# PERSPECTIVE OF USING GROUNDWATER IN THE GANIKH-AYRICHAY FOOTHILLS

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**Abstract**

*Most of the qualitative groundwater resources of Azerbaijan are concentrated in the Ganikh-Ayrichay foothills. As a result of research conducted in this area, it was revealed that the Ganikh-Ayrichay foothills has great prospects for water supply in Baku. According to earlier hydrogeological studies in Ganikh-Ayrichay foothills, widespread sources on the plains are associated with rocks of the fourth period, with gravel and various old rocks. Sources associated with the cliffs of the fourth period, are associated with groundwater rivers.*
*Groundwater areas in the plains are mainly formed under the influence of natural and artificial factors. The role of natural factors in the plain is one of the main factors. Their area of great influence is surrounded by the foothills. The role of river cones and natural hydrological factors near them in the formation of the hydrodynamic regime of underground water should be emphasized. Drinking groundwater in the study area is widespread.*

**Keywords:** Greater Caucasus Mountains, water supply, hydrodynamic regime, aquifer, percent of mineralization, Ganikh-Ayrichay foothills, natural hazards, climate change

## I. İntroduction

In recent times, the demand for drinking water has increased due to global climate change. Climate change is causing problems in many areas, one of which is the reduction of drinking water. The risks of a decrease in water resources due to warming in the Greater Caucasus Mountains in Azerbaijan are also increasing (Fig. 1). The risk of a sharp decrease in drinking water is considered one of the biggest problems in the current period. In order to create a sustainable system, there is a need for integrated management of water resources.

In the eastern part of the Ganikh-Ayrichay foothill plain, it is surrounded by Dashakhilchay from the west, Bumchay, Zaglichay from the east, the southern slopes of the Greater Caucasus Mountains from the north, the Acinohur heights from the south and in the north-west of the South Caspian basin. The length of the working area is 40 km, the width is 15 km, and the area is 600 km$^2$.

The Ganikh-Ayrichay foothills is very rich in underground water due to the accumulation of thick water-permeable sediments, the presence of numerous rivers and the fall of large amounts of atmospheric sediments. Groundwater is collected here in undecomposed continental sediments. They are formed due to infiltration of atmospheric sediments and surface water (rivers, irrigation canals) and condensation of water vapors in the aeration zone. The waters of the underground water streams of the Great Caucasus's bedrock and river valleys are also of great importance in this respect. The presence of a graben-like structure is characteristic for the flow cones of rivers. As a result, a single aqueous complex consisting of coarse-grained rocks is divided into soil and

several pressure-aqueous horizons with a clay and clay layer that increases in thickness towards the south [1,2].

The groundwater horizon is found everywhere in the area. The depth of the soil mirror is 0.5-1.0 m in the wedge zone, 70-90 m in the south of the valley. The direction of groundwater flow is from northeast to southwest. The inclination of the ground water table corresponds to the inclination of the relief and varies from 0.05 to 0.003. The thickness of the horizon is 4.6-328.5 m. The maximum value is marked at the top of the cones. The groundwater horizon is partially drained by springs. Their consumption is 0.4-20.0 l/s. In the borders of the Ganikh-Ayrichay foothills, springs are mainly found in the wedge zones, on the border of the bearing cones and inter-cone depressions, in the valleys of Ganikh and Ayrichay [3].

Consumption of wells crossing the groundwater horizon is 0.1-33.5 l/s, specific consumption is 0.1-13.6 l/s.m. The percolation coefficient of the desiccating rocks varies from 0.2 to 35.5 m/day, the permeability varies from 8.64 to 3900 m²/day. The permeability of the horizon is 3.32x103-8.5x104 m²/day. Groundwater in all areas is sweet, mineralization is 0.6 g/l. The chemical composition of the water is mainly calcium carbonate [4,5].

The average annual variation amplitude of groundwater level in Zagatala region is 2.98 m, and the average monthly variation amplitude is 3.07 m.

