IMPACT OF CLIMATE CHANGE ON THE GROUNDWATER OF THE GANIKH-AYRICHAY FOOTHILLS

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Abstract

Climate change has a negative impact on the water resources of the Republic of Azerbaijan. If we take into account that approximately 70 percent of the water resources of the Republic of Azerbaijan are formed at the expense of transboundary rivers, then the situation becomes even more complicated. According to the generally accepted hydrogeological zoning scheme of the territory of the Republic of Azerbaijan, the Ganikh-Ayrichay artesian basin is a class II artesian basin, included in the composition of the Kura basin. Ganikh-Ayrichay water valley is one of the underground water deposits of Azerbaijan, distinguished by its fresh water resources. Thus, since 2010, 5 m^3 of fresh water per second has been transported from this field to Baku through the water pipeline. In recent years, climate change has had a negative impact on the water resources formed in the Ganikh-Ayrichay foothill plain. Observations on the regime of underground water show that the level and consumption of water in pressurized water wells has decreased.

Keywords: water supply, aquifer, percent of mineralization, Ganikh-Ayrichay foothill plain, climate change

I. İntroduction

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 Great 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 (Fig. 1.).

The following orographic units are distinguished within the boundaries of the research area and adjacent regions: the southern slopes of the Greater Caucasus, the Ganikh-Ayrichay valley and the Acinohur elevation. The absolute height in the drainage part of the southern slopes of the Greater Caucasus along the northern edges of the working area is 3000-3500 m, in the contact areas with the working area it is 700-800 m. The Ganikh-Ayrichay valley is a large orographic unit, a sloping-flat valley depression with a large area. The absolute height of the ground surface along the northern edges of the valley is 400-800 m, and on the southern edges (at the junction of Ganikh and Ayrichay) it is 188 m [1].

The age, lithological and petrographic composition of the rocks distributed in the research area, weathering, transport of the rocks distributed in those areas, etc. is related to Jurassic sediments are widely distributed in the northern part of the research area, in the subducting arch part of the Great Caucasus anticlinorium. Upper Jurassic sediments are mainly developed in this area (Fig. 2). The Upper Leyas (J_1,l) sediments are widely distributed in the watershed of the Great

Caucasus Mountains in the sources of the Philphilichay, Tikanlíchay, and Damiraparanchay rivers. These sediments are widespread in the Duruca anticlinorium extending from Kishchay to Vandamchay, they consist of clayey shales [2].

The Aalen (J_2a) floor is characterized by the Upper Aalen (J_2a_2) sand-clay layer in the studied area. These sediments developed in the upper reaches of Damiraparanchay, Bumchay, Tikanlichay, Philphilichay (southern edge of Leyas sediments flows) and Damiraparanchay, in the arch parts of the anticlinal fold. The thickness of sandstone layers reaches 30-40 m. The thickness of clay shales is 2-3 m.

Upper Aalen sediments form the central axial part of the Duruca anticlinorium. This anticlinorium extends from Shinchay to Vandamchay. Complete cutting of Aalen sediments is observed in the upper reaches of Hamzalichay, Badaldara River (the left tributary of Dashagilchay), Kungutchay and Kishchay. These sediments consist of dark gray, black sheeted clayey shales, sandstone layers.

The middle division (J_2) (Dogger) sediments are distributed in the arch parts of the Duruca anticlinorium in the upper reaches of the Hamzalichay, Badaldara (left branch of Dashagilchay), Chukhadurmaz (left branch of Kishchay) and Shinchay. Sediments consist of Khinalig sandstones, clayey shales, smoothed river pebbles and conglomerates. The total thickness of the layers reaches 200 m [3].

