EU Water Framework Directive (WFD). It outlines the necessity and purpose of surveillance and operational groundwater monitoring programs and provides guidance on the selection of monitoring sites, monitoring frequencies and investigated parameters for each monitoring programme.

This update takes regard the significant progress achieved within the EU4WD programme of the past four years. In the meantime, two new river basin management plans (RBMPs), for the Enguri river basin district (RBD) and for the Rioni RBD, were drafted and two groundwater surveys were implemented in these RBDs (2022 and 2023) with the intention to find appropriate existing sites/wells to be included into the national monitoring network. Furthermore, a transboundary groundwater survey with Armenia at Bagratashen (in the Northern river basin district) was performed in 2023 to explore transboundary interlinkages of groundwater and to coordinate and harmonise groundwater sampling procedures and monitoring results. Finally, a groundwater survey was performed in the Alazani river basin in 2024 at the border to Azerbaijan, which was initially planned as transboundary survey but not realized on the Azeri side of the Alazani river.

There are still significant efforts needed towards WFD conformity of groundwater monitoring, in terms of network, parameters, frequency as well as data assessment.

1. Introduction and scope

The 'EU Water Initiative Plus' (EUWI+) programme (2016-2021) aimed at improving the management of water resources and strengthening capacities in Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine. It supported the development and implementation of River Basin Management Plans (RBMPs), building on the improved policy framework and ensuring a strong participation of local stakeholders. The follow-on programme 'EU4Environment in Eastern Partner Countries: Water Resources and Environmental Data' (EU4WD) continued this support since 2021.

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

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

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

On this basis, an outlook and proposal for further development and capacity building to further ensuring sustainability of project efforts beyond EU4WD is provided.

2. WFD Groundwater monitoring requirements

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

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

2.1. Purpose of WFD monitoring

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

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

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

- establish the chemical and quantitative status of GWBs (including an assessment of the available groundwater resource);
  - identify whether the available groundwater resource is not exceeded by the long-term annual average rate of abstraction;
  - identify saline or other intrusions resulting from alterations of flow within the GWB;
  - identify impacts on associated aquatic and dependent terrestrial ecosystem;
  - identify exceedances of groundwater quality standards and threshold values;
  - identify impairment of legitimate uses of groundwater;
- assist in further characterization of GWBs;

- validate the risk assessments carried out under WFD Article 5;
- estimate the direction and rate of flow in GWBs that cross Member States' boundaries;
- assist in the design of programs of measures;
- evaluate the effectiveness of programs of measures;
- demonstrate compliance with objectives for DWPA and other protected area;
- characterize the natural quality of groundwater including natural trends (baseline); and
- identify anthropogenically induced trends in pollutant concentrations and their reversal.

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

2.2. Conceptual models

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

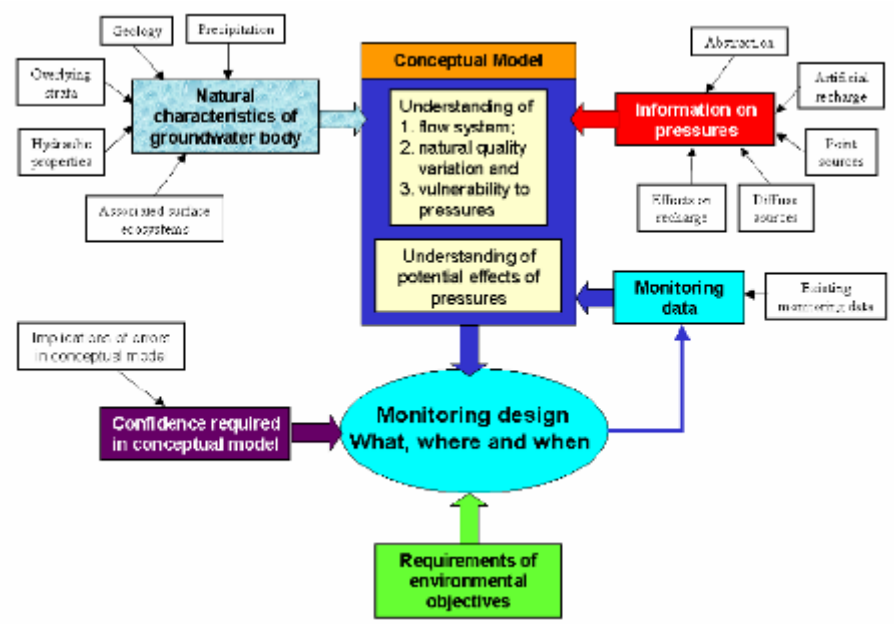


Figure 1: Link between the conceptual model/understanding and monitoring (EC 2004)

2.3. Chemical groundwater monitoring

2.3.1. Surveillance monitoring

Selection of monitoring sites

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

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

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

Monitoring parameters

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

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

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

Monitoring frequency

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

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

2.3.2. Operational monitoring

Selection of monitoring sites

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

Monitoring parameters

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

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

Monitoring frequency

According to the WFD, operational monitoring must be carried out at least once a year during periods between surveillance monitoring for all GWBs that are identified at risk of failing to achieve good chemical status objectives. Operational monitoring must be as sufficient as necessary to establish the status of GWBs at risk and the presence of significant and sustained upward trend in pollutant concentrations.

As for surveillance monitoring, it is recommended to select the appropriate monitoring frequency on the basis of the conceptual understanding of each GWB, the seasonal effects of pollutants, the seasonal use or application of pollutants.

2.4. Quantitative groundwater monitoring

Selection of monitoring sites

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

Monitoring parameters

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

Monitoring frequency

The amount and frequency of monitoring is required to be sufficient ad will be determined by the data needed to determine risk and status, and where necessary to support the design and assessment of a program of measures. Frequency of monitoring predominantly depends of the characteristics of the water body and the monitoring site respectively. Sites with significant annual variability should be monitored more frequently than sites with only minor variability. In general, monthly monitoring will be sufficient for quantity monitoring where variability is low. (EC 2007)

3. Groundwater monitoring in Georgia – current state

Georgia is divided into six river basin districts (RBD): Alazani-Iori, Chorokhi-Ajaristkali, Enguri, Khrami-Debeda, Kura and Rioni. The EPRIB project (2012-2016) focused at the Chorokhi-Ajaristkali, in EUWI+ (2016–2021) focus was put on the Alazani-Iori and the Khrami-Debed RBDs and under EU4WD (2021–2024) the groundwater activities focused at the Enguri and the Rioni RBDs.

After the process of identifying and delineating groundwater bodies (GWBs) in these RBDs, the existing groundwater monitoring network was analysed and described. A special focus was put on the development of groundwater chemical monitoring of GWBs because their current scope and level of operation is rather limited and the scope of improvement is demanding. Less focus was put on groundwater quantitative monitoring as the existing monitoring capacities in terms of monitoring networks, assessment strategies, equipment and staff are better developed due to their long-lasting experience and continuous operation and the aspects of quantitative monitoring are not as challenging as for chemical monitoring.

For quantitative and chemical monitoring, it was a particular challenge to consider the distribution of monitoring points and the representativeness of the overall monitoring network in the light of the newly delineated GWBs, which are the management units of groundwater under the WFD.

The legal requirements on WFD conform monitoring, the particular purposes of the different types of groundwater monitoring as well as guidance for site selection, the selection of monitoring parameters and frequency of monitoring is provided in relation to their respective objectives and they are described in more detail in chapter 2. The existing monitoring and sampling equipment and the needs of investment were discussed since 2019 and refined considering the conclusions drawn in the different EUWI+ and EU4WD groundwater assessment studies and surveys.

The following technical reports were elaborated under EUWI+ and EU4WD:

- Delineation and characterization of GWBs and the design of a groundwater monitoring network in the Alazani-Iori RBD in Georgia (EUWI+ 2019);
- Delineation and characterization of GWBs and the design of a groundwater monitoring network in the Khrami-Debed RBD in Georgia (EUWI+ 2019);
- Groundwater survey report 2018 (EUWI+ 2018);
- Groundwater survey report 2019 (EUWI+ 2020);
- Groundwater survey report 2020 (EUWI+ 2020);
- Geophysical survey of boreholes in the Alazani RBD, Georgia (EUWI+ 2021);
- Specific manual for surveys in groundwater (EUWI+ 2020);
- General manual for chemical freshwater sampling (EUWI+ 2020).
- Groundwater survey report 2022 (in Rioni RBD) (EU4WD 2023);
- Groundwater survey report 2023 (in Enguri RBD) (EU4WD 2024);
- Groundwater survey report 2024 (in Alazani RBD) (EU4WD 2024);
- Groundwater transboundary survey report 2023 (Armenia-Georgia) (EU4WD 2024);
- Transboundary groundwater body report – Armenia-Georgia (EU4WD 2024)
- Transboundary groundwater body report – Azerbaijan-Georgia (EU4WD 2024)
- Audit report: Groundwater sampling – Georgia (EU4WD 2023)
- Mission reports on GWB delineation in Rioni and Enguri (EU4WD 2023)

3.1. Legal background

Georgia has committed itself to the Association Agreement with the European Union to undermine national legislation with EU legislative acts and international legal instruments in accordance with the provisions of the same Annex, including the water quality and water resources referred to in Annex XXVI of this Agreement, including the Marine Environmental Management (Article 306).

For this purpose, the Law on Water Resources Management was adopted for approval in the parliament. Concrete actions have begun to improve the investigation, monitoring and management of water resources.

Résumé

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

3.2. Administrative setup

The National Environmental Agency (NEA), Legal Entity of Public Law under the Ministry of Environment Protection and Agriculture of Georgia (MEPA), is responsible for qualitative and quantitative monitoring of fresh groundwater in Georgia.

Résumé

The administrative setup of groundwater monitoring is well established in Georgia. The responsible institutions have solid experience in successful operations of monitoring and the management of monitoring data and do not need external support or recommendations on the administrative setup.

3.3. Groundwater bodies

In conformity with the stepwise implementation procedure of the WFD, the projects EPIRB, EUWI+ and EU4WD identified, delineated and characterised in total 58 GWBs in the following five RBDs:

- Chorokhi Ajaristskali: 13 GWBs under EPIRB
- Alazani-Iori: 23 GWBs under EUWI+
- Khrami-Debed: 12 GWBs under EUWI+
- Enguri: 3 GWBs under EU4WD
- Rioni: 7 GWBs under EU4WD

These 58 GWBs together with a representative groundwater monitoring network build the basis of future WFD inspired groundwater management in the five RBDs, which are briefly displayed in the following sub-chapters.

In March 2023, transboundary GWBs with Armenia and with Azerbaijan were jointly identified and briefly characterised as a preparatory step for joint transboundary surveys. The joint survey together with Armenia was implemented in autumn 2023, the joint survey with Azerbaijan was cancelled by Azerbaijan.