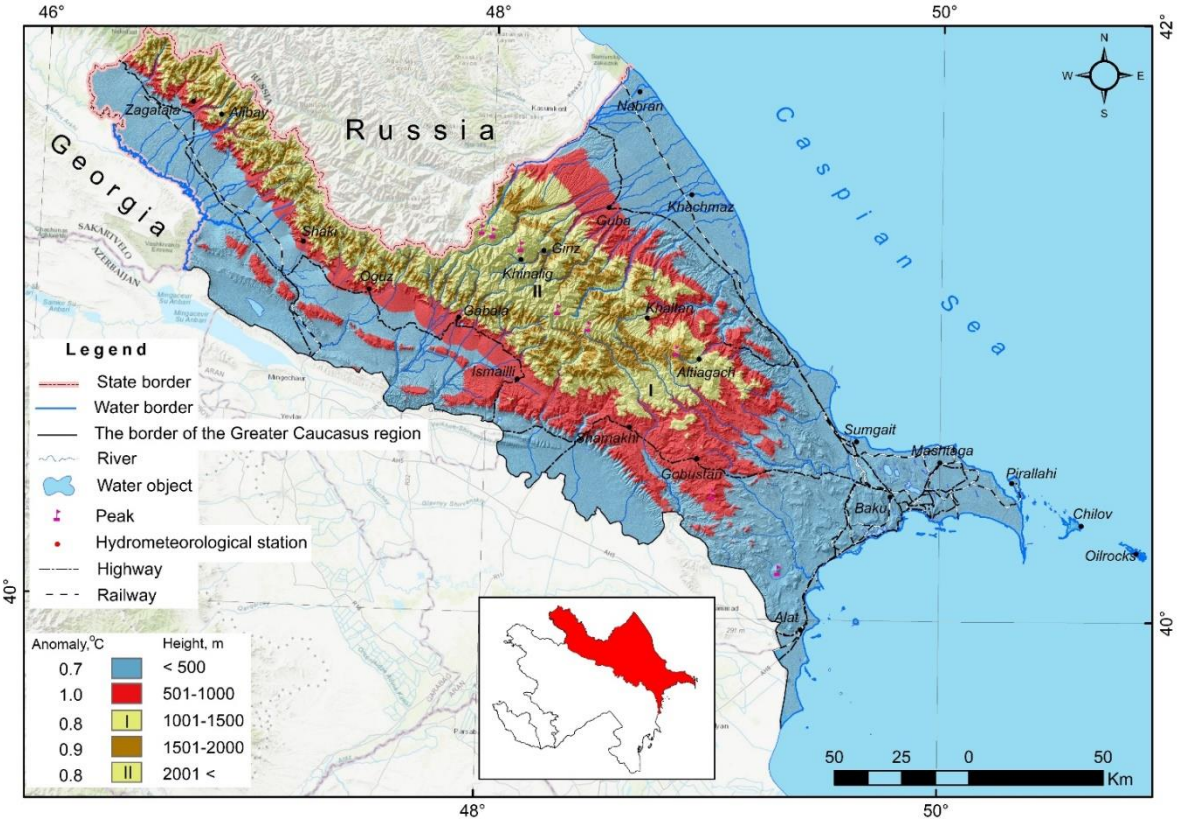


**Fig. 1:** *Air Temperature anomaly by altitude zones (1991-2020)*

A pressurized water horizon consisting of several water layers up to 350 m depth was registered in the area. A pressurized aquifer is found everywhere below the wedge zone. The sedimentary rocks consist of gravels and gravels with sand and sand-silt filler [6].