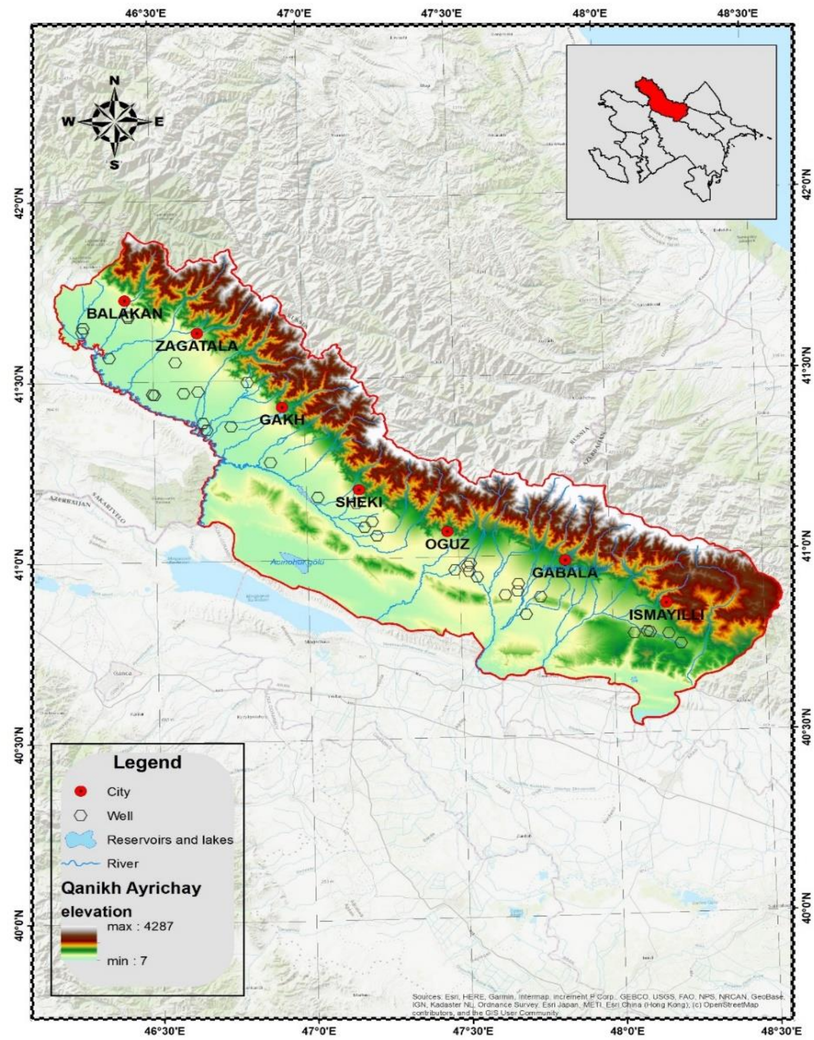

Fig. 1: *Physical map of the Ganikh-Ayrichay foothill plain*

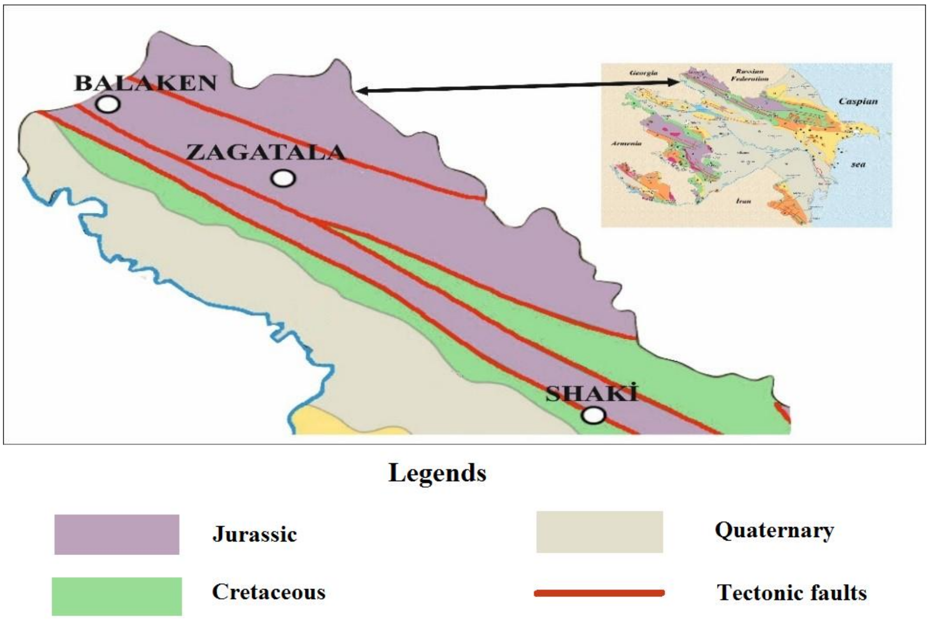

Fig. 2. *Geological map of the study area*

The bedrocks of the rivers flowing from the southern slopes of the Greater Caucasus are mainly composed of well-washed rock fragments of different sizes, smoothed layers of various degrees, and river pebbles. The initial parts of the flow cones are formed in the areas where the rivers leave the foothill zone and consist mainly of different sizes of gravel, large river stones, and a small amount of pebbles. Towards the center of the bearing cones, large-sized cobblestones and pebbles are gradually replaced by relatively small pebbles, sands of various sizes, sands, clays, and a small amount of clays. Since the process of changing the section in this form occurs gradually, sand, clay, and thin-layered clay alternate with sand, gravel, and pebbles of various sizes in the section in the center and skirts of the river cones [7,8,9].