Résumé

58 GWBs have been delineated in five of six RBDs, in Alazani-Iori, Khrami-Debed, Chorokhi Ajaristskali, Enguri and Rioni, according to the specifications of the WFD. It should be endeavored to extend this work for the remaining Kura RBD in Georgia with the same approach and to continue the bilateral harmonisation/coordination of transboundary aquifer systems and GWBs with neighboring countries.

In the following years, during the revision of the RBMPs it is recommended to review and if necessary to revise the delineation of GWBs and to move from the aquifer oriented approach to a more management unit perspective.

The recently defined uniform GWB coding system should be applied to all existing and new GWBs in Georgia.

3.3.1. Chorokhi Ajaristskali RBD

The 13 GWBs were delineated based on the hydrogeological division and characterization of the existing aquifers. All GWBs, except for marine water deposits, are used for drinking, agricultural and/or industrial water supply with abstractions above 10 m^3/d.

Table 1: GWBs in the Chorokhi Ajaristskali RBD

Name of the aquifer	Water-bearing sedimentsandrocks	Identified GWB(n)	GWBtemporary codes
Aquifer of Middle Eocene volcanogenic-sedimentary rocks (P_2^2)	Lava,volcanic breccia, tuff and tuff-sands	3	G101, G102,G103
Sporadicallyspread eluvial Quaternaryaquifers	Loam,debrismaterial,laterites,underlainbyvolcanogenicrocks	1	G200
Recent marine and alluvial aquifers	Pebbles,gravel,sand, clay	2	G301, G302
Aquifer of recent alluvial sediments	Pebbles,gravel,sand	1	G400
Water-bearingcomplex of Upper Miocene-Lower Pliocene(N_1^3+N_2^1)–GoderdziSuite	Andesites,basalts	2	G501, G502
Aquifer of recent bogdeposits	Silt,sand, clay, loam with peat interlayers	1	G600
Water-bearingcomplex of Plioceneseditments (N_2)	Conglomerates,sandstones, clays	1	G700
Aquifer of intrusiverocks of MiddleEocene(γP_2^2)	Syenites, diorites	1	G800
Aquifer of recent marine sediments	Oval stones andsandy-stonyfacies with interlayers of clayand loam	1	G900
	Total	13	

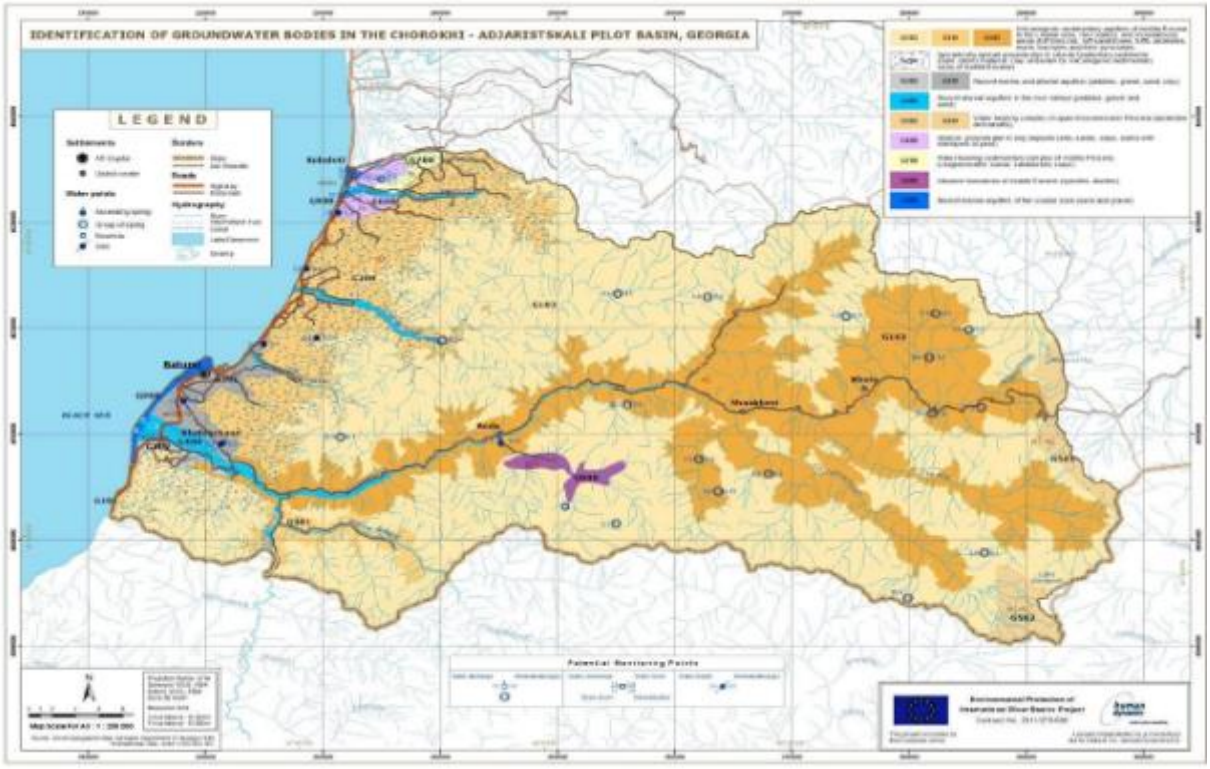


Figure 2: Map of GWBs in the Chorokhi Ajaristskali RBD

3.3.2. Alazani-Iori RBD

The 23 GWBs of the Alazani-Iori RBD were assigned to four different hydrogeological types (porous; karstic; fractured; mix of porous-fractured), on the basis of which the coding system was implemented (see Table 2 and Figure 3).

For the Alazani-Iori RBD, an inventory of the existing GW monitoring network was elaborated as a starting point of proposing potential amendments in order to make GW monitoring fit for the new GWBs. This work was facilitated by EUWI+ in the year 2019 and implemented by local contractors.

Table 2: GWBs in the Alazani-Iori RBD

№	Hydrogeological type	Geographical subtype	Name	Code	Area, km^2
1	Porous (GP)	Alazani (GPA)	AlaAllu	GPA0001	154
			AlaKva	GPA0003	2517
			AlaTel	GPA0005	110
			AlaGur	GPA0006	214
		Iori (GPI)	IorAluv	GPI0002	148
			IoDePro	GPI0004	1774
			IoAgAph	GPI0011	328
2	Fractured (GF)	Alazani (GFA)	AlMlu	GFA0022	558
			AlLey	GFA0023	2160
		Iori (GFI)	AlaPal	GFI0016	172
			IoEoc	GFI0017	48
3	Karstic (GK)	Alazani (GKA)	AlUpCre	GKA0018	406
			ALowCre	GKA0019	580
			AlluCre	GKA0020	282
		Iori (GKI)	AlUplu	GKI0021	21
4	Mix of Porous-Fractured (GM)	Iori (GMI)	IoCoAph	GMI0007	134
			IoMaAph	GMI0008	131
			IomaAgh	GMI0009	237
			IocoAgh	GMI0010	224
			IoShir	GMI0012	753
			IoDush	GMI0013	117
			IoSar	GMI0014	603
			IoMai	GMI0015	64

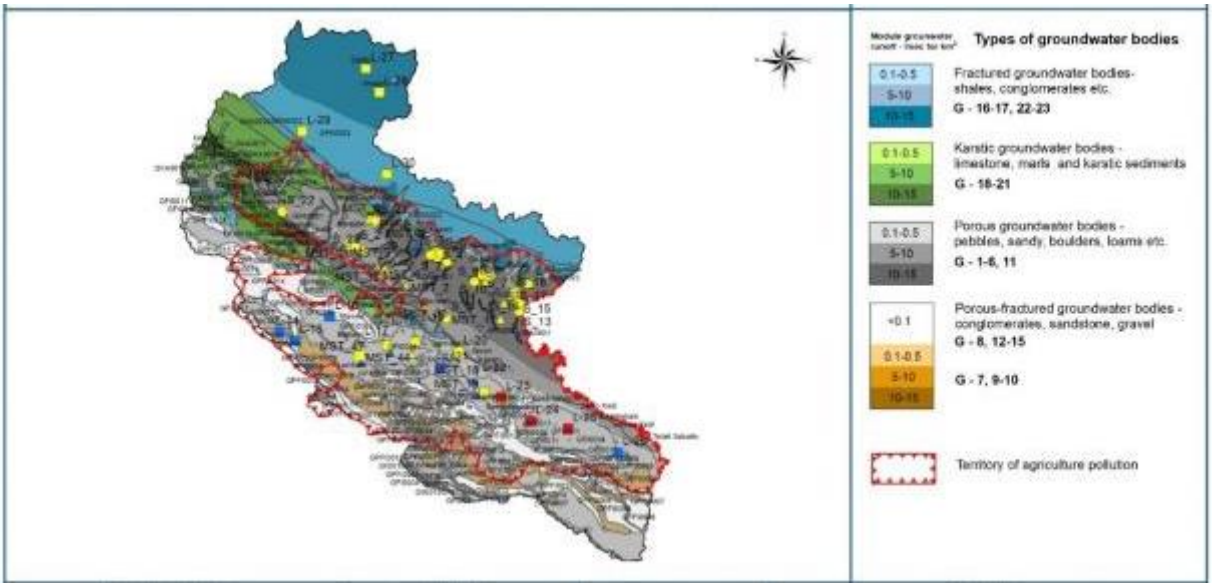


Figure 3: Map of GWBs in the Alazani-Iori RBD

3.3.3. Khrami Debed RBD

The 12 GWBs in the Khrami Debed RBD were assigned to three different hydrogeological types (porous; karstic; fractured), on the basis of which the coding system was implemented (see Table 3 and Figure 4). An inventory of the existing GW monitoring network design was performed as a starting point of proposing potential amendments in order to make GW monitoring fit for the new GWBs. This work was facilitated by EUWI+ in the year 2019 and implemented by local contractors.