The ceiling of the pressurized water horizon was opened at depths of 4.0-177 m through wells. In most parts of the territory, the horizon lies at a depth of 30-40 m. The piezometric level is 71.0 m below the ground surface and at a height of (+35 m). The inclination of the piezometric level is 0.05-0.0025 m according to the terrain. The truncated thickness of the horizon varies from

9.5 to 319 m. The layer separating the soil and pressure water horizons consists of clays and gravelly sediments with clay filler. Their thickness is 5-30 m, sometimes 45 m [7].

Consumption of wells cutting the pressurized water horizon is 0.2-40 l/s, specific consumption is 0.1-10.5 l/s.m. varies between The seepage coefficient of desiccating rocks is 0.1-45.1 m/day, the permeability coefficient is 6-17, sometimes 55 $m^2$/day. The piezoconductivity coefficient varies from 3.9x104 to 1.35x107 $m^2$/day. Pressurized waters are sweet, mineralization is 0.1-0.6 g/l, chemical composition is calcium carbonate, sometimes calcium carbonate-chlorine [8,9,10].

The regime of changes in the level of the pressurized water horizon is closely related to the regime of changes in the level of groundwater. The average monthly change amplitude of the piezometric level is 0.84-0.86 m, the average annual change amplitude is 0.53-1.32 m, the average monthly change amplitude of well consumption is 0.71-1.06 l/s, and the average annual change amplitude is It is 0.44-0.49 l/s.

The amount of microelements found in underground water is within the limit of allowable norms.

## II. Methods

The physico-chemical composition of water samples taken from existing water wells and springs in the Ganikh-Ayrichay valley was studied. Based on the obtained results, the chemical composition of underground water was expressed by the Kurlov formula and interpreted. So, ground and pressure waters of the plain have practically similar chemical composition. The total mineralization rate of pressurized water does not exceed 0.5-0.7 g/l. These waters are mainly hydrocarbonate and mixed cation content (Fig. 2.).