In the Quaternary cross section of the valley, a ribbed structure is present at each of the flow cones of the rivers. In these structures, in the south direction, a single cross-section layer composed of large clastic rocks is divided into several horizons by different clay and clay layers in the south direction. However, although the thickness of siltstones and siltstones ranges from a few cm to 4-5 m, they do not have a regional distribution.

Due to its structural and tectonic structure, the Ganikh-Ayrichay valley is practically a closed basin of underground water [4,5]. It is 15-35 km wide and stretches in the form of a thin strip from north-west to south-east, forming a valley between the Great Caucasus mountain range and Acinohur. This valley is filled with alluvial and alluvial-proluvial sediments of the Quaternary period with great thickness and high permeability. Regionally distributed alluvial-proluvial horizons of the Quaternary period in the valley have a high level of water due to the presence of a large number of rivers passing through the valley, abundant atmospheric precipitation and groundwater from the rivers flowing from the southern slopes of the Greater Caucasus. Groundwater is formed due to percolation of atmospheric sediments, surface water (rivers, irrigation water), condensation of water vapors in the aeration zone, groundwater of rivers and underground flow from parent rocks.

The lithological and granulometric composition of the rocks that make up the valley shows a certain zonation from the foothills to the foothills of the cones of the rivers.

II. Methods

In order to study the impact of climate change on underground water in the Ganikh-Ayrichay valley, the changes of multi-year atmospheric precipitations and the multi-year changes of regime parameters of groundwater were studied (Fig.3).

The climate of the Ganikh-Ayrichay valley is characterized by mild hot summers and dry winters. The Great Caucasus mountain range blocks the Ganikh-Ayrichay valley from the flow of cold air from the north, creating a mild subtropical climate type in its territory. As you go up the slope, the temperate-warm climate type is replaced by a cold climate. The graph of changes in the amount of atmospheric precipitation in recent years is given below.

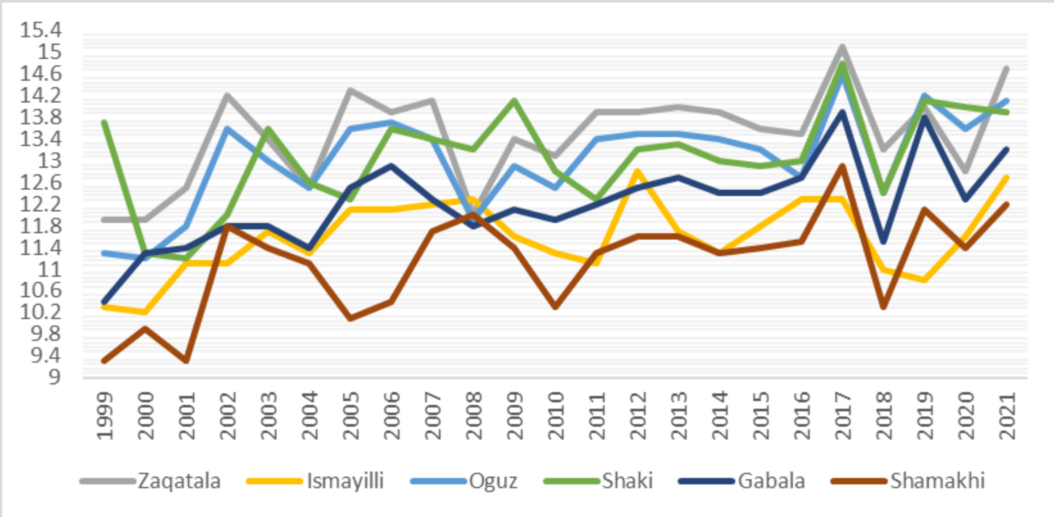

Fig. 3: *Scheme of perennial atmospheric precipitation in the Ganikh-Ayrichay valley*

Ground water horizon is formed as a single underground water horizon in the initial parts of the bearing cones. In the central parts of the bringing cones in the southern direction, the groundwater horizon is divided into several pressurized water horizons with clay and loam layers, as mentioned above. Since clay and clay layers do not have regional development, soil and pressurized water horizons form a single system with a single hydraulic connection.

