Current status and future challenges of fresh groundwater assessment in Georgia

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Fig. 1. Overview map of study area – Georgia

Overview of fresh groundwater resources and monitoring

Groundwater assessment can be considered a base and effective management tool to protect groundwater resources. Fresh groundwater assessment is a multi-component system that is different for each country and depends on existing anthropogenic pressures or ongoing natural processes. However, the key and necessary for all countries is to have groundwater quantitative and qualitative data. These data are essential for groundwater resource assessment and management. Our goal is to review the main issues that reflect the current status of fresh groundwater assessment and management in Georgia and the future challenges that the country must gradually overcome.

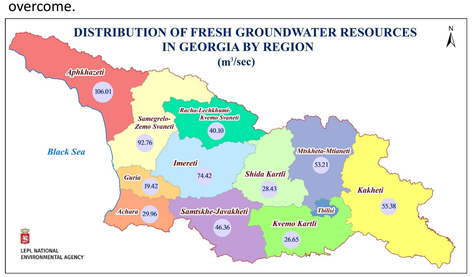


Fig. 2. Fresh groundwater resources of Georgia

- In Georgia, detailed hydrogeological surveys (which had been carried out before early 1990's) have determined that natural fresh groundwater resources amount is **573 m³/sec** and that water has the highest quality;
- Fresh groundwater resources have rather uneven **hydrogeological** and **administrative** distribution: **63% - 363 m³/sec** is formed in western Georgia; **24% - 137 m³/sec -** in Eastern Georgia; **13% - 73 m³/sec -** in southern Georgia.

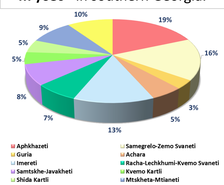


Fig. 3. Percentage distribution of fresh groundwater resources in Georgia by regions

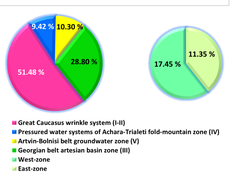
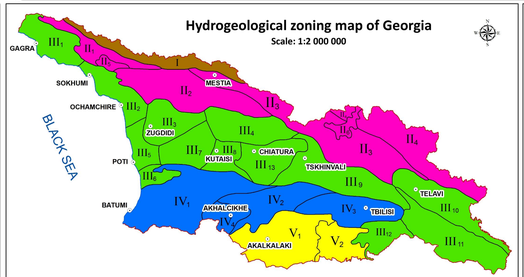


Fig. 4. Hydrogeological distribution of fresh groundwater resources



Hydrogeological region		Hydrogeological district	
I	Great Caucasus Cristal Substrate groundwater zone		
II	Pressured Water System Zone of Great Caucasus Southern Slope	II_1	Abkhazian fractured pressured water system
		II_2	Svanetian crack pressured water system
		II_3	Mestia-Tianeti fractured and fractured/karstic pressured systems
		II_4	Kazbegi-Mtatusheti fractured pressured system
		II_5	Crack groundwater district of Kelasuri crystal massive
		II_6	Fractured groundwater district of Keli-Kazbegi lava formations
III	Georgian belt Artesian basin zone	III_1	Fractured and fractured/karstic artezian basin of Bzipi
		III_2	Porus, fractured and fractured/karstic artezian basin of Kodori
		III_3	Fractured and fractured/karstic artezian basin of Samegrelo
		III_4	Fractured and fractured/karstic artezian basin of Racha-Lechkhumi
		III_5	Porus, fractured and fractured/karstic artezian basin of Kolkheti
		III_6	Porus and fractured water artezian basin of Guria
		III_7	Porus, fractured and fractured/karstic artezian basin of Tskalyubo
		III_8	Porus, fractured and fractured/karstic artezian basin of Argveti
		III_9	Porus, fractured and fractured/karstic artezian basin of Kartli
		III_{10}	Porus, fractured and fractured/karstic artezian basin of Alazani
		III_{11}	Porus and fractured water artezian basin of Iori-Shiraki
		III_{12}	Porus and fractured water artezian basin of Marneuli-Gardabani
		III_{13}	Fractured and fractured/karstic artezian water basin of Dzirula crystal massive
IV	Pressured water systems of Adjara-Trialeti fold mountain zone	IV_1	Fractured pressured water system of Ajara-Imereti
		IV_2	Fractured and fractured/karstic pressured water system of Trialeti
		IV_3	Fractured and fractured/karstic pressured water system of Tbilisi
		IV_4	Fractured water artezian system basin of Akhaltsikhe
V	Artvini-Bolnisi belt Groundwater zone	V_1	Fractured water system district of Akhalkalaki lava sheet
		V_2	Javakheti East slope fractured ground water district