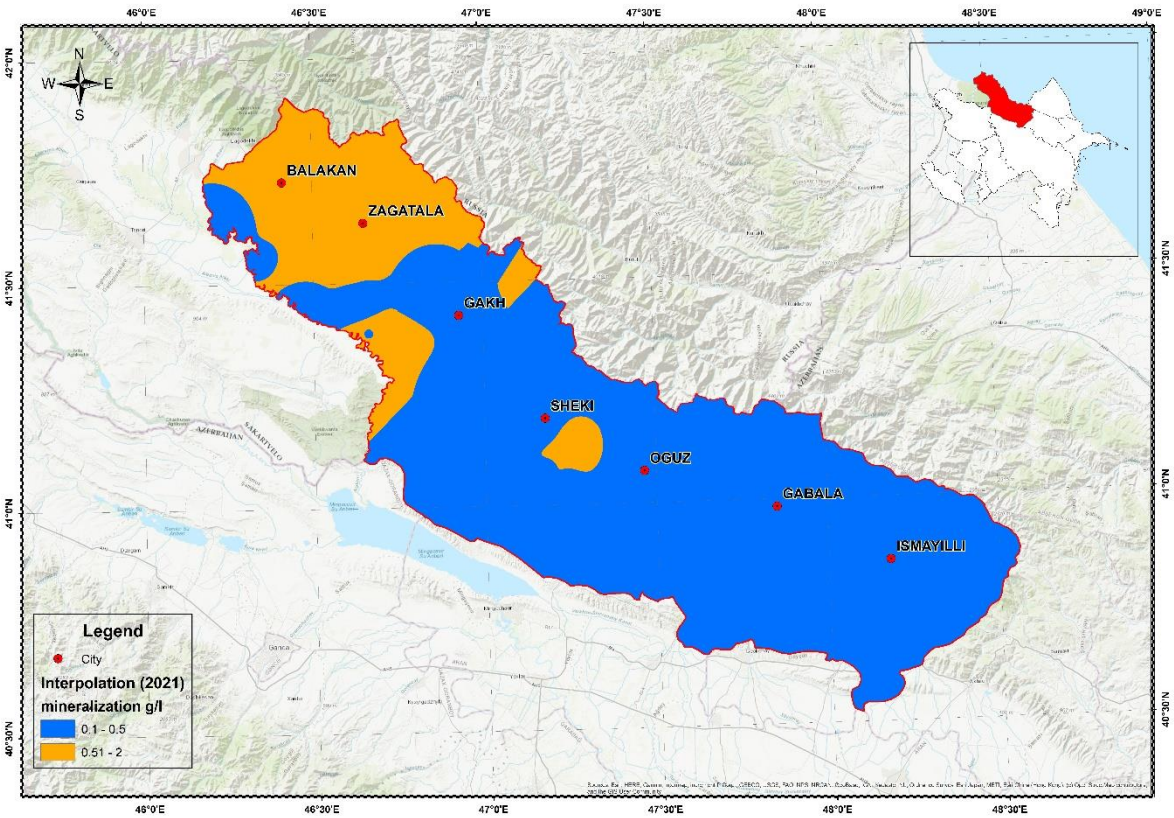


**Fig. 2:** *Map of the degree of mineralization of groundwater in the Ganikh-Ayrichay valley*

Hydro-chemical regimes of pressurized waters in the region are distinguished by their stability over many years. The temperature of pressurized water varies between 11.0-16.5 $^0$C. The

annual amplitude is 3.5-4.5 $^0$C. The minimum temperature is recorded in March-April, and the maximum temperature is recorded in September-October. The temperature of groundwater varies from 10-12 $^0$C to 15-16 $^0$C, depending on their depth. The annual amplitude of groundwater temperature is 4-5 $^0$C in areas located in irrigated areas with a depth of 1.0-3.0 m, and in areas with a depth of 30-40 meters, the annual amplitude of groundwater temperature varies around 0.5-1.5 $^0$C (table 1).

The role of atmospheric sediments in the formation of their annual and multi-year regimes is more pronounced in the observation points located directly in the groundwater feeding zone in the territory of Oguz region. In recent years, the depth of groundwater level in these observation points varies between 15.0-20.0 m, 35.0-40.0 m. In the annual section, their closer lying on the ground surface was recorded in April-May, when the snow melts and spring rains increase, and their deeper lying in August-September.