Table 3: GWBs in the Khrami Debed RBD

№	Hydrogeological type	Name	Code	Area, km^2
1	Porous (GP)	KhraAlu	GPK0024	68
		KhraProl	GPK0025	730
		KhraElu	GPK0026	321
		KhraLoMio	GPK0028	252
2	Fractured (GF)	KhrPli	GFK0027	1422
		KhUpPli	GFK0029	12
		KhraEoc	GFK0030	803
		KhBay	GFK0033	92
		KhLey	GFK0034	54
		KhPz	GFK0035	237
3	Karstic (GK)	KhCaCr	GKK0031	26
		KhVoCr	GKK0032	905

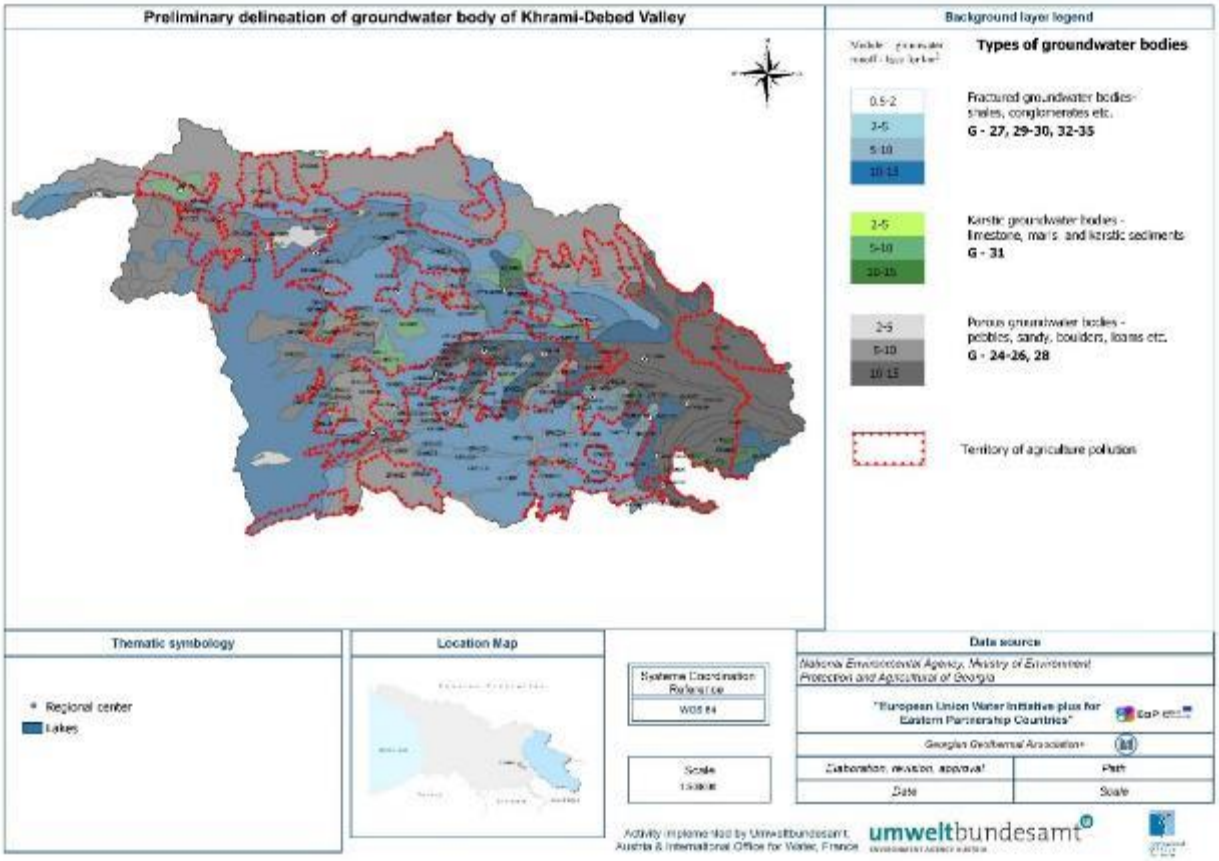


Figure 4: Map of GWBs in the Khrami-Debed RBD

3.3.4. Enguri RBD

In total three GWBs were identified, delineated and characterised in the Enguri RBD (see Figure 5). They cover in total 18 aquifers, which are in direct contact with surface ecosystem. These 3 GWBs are:

- Svaneti GEGWB001. On the territory of Svaneti region;
- Gali GEGWB004. On seaside territory of Samegrelo region, Gali district;
- Samegrelo GEGWB005. On the territory of central part of Samegrelo region;

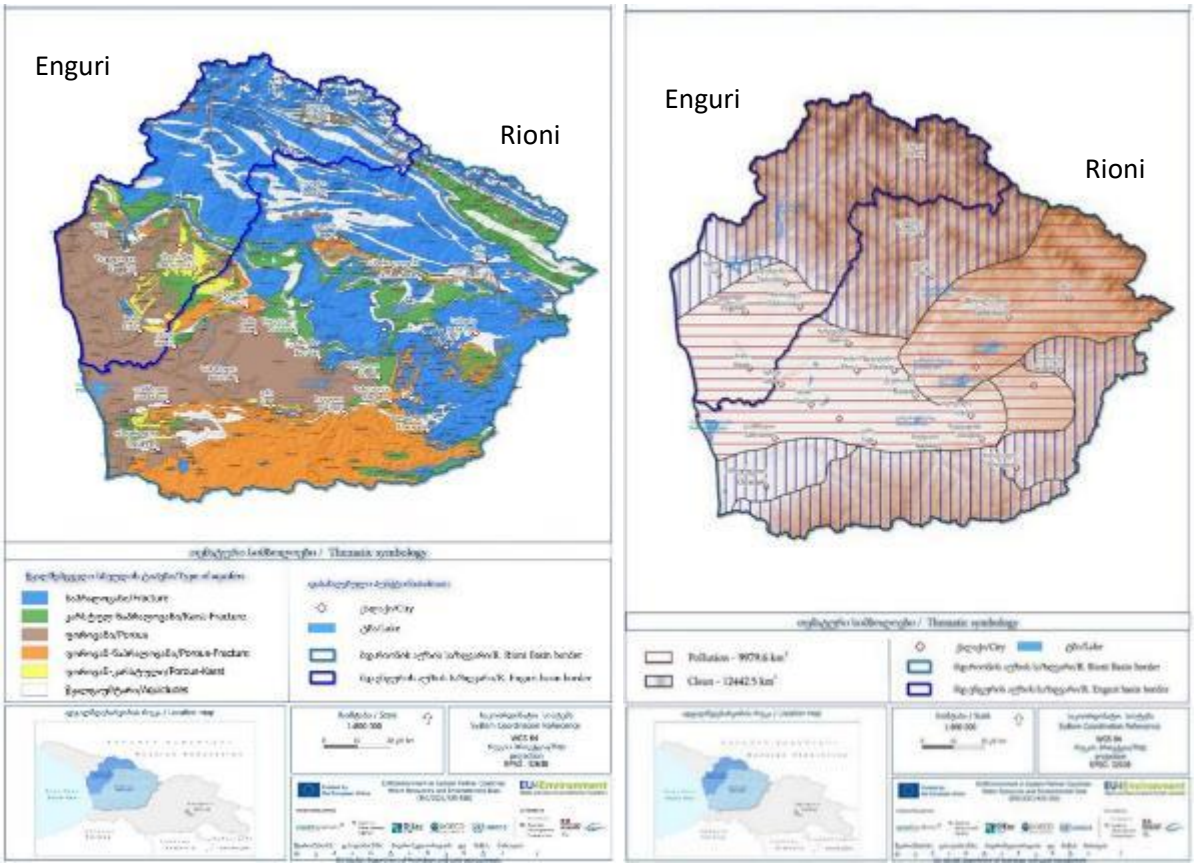


Figure 5: Map of Aquifers (left figure) and GWBs (right figure) in Enguri RBD (western part) and Rioni RBD (Eastern part).

3.3.5. Rioni RBD

In total seven GWBs were identified, delineated and characterised in the Rioni RBD (see Figure 5). They cover in total 18 aquifers, which are in direct contact with surface ecosystem. These seven GWBs are:

- Racha GEGWB002. On the territory of Rach region;
- Lentekhi GEGWB003. On the territory of Lentekhi region
- Imereti GEGWB006. On the territory of Imereti region;
- Chiatura GEGWB007. On the East territory of Imereti region, Chiatura district;
- Tkibuli GEGWB008. On the North-East territory of Imereti region, Tkibuli deistrict.
- Guria GEGWB009. On the territory of Guria region;
- Trialeti GEGWB010. On the territory of Trialeti region

3.4. Groundwater monitoring design

Monitoring of fresh groundwater in Georgia has been resumed in 2013 at the Geological department of NEA, which is the Legal Entity of Public Law under the Ministry of Environment Protection and Agriculture of Georgia.

3.4.1. Monitoring network

NEA currently monitors 65 water points (mainly wells) in entire Georgia. Monitoring started in 2013 and new stations have been added step by step. With the support of the EPIRB project six natural springs were equipped and started instrumental monitoring in the Adjara region, which allows the constant control of water discharge and temperature. In December 2017, the number of monitoring water station increased by 11 stations, with support of the Czech Development Agency. Other monitoring stations were financed by MEPA. With the support of EUWI+ seven automated GW monitoring stations were installed and equipped, consisting of data loggers measuring several key quantitative and qualitative parameters with independent electricity supply by solar panels. The new devices allow for prompt transfer of the observed data into the national database of NEA. Three automated GW monitoring stations have been installed in the Alazani basin with the support of the UNDP-GEF Kura II project.

The following 4 sub chapters describe the current state of the GW monitoring network in the five RBDs where RBMPs have been developed and the transboundary monitoring sites which were proposed for joint transboundary survey with Armenia and Azerbaijan.

Résumé

The current GW monitoring network in Georgia does not meet the WFD requirements. Looking at the five RBDs where RBMPs were elaborated, the GW network does not yet cover all GWBs and in GWBs where GW monitoring exists, the network is not representative and the number of monitoring sites is too small.

For the Enguri and Rioni RBDs, where RBMPs were already drafted, and for the Kura RBD, there is not yet a monitoring network assigned, For Enguri and Rioni candidate sites have been selected and sampled with the support of EU4WD. It is necessary to continue this activity and finally form stable monitoring networks to allow for gathering long time series of data for future reliable assessments of risk, status and trends.

EUWI+ supported the checking of 30 existing monitoring sites on their technical status which was only a first step to be continued in the coming years. Each existing monitoring sites needs to be checked whether it is representative for the GWB, suitable for sampling and can provide reliable and representative monitoring data for representative risk and status and trend assessment. When searching for new monitoring sites, preference should be given to finding and integrating appropriate existing objects instead of drilling new monitoring wells.

It is also necessary to cover all GWBs with monitoring sites and not to forget the shallow GWBs which are not the main source of drinking water supply for a large number of people but nevertheless an essential source of drinking water for the population not connected to central water supply

Finally, it is necessary to continue the bilateral coordination of identifying suitable monitoring sites for transboundary monitoring and establish harmonized and bilaterally agreed regular data exchange.

Chorokhi - Ajaristskali RBD

When the RBMP of the Chorokhi-Ajaristskali RBD was prepared (between 2012 and 2015), there was no GW monitoring. At some well fields (Batumi, Kobuleti) water levels were measured and groundwater chemistry was analysed by water supply companies (Batumi Water and Kobuleti Water) for their own purposes only. The RBMP gives some proposals on the establishment of a GW monitoring network.