Fig. 5. Hydrogeological zoning map of Georgia

Although the study of fresh groundwater resources has a long history in our country, there are currently many challenges for sustainable groundwater management. This is caused by several factors, of which it's worth noting:

- Since the beginning of the 1990s, the monitoring of observed waterpoints has been discontinued;
- Since then-until now, uncontrolled drilling of boreholes to obtain fresh drinking water;
- The oldness of the technical condition of existing wells;
- The lack of information on groundwater quality and quantity in aquifers;
- The termination of updating hydrogeological maps and the absence of historical materials in digital format.

In addition to the above topics, there is a lack of qualified personnel, which is especially felt after the renewal of hydrogeological monitoring by the Geology Department of the LEPL National Environmental Agency.

Restoration of the fresh groundwater monitoring network

Despite the above and even in conditions of small resources, it became possible, and in recent years, the foundation was laid for the gradual elimination of existing challenges, such important activities as:

- Renewal of fresh drinking groundwater monitoring, expanding the national monitoring network every year with state efforts and the support of donor organizations; Annually, with the support of the state and donors, the expansion of the national monitoring network;

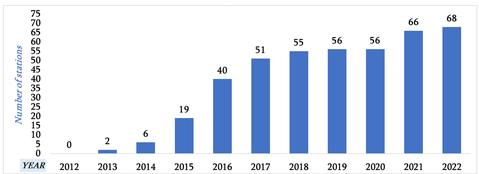


Fig. 6. Number of fresh groundwater monitoring stations in 2013-2022

- Implementation of online monitoring methodology (remote monitoring of groundwater is carried out by automatic and instrumental stations).

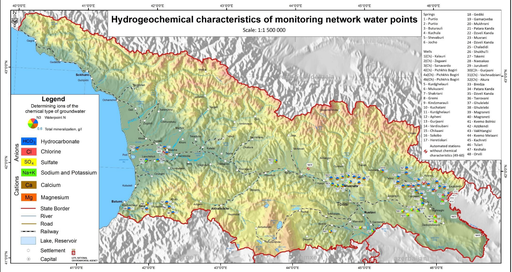


Fig. 7. Fresh groundwater monitoring network in Georgia

- Each well is equipped with a monitoring station, which uses sensors and dataloggers to perform continuous automatic monitoring of main quantitative and qualitative parameters of groundwater regimes;
- Monitoring of springs is carried out by electronic sensors and data collector ,,Levelogger".

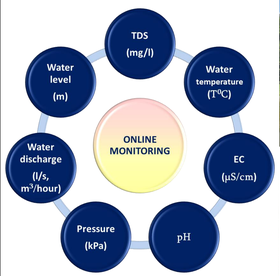


Fig. 8. Water regime parameters received during online monitoring

Fig. 9. Automatic station

Fig. 10. Instrumental station

Online monitoring results in 2015-2023 (at one of the stations)

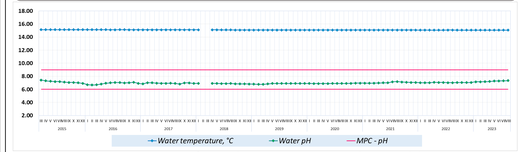


Fig. 11. Dynamic of groundwater temperature and PH variability

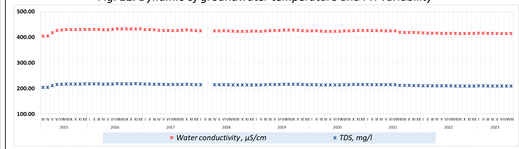


Fig. 12. Dynamic of groundwater conductivity and total dissolved solids variability