**Table 1:** *Some well data on groundwater in the Ganikh-Ayrichay valley*

| No | Research stations, No. | Location of research stations | Depth of wells, m | Groundwater $\frac{\text{level (m)}}{\text{consumption (l/s)}}$ | Groundwater temperature, ($^o$ C) | Chemical composition of water (by Kurlov's formula) |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 5 | 7 | 8 | 9 |
| 1 | 113 | Ititala village, Balakan district, opposite Goshabulag | 20,0 | $\frac{0,55}{x}$ | 15.0 | $M_{0.3}\frac{HCO_3\ 52{,}1\ SO_4\ 43{,}7}{(Na+K)\ 82{,}7Ca\ 11{,}2}$ |
| 2 | 114 | Lahic village, Zagatala region, garden yard | 120,0 | $\frac{x}{0,32}$ | 15.0 | $M_{0.5}\frac{HCO_3\ 63{,}3\ SO_4\ 32{,}4}{(Na+K)77{,}0\ Ca\ 12{,}7\ Mg10{,}3}$ |
| 3 | 114a | The center of Layj village, Zagatala region | 12,0 | $\frac{2,63}{x}$ | 15.5 | $M_{0.6}\frac{HCO_3\ 63{,}8\ SO_4\ 27{,}7}{Mg55{,}3Ca28{,}7(Na+K)\ 16{,}3}$ |
| 4 | B-262 | Naib spring, southeast of Danachi village, Zagatala region | – | $\frac{x}{0,43}$ | 14.0 | $M_{0.4}\frac{HCO_3\ 52{,}4\ SO_4\ 46{,}4}{Ca50{,}8\ (Na+K)\ 41{,}6}$ |
| 5 | 7/1 | Kharabtala village, Gakh region, entrance of the forest | 200,0 | $\frac{x}{0,50}$ | 16.0 | $M_{0.4}\frac{HCO_3\ 65{,}3\ SO_4\ 31{,}5}{(Na+K)\ 87{,}0}$ |
| 6 | 18/18 | Gulluk village, Gakh district | 20,0 | $\frac{16,26}{x}$ | 15.5 | $M_{0.5}\frac{HCO_3\ 71{,}4\ SO_4\ 25{,}7}{Ca\ 52{,}3(Na+K)\ 42{,}1}$ |
| 7 | 29 | Gulluk village, Gakh district | 40,0 | $\frac{x}{0,30}$ | 15.5 | $M_{0.6}\frac{HCO_3\ 66{,}2\ SO_4\ 30{,}0}{(Na+K)\ 83{,}0Ca\ 12{,}6}$ |
| 8 | 52 | Gulluk village, Gakh district | 120,0 | $\frac{17,17}{x}$ | 16.0 | $M_{0.6}\frac{HCO_3\ 68{,}9\ SO_4\ 28{,}3}{Ca\ 55{,}3(Na+K)\ 26{,}6Mg18{,}1}$ |
| 9 | 55 | Gulluk village, Gakh district | 70,0 | $\frac{0.04}{x}$ | 16.0 | $M_{0.5}\frac{HCO_3\ 67{,}5\ SO_4\ 26{,}9}{(Na+K)\ 41{,}1Ca\ 37{,}6Mg\ 21{,}3}$ |
| 10 | 116 | Gakh region, Kipchak village, hospital yard | 120,0 | $\frac{+0,27}{x}$ | 15.0 | $M_{0.5}\frac{HCO_3\ 60{,}3\ SO_4\ 37{,}9}{(Na+K)\ 60{,}6,Ca\ 31{,}3}$ |
| 11 | B-401 | Gakh district, Ilisu road, Amin spring | – | $\frac{x}{1,25}$ | 16.0 | $M_{0.4}\frac{HCO_3\ 59{,}9\ SO_4\ 38{,}3}{(Na+K)\ 56{,}4Ca34{,}0}$ |

In the foothill region, observation points located directly in the upper parts of the flow cones of the Alijan and Damiraparan rivers are in the zone of influence of the hydrological regimes of

the rivers. In the reporting years, the depth of the groundwater level in these observation points varied from 69.0 to 92.0 meters, and the annual amplitudes were from 0.38 to 2.11 m in these wells.

Irrigation agriculture has developed in the central and southwestern regions of the plain. Surface and underground water are widely used for irrigation. In the reporting years, the average annual depth of the groundwater level in observation points $10^{A}$ and $114^{A}$ located in these areas was in the range of 0.07-0.79 m. The annual amplitude of the level is 0.47-0.60 m, the minimum depth of groundwater is 0.07-0.19 m, even some years it is above the surface of the earth, in spring months in April-June, the maximum depth is 0.65- 1.48 m was recorded in late summer and early autumn, when irrigation works were completed, in August-October.

In the plain, the pressure water horizons and water complexes of the Quaternary period were opened in full thickness by means of hydrogeological exploration wells. In general, pressurized water is widespread throughout the plain.

The depths of the wells studying the regime of pressurized water horizons included in the observation network do not exceed 250-300 meters. Hydrodynamic regimes of pressurized waters are characterized by their relative stability compared to ground waters throughout the plain. The annual change of the amplitude of pressurized water, close to the amplitude of the ground water level, indicates that the source of nutrition and conditions of the soil and pressurized water horizons are the same.