Alazani-Iori RBD

By 1965, 573 searching and exploration wells had been drilled in the Alazani basin alone and studies and hydrogeological tests were carried out on the groundwater regime. Between 1990 and 2013, centralized hydrogeological exploration and monitoring works were suspended. In 2013, the Department of Geology of NEA resumed monitoring of fresh GW in Georgia with the support of the Czech Development Agency. Gradually, new stations were added to the monitoring network, including springs (on the territory of Autonomous Republic of Adjara), with support of EU-financed EPIRB project.

The monitoring situation in the Alazani-Iori RBD is described in the Alazani-Iori RBMP. Out of the 65 GW monitoring points in Georgia, 33 are located in the Alazani-Iori RBD. All 33 water points are equipped with automatic data logging equipment continuously recording and transmitting key quantitative and qualitative parameters (water flow, water temperature, pH, electric conductivity, total dissolved solids). The 33 monitoring sites are concentrated in the areas of highest anthropogenic activity and groundwater use in the central parts of the Alazani-Iori river basin, where monitoring is most urgently needed.

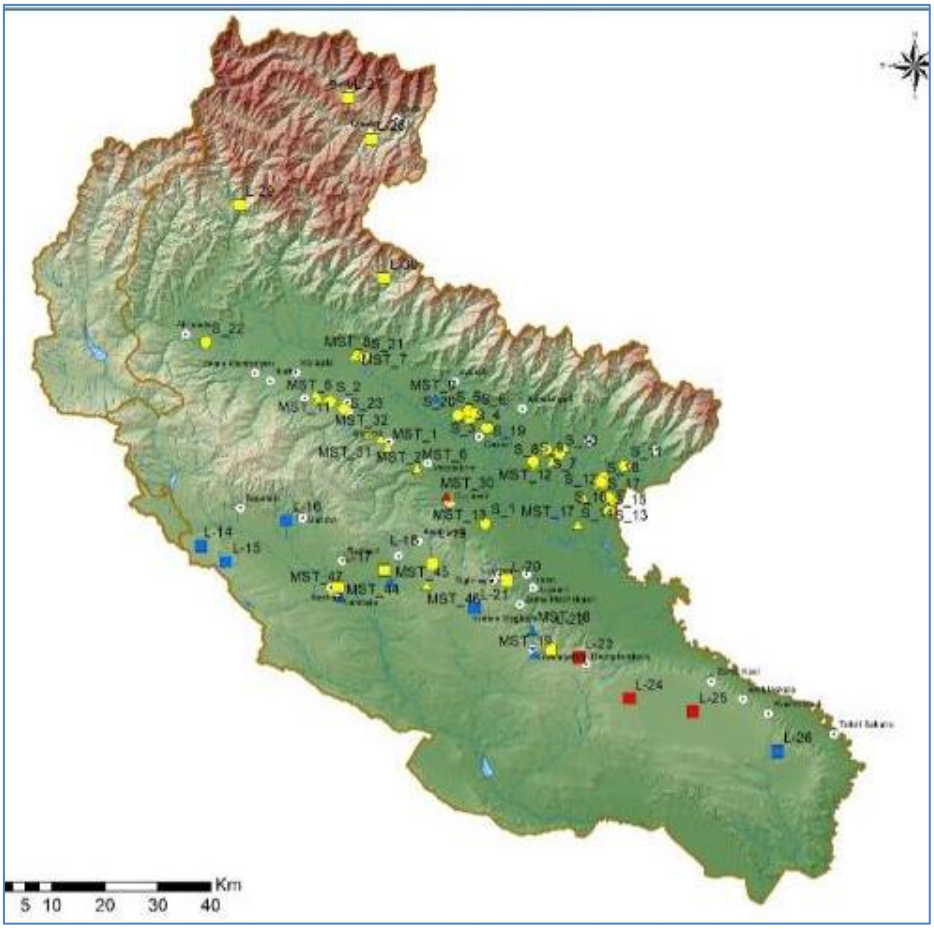


Figure I: Groundwater monitoring stations in the Alazani-Iori RBD

However, on the long run it is necessary to monitor all GWBs to understand the impacts of anthropogenic pressures on GW, as stipulated by the WFD. The number of monitoring points is not enough yet to characterize all GWBs and to assess risk and status. According to the requirements of the WFD each GWB has to be subject to monitoring. The GW monitoring guidance of the Common Implementation Strategy for the WFD recommends at least three points, but more points might be necessary to reflect the results of anthropogenic impact on its natural conditions.

In order to improve the GW monitoring network, from 2018 to 2020 EUWI+ supported NEA to conduct three rounds of additional field surveys to new water points which could be added to the monitoring network to improve the network coverage. With EUWI+ 67 water points were sampled and analysed by the NEA (29 wells, 37 springs and 1 household well). 15 water points were tested two or three times.

A geophysical inspection of boreholes, contracted by EUWI+ in 2019 and 2020, aimed at checking 30 existing boreholes by video-logging and 14 wells by comprehensive geophysical-logging and pumping tests. For several of the wells refurbishment needs were identified.

Khrami-Debed RBD

The GW monitoring situation in the Khrami-Debed RBD is described in the Khrami-Debed RBMP. Two GW monitoring sites are located in the Khrami-Debed RBD, both boreholes are equipped with automatic data logging equipment. This equipment continuously records and transmits key quantitative and qualitative parameters (water flow, water temperature, pH, electric conductivity, total dissolved solids).

The current monitoring network does not yet cover all GWBs of the Khrami-Debeda RBD, and the network is not yet adequately representative in those GWBs that do have monitoring sites. In order to improve the GW monitoring network, EUWI+ supported NEA to conduct three rounds of additional field works (the 2018, 2019 and 2020 EUWI+ groundwater field surveys) to new sampling sites which could be added to the monitoring network. To improve its coverage, NEA assessed 4 such existing wells in the Khrami-Debed RBD, and collected and analysed samples from these wells in 2018.

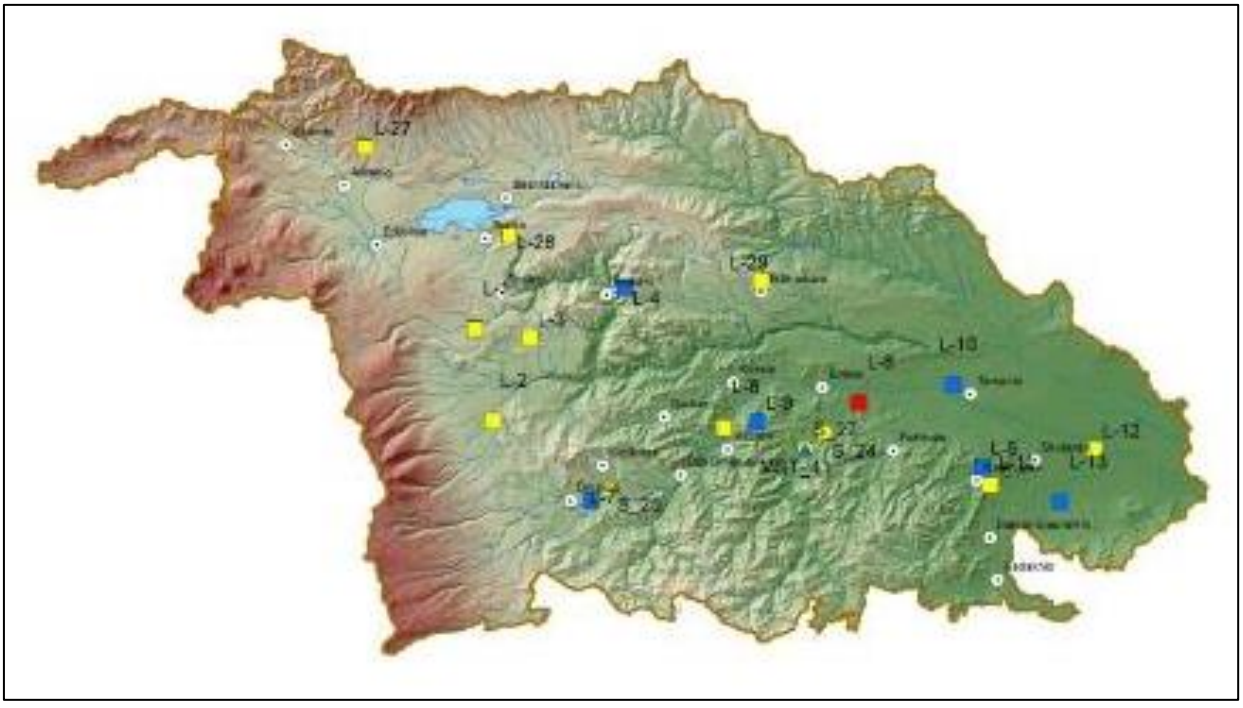


Figure 6: Groundwater monitoring stations in the Khrami Debed RBD

Enguri RBD

No monitoring network is currently in place within the Enguri RBD. The programme of measures within the RBMP aims for the improvement of the groundwater monitoring network and provides suggestions for its. A groundwater survey in 2023 aimed at finding and sampling of 15 potential monitoring sites (13 springs and 2 household wells) which could be candidates for inclusion into the national groundwater monitoring network (see Figure 7).