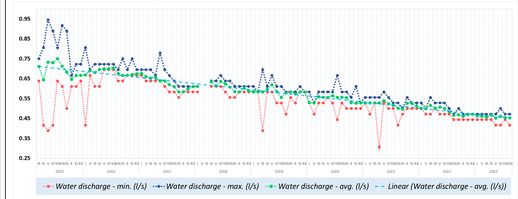


Fig. 13. Dynamic of groundwater discharge variability

Twice a year water samples are taken for laboratory analysis from water points of the monitoring network. Laboratory analysis include:

- *Chemical analysis (among them, nitrogenous compounds);*
- *Bacteriological analysis;*
- *Heavy metals analysis;*
- *Pesticides analysis;*
- *Total petroleum hydrocarbons analysis*.

Fig. 14-16. Field sampling

Availability of data on qualitative and quantitative groundwater monitoring results

In 2021, Department of Geology (NEA) published Informational hydrogeological report - **,,Assessment of quantitative and qualitative characteristics of Fresh drinking groundwater resources of Georgia (analysis of the current situation, forecast and recommendations)"** The report was sent to all interested organizations - the scientific community and water management policy implementing agencies. Also available on the website of the LEPL National Environment Agency: https://nea.gov.ge/Ge/Departments/Geology/Biulettins

Within the framework of state monitoring, the following was implemented and is ongoing:

- Field sampling and preliminary hydrogeological field survey for selection of relevant monitored waterpoints;
- Groundwater sampling according to the EU Water Framework Directive;
- Search and systematization of historical materials;
- Beginning delineation of groundwater bodies;
- Beginning transboundary groundwater survey;
- On the basis of the new law „On Water Resources Management", which was approved by the Parliament of Georgia on June 30, 2023, the resolution of the Government of Georgia is being prepared with the relevant technical regulations: „State registration of drilling wells for the purpose of extracting fresh drinking groundwater".

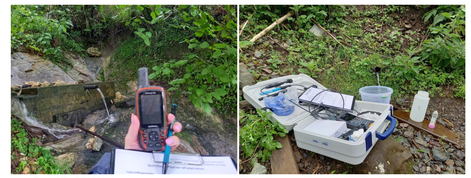


Fig. 17, 18. Waterpoint inventory and field data sampling process (to improve the fresh groundwater monitoring network)

- The mentioned works allowed the country to participate in the appropriate periodic reporting of the progress of the UN sustainable development goals (SDGs) and in the step-by-step implementation of the Georgia-EU Association Agreement.

Fig. 19, 20. State monitoring network boreholes: Groundwater monitoring is especially important where borehole water is used for drinking

In 2023, in the Department of Geology of the LEPL National Environmental Agency, a new structural unit - Hydrogeological Monitoring and Technical Maintenance Division, was created. The goal is to expand and improve the activities listed above by introducing modern methodologies. Accordingly, the issue of providing staff resources with appropriate qualifications is on the agenda, which requires effective solutions and activities, including in the educational direction.

Future challenges and planned activities:

- In order to appropriately assess and forecast qualitative and quantitative characteristics of groundwater aquifers, it's necessary to expand the groundwater monitoring network;
- State control of groundwater water well drilling and abstraction;
- Based on information of monitoring water points, daily data received from automated monitoring, results of chemical analysis and historical materials (Maps, Catalogues, Cross-sections, etc.) it is necessary to create a hydrogeological database. The database should also contain information about newly drilled wells, licensed water points and groundwater abstraction. For this purpose, it is important to develop a prototype groundwater database;
- The main challenges must be solved with the active participation of all relevant agencies;
- It's important to introduce a groundwater modeling system, to make it possible to quantitative assessment and forecasting of groundwater (including using climate scenarios), pollution control and forecasting.

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