Although there is no noticeable difference in the annual changes in the consumption of pressurized water, in general, the increase in consumption is recorded in the spring-summer season, and the minimum limits are observed at the end of the year. Although the observation points are located in different areas of the plain, a general regularity is observed in the change of their costs. In the reporting years, the average annual consumption of water in wells at these observation points is 0.50-3.00 l/sec, and the annual amplitude change is 0.60-3.50 l/sec. Thus, the average annual consumption in well No. 29 is 1.80-2.20 l/sec, and the annual amplitude change is 1.50-2.00 l/sec.

In the studied areas and in the parts connected with the foothills of the Greater Caucasus, the waters of the groundwater horizon come to the surface in the form of springs. The consumption of springs varies from 0.4 l/s to 300 l/s. The largest springs are located 2.5-3.0 km north of Mollali village of Oguz region. Here, the consumption of springs varies between 285-305 l/s. The most common consumption of springs varies between 10-40 l/s. The groundwater of the Ganikh-Ayrichay foothills spreads along horizons with an absolute height of 380-400 m, coming out in the form of a spring at the foot of the cones of the rivers and in the depressions between the cones. The consumption of springs in these areas varies from 0.1-0.2 l/s to 20-30 l/s.

The spring of ground water to the surface of the earth is spread along horizons with an absolute height of 380-390 m in the areas where the southern edges of the Ganikh-Ayrichay foothills meet with Acinohur. The consumption of the largest springs in these areas reaches 155 l/s. Among such springs, the "Girkhbulag" spring can be mentioned. This spring is located 3 km south of the village of Nich in the area where the northern foot of Acinohur elevation and the valley meet. The area of the spring is 1, 1.5 ha and it consists of many springs. The total consumption of those springs is up to 150 l/s. The consumption of other springs spread here varies from 15-20 l/s to 1-6 l/s. These springs combine to form the Karasu and Sarisu rivers.

Rocks in which groundwater is distributed have great water content. Consumption of wells detecting groundwater varies between 10÷15-45÷50 l/s. The specific consumption in wells varies between 0.6-6.7 l/s.m. The seepage coefficient of water retaining rocks varies between 1.4-31.51 m/day. The permeability of the groundwater horizon varies between 138-7620 $m^2$/day. The coefficient of level transfer in groundwater varies between 3.33x103 - 8.5x104 $m^2$/day.

The degree of mineralization of groundwater in the territory of the Ganikh-Ayrichay foothills varies between 0.2-0.5 g/l and reaches 0.7 g/l in the southern parts of the valley. The type of chemical composition of groundwater is mainly hydrocarbonate-calcium.

The exact description of the chemical composition of groundwater and the degree of mineralization is given in the title "Characteristics of the quality of groundwater". Pressurized

underground water is distributed in the area of the Ganikh-Ayrichay foothills, starting from the zone where the groundwater comes to the surface in the form of a spring, and some areas to the north of it. In this zone, as mentioned above, groundwater and pressurized water create an aquifer that forms a single hydraulic system.

In the areas explored up to a depth of 350 m in the Ganikh-Ayrichay foothills, water retaining layers consisting of several floors were discovered.

## III. Results

Based on the results of the studies, it is known that the hydro-chemical regimes of the groundwater of the plain are characterized by their relative stability. Indicators of general mineralization do not exceed 0.5-0.7 g/l throughout the plain, with the exception of discharge zones. In discharge zones, the total mineralization of groundwater often rises to 1.0-1.3 g/l. According to the hydro-chemical composition, they belong to the hydro-carbonate, sulfate-hydro-carbonate, calcium-magnesium-sodium type.

Groundwater regimes on the plain are formed under the influence of natural and artificial factors. The role of natural factors is the main one on the plain. Their large sphere of influence covers the foothills. Along with the foothill areas, special attention should be paid to the runoff cones of rivers widely developed on the plains, and the role of natural hydrological factors near them in the formation of the hydrodynamic regimes of groundwater.

Conducted studies show that underground water in the Ganikh-Ayrichay foothills is suitable for drinking. Also, there are waters of therapeutic importance in this area.

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