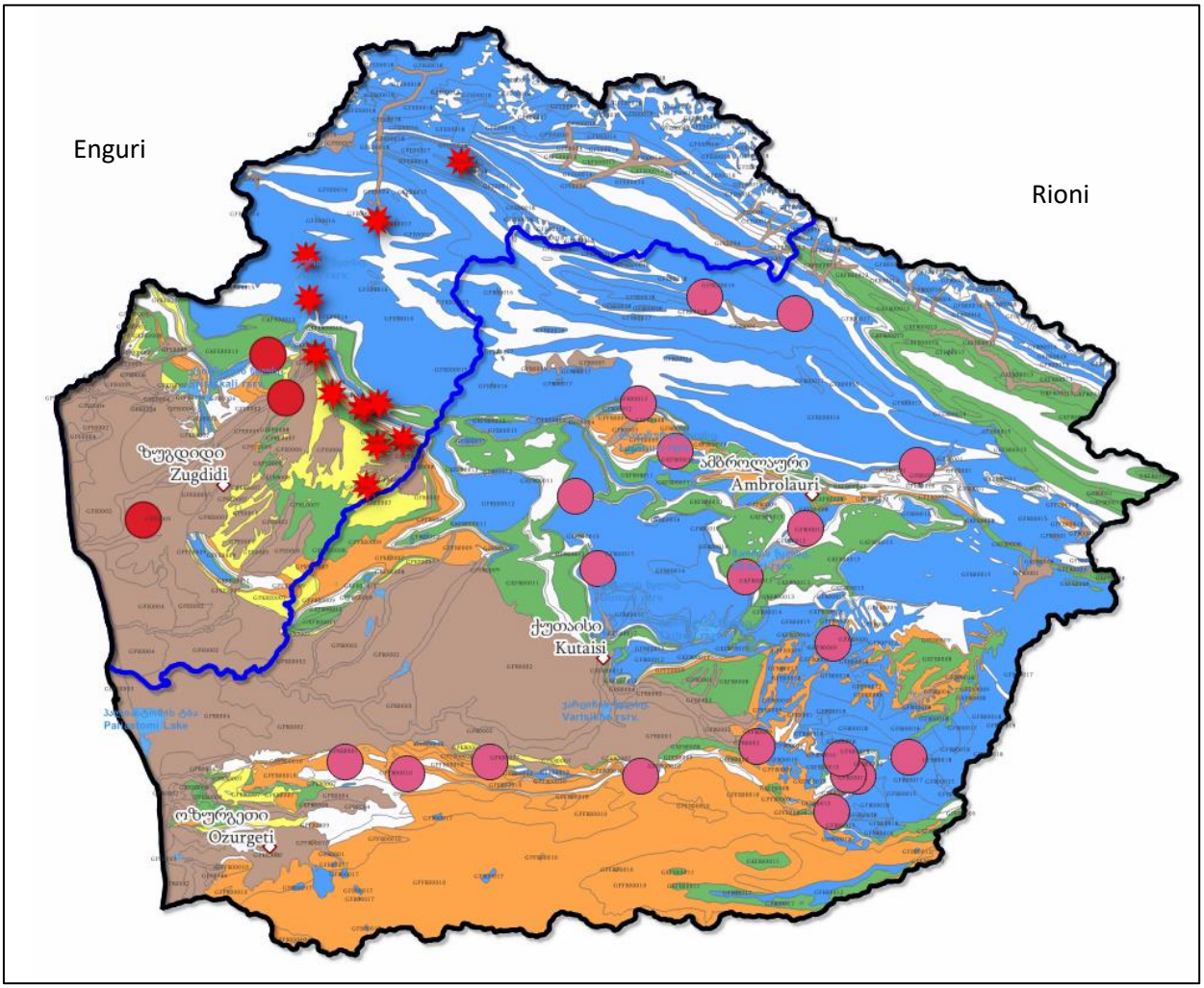


Figure 7: Location of candidate groundwater monitoring stations sampled within the groundwater surveys in Enguri RBD (Western part of the map) and in the Rioni RBD (Eastern part of the map)

Rioni RBD

No monitoring network is currently in place within the Rioni RBD. The programme of measures within the RBMP aims for the improvement of the groundwater monitoring network and provides suggestions for its. A groundwater survey in 2022 aimed at finding and sampling of 20 potential monitoring sites (19 springs and 1 household well) which could be candidates for inclusion into the national groundwater monitoring network (see Figure 7).

3.4.2. Monitoring parameters and frequency

In addition to the continuous data collection by automatic data logging equipment, NEA conducts chemical and bacteriological analysis of water samples from each monitoring site twice per year.

Together with major ions, also the composition of main components for drinking water such as pH, dissolved oxygen in water (DO), Biochemical Oxygen Demand (BOD), nitrite, nitrate, ammonium nitrogen, phosphate, sulphate, iron, zinc, copper, lead and manganese content, electro conductivity and mineralization are measured.

Monitoring of specific organic substances (for instance PAH, PCB, pesticides, etc.) are not covered under the National Quality Monitoring Program

NEA manages and analyses the data from all monitoring sites and prepares information bulletins twice a year based on the hydrogeological monitoring results.

Résumé

Monitoring frequency and monitoring parameters for groundwater quantity are fully in line with the minimum requirements of the WFD.

Monitoring parameters for groundwater quality monitoring are covering some basic substances and indicators. Nevertheless, it is recommended to introduce the risk based and tiered approach of the WFD where surveillance monitoring is acting as kind of wider screening monitoring to validate the risk assessment and operational monitoring is putting focus at the substances causing risk of not achieving the environmental objectives for groundwater.

It is recommended to implement a monitoring frequency of 4 times per year for surveillance monitoring to get a more complete picture about the pollution situation at different seasons of the year. Operational monitoring can be implemented at a lower frequency once the variability of pollutants is identified during surveillance monitoring, tailored to the hydrogeological characteristics of GWBs.

To enable such a risk based approach and tailoring, the respective legislation needs to provide some flexibility. The funding of the monitoring activities should be guaranteed in a long-term to facilitate full scale and uninterrupted monitoring of GWBs over a longer time period to enable trend assessments.

3.4.3. Equipment and consumables

The existing sampling and monitoring equipment and the needs of investment were discussed in 2018 at the sampling training and during the preparation phase of the EUWI+ surveys. For the preparation of the groundwater survey an inventory of available equipment of NEA was prepared in the GW survey manual where also general aspects, contact persons and responsibilities, analysed substances and preservation methods, checklists, sampling methods and templates for the documentation can be found.

Table 4: Available groundwater sampling and monitoring equipment and consumables of NEA

Item	Type / Specification	Remark
Bailer		
Pump, tubing, batteries		Springs or artesian wells. Pump and equipment can be borrowed from the Georgian Geothermal Association
Groundwater level meter	Solinst Model 101	
Multimeter	Hanna Combo pH/EC/TDS/C/PPM Tester HI98129	
Test stripes	pH, hardness, NH_4	Purchased by EUWI+
Various bottles (PET, light glass, brown glass)		
Cooling box and cooling elements		

The inventory of available sampling and monitoring equipment, the conclusions drawn in the various GW assessment studies in 2019 and 2020 and the discussions held with the national thematic expert for GW provide an excellent basis for an inventory of equipment and monitoring infrastructure that should be purchased and installed in future. All 65 GW monitoring stations are equipped with automatic data logging equipment.

Table 5 gives an overview about the urgently needed equipment and it indicates, which and how many unites have been tendered and already purchased by EUWI+ in 2020 and 2021.

Table 5: Needed and purchased groundwater monitoring equipment

Units needed	Item	Specification	purchased
At least 1 per GWB	Automated groundwater monitoring stations	Permanent measurement of five main characteristic parameters (water discharge, temperature, total mineralization, pH, electrical conductivity)	7
1	Pump, tubing, batteries	InSitu WaSP 12 V pump and tubing or equivalent	-

Résumé

Modern groundwater sampling and field measurement equipment is partly available. Each monitoring station is equipped with automatic data logging equipment. EUWI+ purchased automatic data logging equipment for seven new monitoring sites. Remaining equipment should be purchased in the near future.

3.5. Transboundary coordination

As water does not respect any country borders, the WFD and its river basin approach endeavours for transboundary coordination and harmonisation at several aspects of the directive. Hence, it is very important to strengthen transboundary coordination, to identify transboundary GWBs and to establish transboundary monitoring and data exchange. There should be mutual agreement for a monitoring program with common standards for information exchange and joint assessment of groundwater body status.

The cooperation in this direction has already started within the UNEP GEF funded project "Kura II" with the construction of 3 automatic sites near the border of Georgia and Azerbaijan in the Alazani-Iori RBD by 2020. And it has been continued under EU4WD in 2023 with Armenia and Azerbaijan.

With the support of EU4WD a bilateral agreement in the field of monitoring and exchange of information in the transboundary Khrami-Debed River Basin between Armenia and Georgia was elaborated and finalised in October 2024. This agreement provides the legal basis for joint monitoring activities, information exchange and reporting on the status of water bodies (both surface water and groundwater bodies). Details on monitoring and data exchange are laid down in the guidance document set out in the Annex to this agreement. This final agreement still waits for its adoption by mutual signing.

Résumé

First steps towards transboundary cooperation have been take. Transboundary GWBs have been identified with Azerbaijan and Armenia and a joint groundwater survey with Armenia has been successfully implemented in 2023. Based on these preparatory activities, a transboundary monitoring agreement between Armenia and Georgia for the Khrami-Debed RBD has been elaborated and finalised with substantial support of EU4WD.

It is recommended to sign this agreement and implement the monitoring activities accordingly. Furthermore, it is recommended to elaborate and adopt such agreements with the other neighbours, in particular with Azerbaijan for the Kura, Alazani-Iori and Khrami-Debed RBDs.

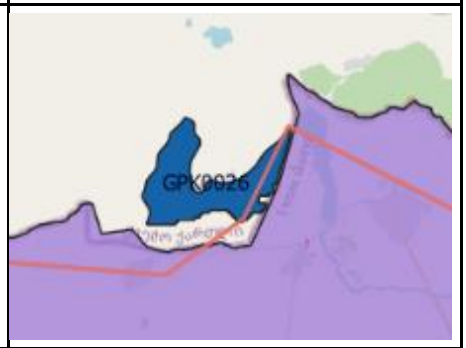
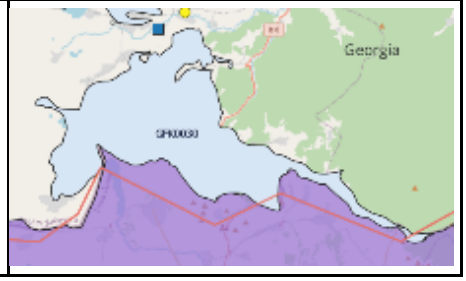
3.5.1. Transboundary groundwater bodies

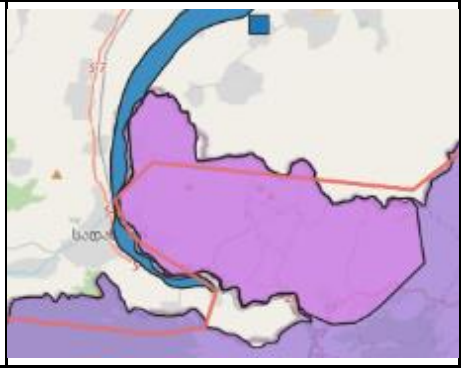
In March 2023 representatives of Georgia and Armenia and Georgia and Azerbaijan identified and briefly characterised transboundary GWBs as well as the current monitoring situation in bilateral coordination workshops.

Georgia and Armenia

The following six transboundary connections of national GWBs were identified between the Khrami-Debed RBD in Georgia and the Northern RBD in Armenia. Four GWBs in Georgia are transboundary linked with four GWBs in Armenia. In addition to these transboundary connections for further national GWBs touching the country border in these RBDs, it was clarified that there is no transboundary interlinkage.

Table 6: Transboundary GWBs between the Khrami-Debed RBD in Georgia and the Northern RBD in Armenia.

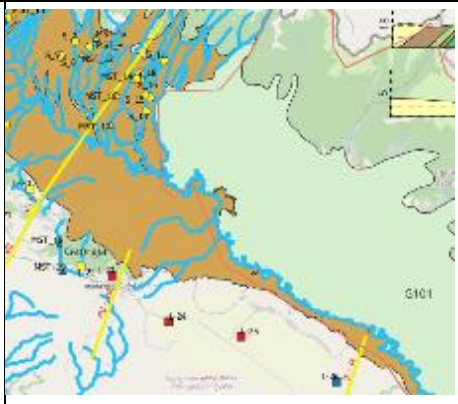
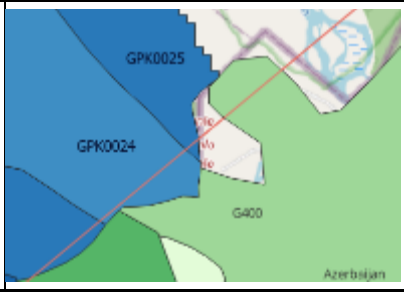
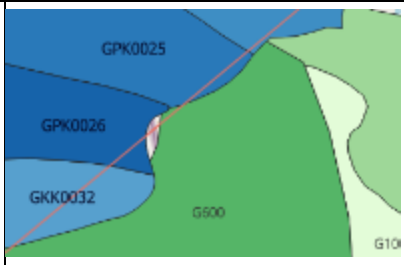
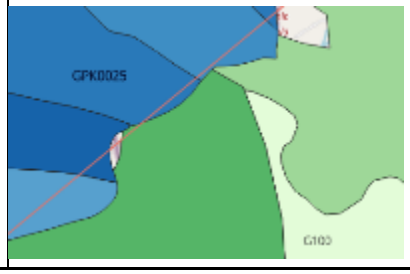
No	GWB in Armenia (pink colors)	GWB in Georgia (blue colors)	
1	6G-12 (east) GW flow direction: **AM→GE**	GPK0026	
2	6G-5 (west) GW flow direction: **GE→AM**	GPK0026	
3	6G-6 GW flow direction: **AM→GE**	GFK0030 (only the border part)	

No	GWB in Armenia (pink colors)	GWB in Georgia (blue colors)	
4	6G-22 (eastern part) Will be clarified. Might not be relevant. GW flow direction: **AM→GE**	GKK0032 Only the border part on the eastern side.	
5	Corresponding GWB in the Alaverdi area will be clarified. GW flow direction: **AM→GE**	GKK0032 North of Alaverdi area.	
6	6G-12 GW flow direction: **AM→GE**	GPK0024 Southern part is linked with AM and the other part with AZ	

Georgia and Azerbaijan

The following four transboundary connections of national GWBs were identified between the Alazani-Iori and the Khrami-Debed RBDs in Georgia and the Kura-Araz RBD in Azerbaijan. One GWB in the Alazani-Iori and four GWBs in the Khrami-Debed of Georgia are transboundary linked with 4 GWBs in the Kura-Araz RBD of Azerbaijan. In addition to these connections, it was clarified for further national GWBs touching the country border, that there is no transboundary interlinkage.

Table 7: Transboundary GWBs between Georgia and Azerbaijan.

No	GWB in Azerbaijan	GWB in Georgia	
	Kura-Araz RBD	Alazani-Iori RBD	
1	G101 GW flow direction: NE→SW (to GE) but in the South it feeds the river and moves parallel to the river	GPA0003 GW flow direction: In the North: NW→SE (to AZ)	
	Kura-Araz RBD	Khrami-Debed RBD	
2	G400	GPK0024, GPK0025	
3	G600	GPK0025, GPK0026, GKK0032	
4	G100	GPK0025	

3.5.2. Transboundary monitoring

Georgia - Armenia

Four GWBs in Georgia are transboundary connected with four GWBs in Armenia. For the joint groundwater survey in October 2023 the GWBs 6G-12 within the Northern RBD of Armenia and GWB GPK0024 within the Eastern part of Khrami-Debed RBD in Georgia were selected. In total 4 monitoring sites have been jointly selected, two wells in Armenia and 2 springs in Georgia. (see Figure 8)

Figure 8: Joint groundwater survey between Georgia and Armenia

Georgia - Azerbaijan

Five GWBs in Georgia are transboundary connected with four GWBs in Azerbaijan.

For the joint groundwater survey in October 2023 the GWBs GPA0003 within the Alazani-Iori RBD in Georgia and G101 in the Kura-Araz RBD of Azerbaijan were selected. In total 13 monitoring sites have been jointly selected, seven wells in Azerbaijan and six wells in Georgia. (see Figure 9)

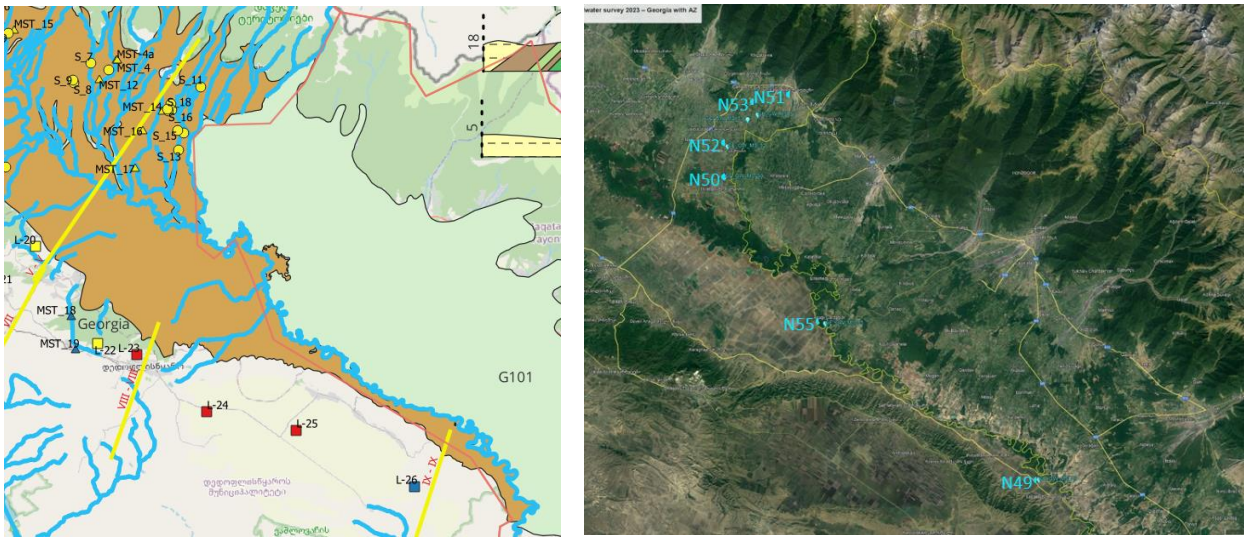


Figure 9: Georgian monitoring sites for the planned joint groundwater survey with Azerbaijan

4. Support provided by EUWI+ and EU4WD (2018–2024)

4.1. Infrastructure and equipment

The investment in infrastructure and equipment happened during EUWI+ project as follows:

- The technical checking of 30 monitoring sites;
- Purchase of modern sampling (data loggers) and on-site monitoring equipment;
- Some consumables (test strips, syringes and filters) for onsite measurements during groundwater surveys.

4.2. Trainings

The groundwater training aimed at covering all important steps of groundwater monitoring and assessment, starting from the general principles of the WFD, the identification, delineation and characterisation of GWBs, the identification of transboundary GWBs with neighbouring countries, the pressure and impact (risk) assessment, designing WFD compliant monitoring, quality assured monitoring (sampling, field measurements), transboundary coordination to trainings in the field of GWB chemical and quantitative status assessment, status and trend assessment.

EUWI+ and EU4WD provided know-how and country experiences, guidelines, feedback on sampling procedures (witness audit), manuals and templates to be used for quality assured sampling campaigns, which were adapted to the country needs and administrative setup.

All trainings, except for transboundary harmonisation of field measurements, were arranged nationally with a focus at the Alazani-Iori, Khrami-Debed, Enguri and Rioni RBDs to allow for focusing at the national/basin-specific aspects and needs and to enhance the development of tailored solutions for the local implementation of the WFD and the development of the Alazani-Iori, Khrami-Debed, Enguri and Rioni RBMPs.

It was continuously emphasised that monitoring is not an isolated activity for itself but it is key in targeted and effective groundwater governance and management. The following figure underlines the importance of monitoring as part of the groundwater management cycle and the importance of gathering targeted, reliable, quality assured and timely monitoring data as the foundation of taking informed decisions and response.

The focus of the trainings was groundwater chemical monitoring. Groundwater quantity monitoring has a far longer tradition in Georgia and the knowledge and the capacities are more advanced than for chemical monitoring.

Since the approach followed in EUWI+ and EU4WD aimed at strengthening national and local capacities via cooperation rather than providing technical assistance, the main goal of the trainings was to strongly involve the responsible national and local experts and stipulate active participation. A sub-regional survey was organised and intended to enhance the transboundary cooperation of monitoring experts between Georgia and Armenia. The training concept was based on joint efforts of international consultants and national experts.

The steps of the water management cycle were subsequently covered and reiterated at different workshops/trainings of national and local experts in terms of:

- GWB identification, delineation and characterisation, pressures and impacts (= risk) assessment
- Groundwater monitoring design (network, frequency, parameters)
- Theoretical and practical groundwater sampling training, methods and field measurements, quality assurance and quality control aspects, witness audit and sampling certification;
- Surveys (preparation, survey manual, implementation, documentation);
- Data checking and interpretation, status assessment;
- Transboundary cooperation

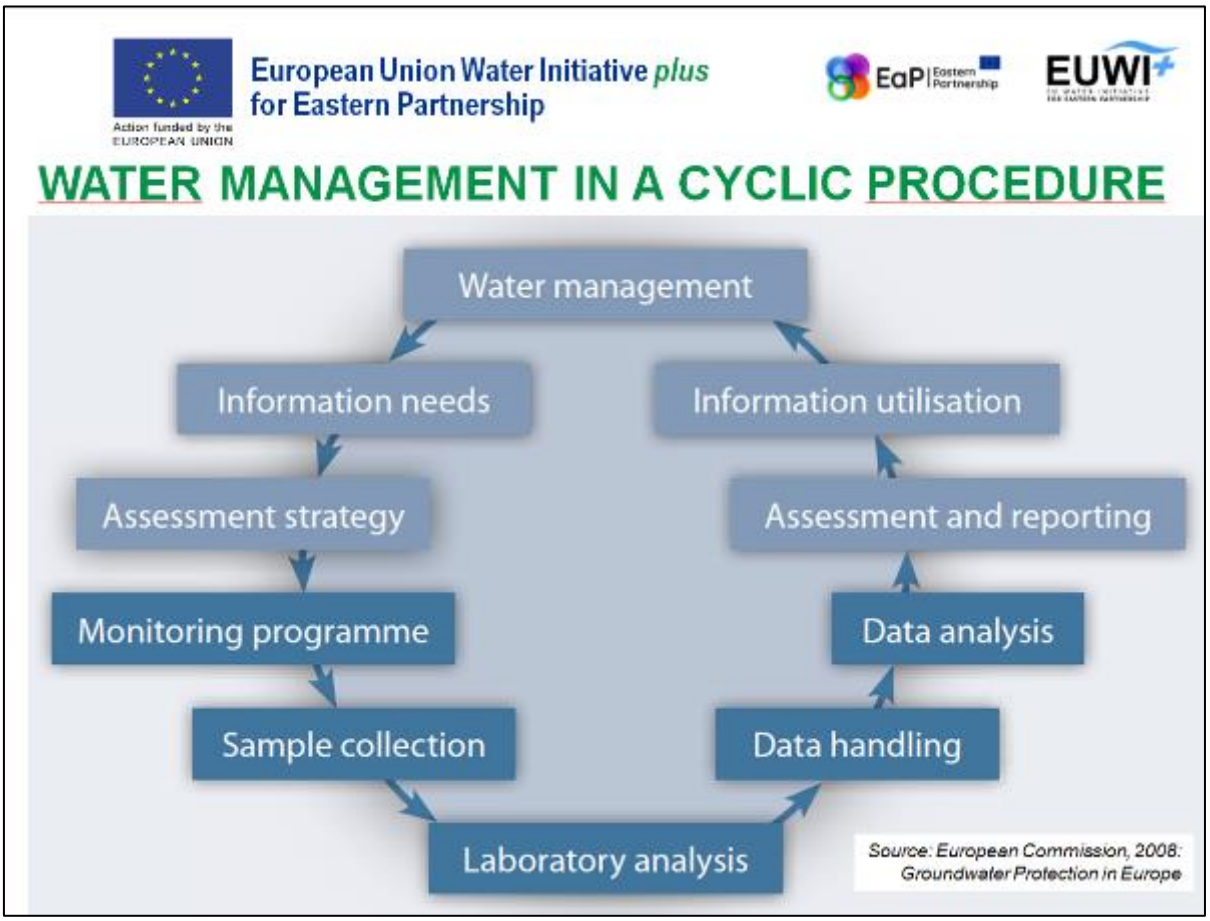


Figure 10: The water management cycle (EC 2008).

The following Table 8 summarises all training events that were provided by the EUWI+ and EU4WD groundwater experts during the operative project period of 2018–2024. The table lists the training events in chronological order. The scope of training activities was usually national, to ensure targeted discussions to the needs in Georgia. The competence profile outlines the competence of trained participants after the training, based on the previously defined training targets.

Comprehensive training material was prepared and provided including workshop presentations, EU guidance documents, Austrian guidance documents, a Specific Manual for Surveys in Groundwater and a specific GW survey manual template to be used and completed for each individual survey.

It should be considered that at the end of EUWI+ and beginning of EU4WD the Covid crisis suspended all travels and personal meetings, hence, personal trainings were no longer possible in that time.

Table 8: EUWI+ and EU4WD groundwater trainings in Georgia between 2018 and 2024.

Time	Activity / Training	Competence profiles	Training targets	Partici-pants (♀ / ♂)
2018 Q2	Workshop on GWB identification and delineation	• Principal understanding of the WFD, their approach, the implementation steps and the role of GWBs. • Understanding of subsidiary principle in the implementation of the WFD and the need for developing tailored, national approaches.	• Gathering information from national experts about GW management in Georgia. • Presentations of UBA experts on the WFD principles of GWB delineation and characterisation with focus on the tasks and deliverables of the contract for GWB delineation. • Discussion of examples from EU Member States and EU guidance documents. • Hands-on exercise in GWB delineation.	**12** 3 / 9
2018 Q2	Workshop on GWB monitoring	• Principal understanding of the WFD principles and approach, the implementation steps, the role of monitoring and their design. • Understanding of subsidiary principle in the implementation of the WFD and the need for developing tailored, national approaches.	• Gathering information from national experts about GW monitoring in the Alazani-Iori and Khrami-Debed River Basin Districts in Georgia. • Presentations of UBA experts on the WFD principles of GWB surveillance and operational monitoring with focus on the tasks and deliverables of the contract for GWB monitoring design. • Discussion of examples from EU Member States and EU guidance documents. • Hands-on exercise in GWB monitoring design.	**12** 3 / 9
2018 Q4	Theoretical and practical training on GW sampling. Preparation of GW manual and survey	• Understanding of the role of monitoring in GW management. • Awareness for quality assurance and quality control in field measurements, GW sampling, sample stabilisation and transport. • Practical handling of equipment and check. • Importance of careful survey planning, possible mistakes in sampling and consequences.	• Theoretical training in survey planning, handling and treatment of field equipment, coordination with the laboratory, sample treatment and conservation, documentation. • Practical sampling training in the field. • Discussion of experiences and need for equipment. • Careful preparation of a GW survey. Preparation of a survey manual and discussion of deliverables of the contracted survey.	**13** 4 / 9

Time	Activity / Training	Competence profiles	Training targets	Partici-pants (♀ / ♂)
2018 Q4	Worksop on WFD Pressure and Impact analysis	• To understand and master the first steps of River Basin Management Plan development • To coordinate the on-going contracts about Alazani/Iori and Khrami-debed (delineation, characterisation and RBMP)	• Brief presentation of Water Framework Directive and RBMP process with illustrations from French and Austrian RBMPs (successive steps, maps, charts) • Presentation/discussion on available concepts and methodologies about pressures-impacts analysis: • Discussion about thresholds for the identified pressures	**24** 12 / 12
2022 Q3	Workshop on GWB delineation and data interpretation	• Principal understanding of the WFD and the role of GWBs • Handling with monitoring data	• Discussion of current GWB delineation in Khrami-Debed and Alazani-Iori RBDs • Simple monitoring data quality checks and data interpretation	**11** 4/7
2023 Q1	Workshop on bilateral coordination of transboundary GWBs with Armenia	• Principal understanding of the WFD, the role of GWBs and the need for transboundary coordination	• Joint agreement on transboundary GWBs • Brief characterisation • Selection of monitoring sites for joint GW survey	**16** 6/10
2023 Q1	Workshop on bilateral coordination of transboundary GWBs with Azerbaijan	• Principal understanding of the WFD, the role of GWBs and the need for transboundary coordination	• Joint agreement on transboundary GWBs • Brief characterisation • Selection of monitoring sites for joint GW survey	**15** 6/9
2023 Q2	Workshop on certified sampling, theory and practise.	• Practical experience in GW sampling. • Practical handling of equipment and check.	• Sampling according to ISO standards. • Awareness of importance of QA/QC in all aspects of GW sampling. • Sampling mistakes and consequences. • Certification of sampling.	**7** 3/4
2023 Q2	Workshop on GWB status assessment.	• Principal understanding of the WFD and the role of GWB status assessment	• WFD needs of GWB status assessment. • Discussion of methodologies for the assessment of chemical and quantitative status of GWB.	**14** 8/6
2023 Q2	Workshop on GWB delineation	• Principal understanding of the WFD and the role of GWBs	• Discussion of current GWB delineation in Khrami-Debed and Alazani-Iori RBDs and potential need for revision.	**10** 4/6
2023 Q4	Joint GW survey with Armenia and with witness audit	• Practical experience in GW sampling. • Practical handling of equipment and check.	• Harmonisation of sampling technics. • Feedback on sampling procedures and proposals for improvement.	**10** 1/9
2023 Q4	Workshop on GWB delineation	• Principal • understanding of the WFD and the role of GWBs	• Discussion of GWB delineation in Enguri and Rioni RBDs and hands-on revision.	**6** 2/4
2024 Q1	GW survey at AZ border with witness audit	• Practical experience in GW sampling. • Practical handling of equipment and check.	• Feedback on sampling procedures and proposals for improvement.	**4** -/4

5. Status quo of groundwater monitoring

Following Table 9 indicates briefly the status quo of WFD compliant groundwater monitoring and the associated aspects in Georgia and the accomplished steps so far.

Groundwater monitoring is not an isolated activity by itself but has to be seen in a wider context. WFD compliant monitoring has to provide evidence whether certain objectives are achieved (status, trends), to provide information about the significance of various pressures and impacts to establish appropriate measures, and it has to demonstrate the effectiveness of measures implemented during active groundwater management.

This overview allows for planning the next steps towards establishing a comprehensive and really WFD compliant monitoring system.

Table 9: Status quo and requirement towards WFD groundwater monitoring.

	Steps		Chorokhi-Ajaristskali RBD	Alazani-Iori and Khrami-Debed RBDs	Enguri and Rioni RBDs	Kura RBD
1	Delineate GWBs [A, B]		Completed during EPIRB	Completed during EUWI+, revision needed	Completed during EU4WD, revision needed	needed
2	Characterise GWBs [A, B]		Incomplete	Completed during EUWI+, revision needed	Completed during EU4WD, revision needed	needed
3	Pressure/impact (Risk) assessment for GWB [B]		Completed during EPIRB	Completed during EUWI+, revision needed	Completed during EU4WD, revision needed	needed
4	Quantity monitoring	Legal basis	In line with WFD			
		Operative budget	Seems guaranteed			
		Network density	A review per GWB is needed, after GWB revision			
		Practical implementation	In line with legal requirements			
5	Chemical monitoring	Legal basis	Needs small amendments (parameters, frequency)			
		Operative budget	Not fully guaranteed			
		Network density [D]	A review per GWB is needed, after GWB revision			
		Practical implementation	In line with legal requirements			
6	Sampling	Training [C]	Completed during EUWI+ and EU4WD			
		Certification	Completed during EU4WD			
		Equipment	Seems sufficient			
7	Data management		Started during EUWI+			
8	Set GW threshold values		Still needed			
9	Natural GW background levels		Still needed			
10	Status and trend assessment	Introduction	Accomplished under EU4WD			
		Establish methods	Still needed			
		Perform assessment	Still needed			

EUWI+ and EU4WD deliverables: *(A) Delineation report, (B) RBMP, (C) GW survey manual, (D) Monitoring network reports*

6. Outlook and proposal for further development and capacity building

Within the assessment of the current status of groundwater bodies and groundwater monitoring and the description of improvements provided by EUWI+ and EU4WD in the previous chapters, gaps have been highlighted and proposals for further improvement of groundwater monitoring are given, in the following sub-chapters.

6.1. Groundwater bodies

- It is recommended to delineate GWBs in the remaining Kura RBD with the same approach (GWB as management unit) that was finally applied in Enguri and Rioni RBDs.
- When the currently existing RBMPs are reviewed and updated, it is recommended to:
  - Apply the uniform GWB coding system, which was proposed in 2024, to all GWBs of Georgia.
  - Review the currently delineated GWBs in the Chorokhi-Ajaristskali, Alazani-Iori and Khrami-Debed RBDs and potentially revise them in a way as the GWBs were finally delineated in the Enguri and Rioni RDB, where focus was put on the GWB as a management unit and less to reflect the aquifer types. Check whether the GWBs completely fit for the purpose of optimal management of groundwater resources. If the situation is not completely satisfactory, do not hesitate to re-delineate, merge or divide the GWBs.
  - Potentially split the large GWBs (in particular the groups of GWBs) into smaller GWBs, where the pressure situation is not uniform, to allow for more targeted management.
  - Be aware, that a GWB can only be assigned to only one individual RBD. If this is not possible or practical, then split this GWB.
  - If GWBs are split, grouped or significantly re-delineated, discard the existing GWB codes and assign new codes for the new GWBs. This allows for better traceability and avoids making wrong conclusions when comparing results over time.
  - Repeat the characterisation and risk assessment after updating the human pressure data.
- Identify and characterize jointly all GWBs which are transboundary linked with all neighbors.

6.2. Groundwater monitoring design

6.2.1. Monitoring network

The current GW monitoring design is not fully in line with the requirements of the WFD. The introduction of GWBs as new GW management units causes the need for network review and adaptation to achieve representative spatial distribution of sites. The WFD CIS guidance 18 recommends a minimum number of three monitoring sites for homogenous hydrogeological condition.

The following improvement activities are recommended:

- After revision of the GWBs in Chorokhi-Ajaristskali, Alazani-Iori and the Khrami-Debed RBDs, assign each existing monitoring site to exactly one GWB (in particular essential for overlaying GWBs).
- Assess for each individual GWB (of all RBDs) the existing monitoring network on its representative-ness in terms of hydrogeology, spatial coverage and the distribution of existing anthropogenic pressures. Perform the assessment for both aspects separately – for GW quantity and GW quality.
- Check existing monitoring sites, which fit to a representative network, on their technical status in terms of accessibility and allowing for quality assured sampling and field measurements and allowing for delivering reliable and representative monitoring data.
- Continue the refurbishment of suitable sites.
- Finally, frequently revisit and maintain wells/springs and passports.
- In case both existing monitoring networks (quantity and chemical) are not sufficient:
  - Check whether existing wells/springs are available and appropriate for inclusion into a representative network. Inclusion of existing is more cost efficient than drilling new wells.
  - When using already existing wells or springs, which are owned and already monitored by other organisations or owners, it is recommended to develop standard rules and contracts, to guarantee long-term access to the wells and/or to the data.
  - Don’t forget to assign a monitoring network also to the shallow GWBs, which are often used to meet private drinking water needs, often in remote areas.

As recommended by respective EU CIS guidance documents, the GW monitoring network should also include wells, springs and points for measuring surface water levels during the dry period as well as waterlogged territories and lakes that are essentially dependent on GW.

- Identify / establish monitoring sites for the transboundary GWBs which should be subject of joint monitoring and mutual data exchange
- Sign the recently (2024) finalized bilateral agreement for joint monitoring and data exchange with Armenia and elaborate similar agreements with other neighbors (Azerbaijan, Turkey).

6.2.2. Monitoring parameters and frequency

Groundwater quantity monitoring

The WFD requests at least one measurement per year. The 33 monitoring sites in the Alazani-Iori RBD and the 2 monitoring sites in the Khrami-Debed RBD are equipped with automatic data logging

equipment. This equipment continuously records and transmits several key quantitative and qualitative parameters (water flow, water temperature, pH, electric conductivity, total dissolved solids - TDS).

The current efforts in gradually installing electronic sensors and automatic data loggers offer the possibility of easily gathering monitoring data of higher timely resolution.

Nevertheless, it should carefully be evaluated whether increased frequency of monitoring data always contributes to better conceptual understanding of the groundwater, in particular this might not be the case for deep and slowly reacting GWBs. Sometimes the financial resources should be better invested in enhanced chemical monitoring.

Groundwater chemical monitoring

According to the legal requirements, the current frequency of water sampling and chemical analyses is twice per year. The list of substances covers basic parameters.

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

Starting at the current state of GW chemical monitoring in Georgia, the following aspects need to be considered when amending the existing approach (parameters and frequency) towards WFD compliance:

- the need of data to establish comprehensive conceptual understandings of the GWBs;
- the need of data for the establishing natural background levels;
- the need of sufficient data (time series) to perform trend assessments;
- the tiered and risk-based approach of the WFD (surveillance and operational monitoring). It is recommended to implement a higher monitoring frequency for surveillance monitoring (screening of the pollution situation at different seasons of the year). Operational monitoring can be implemented at a lower frequency once the variability of pollutants is identified;
- the need of wider parameter screening in the form of surveillance monitoring every 6 years to validate the risk assessment by e.g.:
  - Identify those pesticides that are used/sold in Georgia in high volumes or most toxic.
  - Identify the dangerous substances linked to the anthropogenic activities (e.g. industry, mining, storage, etc.) which were identified within the risk assessment.
  - Consider isotope screening to enable age dating of groundwater.

6.2.3. Monitoring equipment

- Purchase necessary equipment according to the list of deficiencies resulting from the inventory. Foresee back-up equipment.
- Purchase all necessary consumables (e.g. filters, stabilizers, calibration standards, batteries or gasoline for pumps) for sampling, stabilization and cooling of samples.
- Check the sampling and field measurement equipment regularly. Calibrate the equipment according to the manuals.

6.3. Data assessment

To turn the monitoring data into usable information for decision-making, structured methods that aggregate chemical and quantitative monitoring data into reliable assessments of chemical and quantitative status and risk of not to achieve good status, still need to be developed, taking regard of the specifications laid down in the WFD.

- Routinely check monitoring data with simple geo-statistical tools (e.g. ion balance, Pipe-Furtak diagrams) and interpret the data in the light of the hydrogeological characteristics of the GWB.
- Develop national methods for the chemical and quantitative status assessment and for trend assessment, once time series are sufficiently long.

6.4. Personnel and responsibilities

- Assign sufficient, trained and well-paid staff responsible for groundwater sampling.
- Provide regular sampling training to the staff.
- Nominate an institute and personnel that is responsible for training sampling personnel.
- Establish a national working group on groundwater that brings together the main national expertise in groundwater management (institutes, university and regional administration) to communicate and discuss approaches about the implementation of the groundwater related aspects of the WFD.

6.5. Costs, budget

Improvement and maintenance of monitoring capacities needs a sufficient one-time budget to cover the investment costs and sufficient long-term guaranteed permanent budget to coverage maintenance of infrastructure and equipment and operational costs. The assessment exercise revealed that the available budgets for groundwater monitoring seem sufficient and long term guaranteed.

6.6. Proposed trainings

In continuation of the work stipulated by EUWI+ and EU4WD it is recommended to support the successful implementation of the Association Agreement and its roadmap and improvement of the GW monitoring capacities throughout the whole country by follow-up trainings and workshops. The following table provides a rough overview of ideas for trainings which should be arranged in the coming years.

Table 10: Groundwater Training plan Georgia after 2024

Activity / Training	Competence profiles	Training targets
Follow-up hands-on training on the development of a tailored WFD assessment methodology for risk, status and trends – for GW quantity and chemistry	• Ability to applying different methods of data aggregation and interpretation of the results. • Ability to judge the methods used by different countries and to conclude on most appropriate national approaches	• Common discussion of the current proposals of (aggregating and) analysing monitoring data and in concluding on the status. • Main emphasis on GWBs with only few data. • Discussion and interpretation of the testing results of different approaches. • Development of an national approaches
Follow-up coordination meeting(s) on transboundary GWB delineation and harmonisation with neighbouring countries (AZ, AZ, TR)	• Understanding of scope and role of transboundary coordination. • Bilateral harmonisation of GWB boundaries and monitoring networks	• Bilateral exchange of approaches for GWB delineation and monitoring design by GW experts from neighbouring countries. Exchange of GIS data and information. • Discussion of the tasks for the identification of common transboundary aquifers/GWBs and common monitoring sites.
Follow-up coordination meetings on transboundary GW monitoring with neighbouring countries.	• Experience in the delineation of transboundary GWBs and the design of groundwater monitoring networks. • Experience in bilateral discussions	• Common discussion and harmonisation of transboundary GW monitoring networks.
Follow-up preparation of joint transboundary groundwater monitoring campaigns with neighbouring countries	• Experience in GW monitoring and in the preparation of surveys.	• Joint design of the monitoring campaign. • Joint elaboration of GW survey manuals, coordination with laboratories, organisation of logistics, equipment etc. • Clearance of transboundary challenges (travelling, border crossing etc.)
Refresh witness audit of GW sampling.	• Solutions for questions raised during routine sampling work. • Awareness for QA/QC in field measurements, GW sampling, sample stabilisation and transport. • Practical handling of equipment and check.	• Refresher training in survey planning, handling and treatment of field equipment, coordination with the laboratory, sample treatment and conservation, documentation. • Witness-check of practical sampling in the field. • Discussion of experiences and need for equipment.

7. Technical reports/ EUWI+ and EU4WD References

EU4WD products

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2. EU4WD 2024: Rioni River Basin Management Plan. Draft.
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5. EU4WD 2024: Groundwater transboundary survey report 2023 (Armenia-Georgia);
6. EU4WD 2024: Transboundary groundwater body report – Armenia-Georgia
7. EU4WD 2024: Transboundary groundwater body report – Azerbaijan-Georgia
8. EU4WD 2023: Transboundary groundwater bodies. Armenia–Georgia.
9. EU4WD 2023: Audit report: Groundwater sampling – Georgia
10. EU4WD 2023: Groundwater survey report 2022 (in Rioni RBD);

EUWI+ products

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12. EUWI+ 2020: Khrami Debed River Basin Management Plan. Draft available.
13. EUWI+ 2020: Geophysical survey of boreholes in the Alazani-Iori district, Georgia
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14. EUWI+ 2020: Strategic Environmental Assessment (SEA) of the draft Alazani-Iori River basin management plan.
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18. EUWI+ 2020: General manual for Chemical Freshwater Sampling.
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20. EUWI+ 2019: Groundwater survey 2019.
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21. EUWI+ 2019: Support in the delineation and characterization of groundwater bodies and the design of a groundwater monitoring network in the Alazani-Iori River Basin Districts in Georgia
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24. EPIRB 2016: The Chorokhi-Ajaristskali River Basin Management Plan.

Legislation and Guidance documents

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