Groundwater is widespread everywhere in the Ganikh-Ayrichay valley. An accurate description of the underground waters of the Ganikh-Ayrichay valley up to a depth of 300 m has been reflected in a number of research works. Groundwater in the areas where exploratory work is being conducted has been studied based on numerous well data. The depth of the groundwater is fully compatible with the morphological conditions of the area where it is spread. Thus, along the northern edges of the valley, in the upper parts of the flow cones of the rivers, the depth of groundwater is 70-100 m, and in the southern areas, at the foot of the flow cones and in the inter-cone sediments, it varies from a few cm to several meters.

The absolute height of the groundwater level decreases in the south and southwest direction from the foothills of the Greater Caucasus [4,5,6]. The level of non-pressurized water in the Ganikh-Ayrichay valley varies in the range of 0.8-5.9 meters (Fig. 4). According to the relief of the surface of the bearing cones and intercone depressions, the hydroisohypses of groundwater have a wavy shape. The underground water flow is in the south and south-west direction according to the slope of the relief. The slope of the ground water surface corresponds to the relief of the earth's surface and varies from 0.05 to 0.003. The thickness of the groundwater horizon varies from 4.6 m to 328.6 m (up to 400 m depth in the studied areas). The greatest thickness of the groundwater horizon is spread in the head parts of the bringing cones of the rivers.

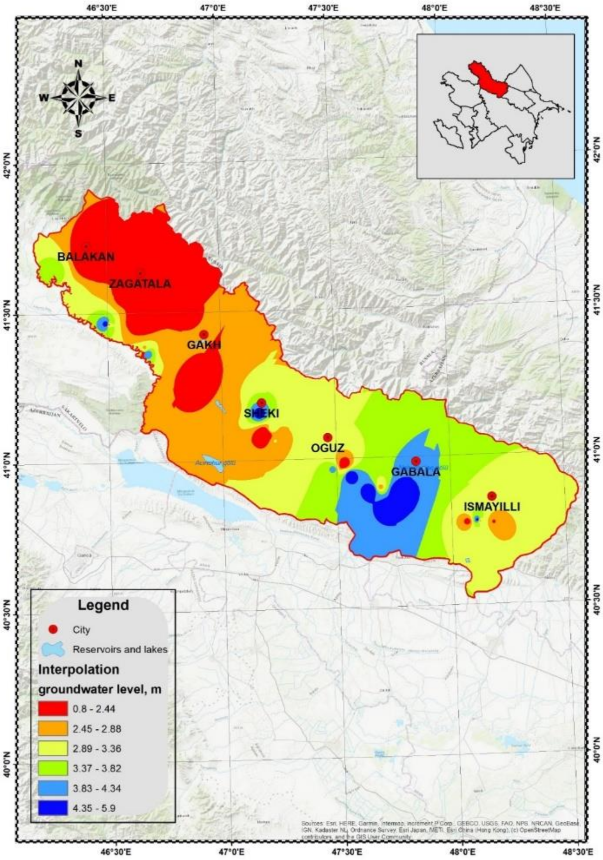

Fig. 4: *Groundwater level in the Ganikh-Ayrichay valley*

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 valley 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 valley meet with Acinohur. The consumption of the largest springs in these areas reaches 150 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 10-20 l/s to 1-5 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 0.6-6.6 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 137-7620 m^2/day. The coefficient of level transfer in groundwater varies between 3.32x103 - 8.5x104 m^2/day.

The degree of mineralization of groundwater in the territory of the Ganikh-Ayrichay valley varies between 0.2-0.4 g/l and reaches 0.6 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 valley, 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 valley, water retaining layers consisting of several floors were discovered.

Pressurized water horizons are spread everywhere in the area, starting from the zone where groundwater appears in the form of a spring, to Acinohur in the south. The sedimentary rocks consist of cobbles, gravels, and occasional cobblestones and cobblestones. Fill rocks consist of sands, siltstones, and silts of various sizes. Pomegranate-grained sands dominate the granulometric composition of the filler rocks [10].

The depth of the ceilings of pressurized water horizons was revealed by means of wells at a depth of 4.0 m to 177 m (Tab 1., Fig.5.). In large parts of the studied areas, ceilings of pressurized water are spread at a depth of 30-40 m. Piezometric levels of pressurized water are located both below the ground surface (up to 71.0 m) and above the ground surface (+35 m). The slope of the surface of the piezometric level corresponds to the slope of the earth's surface. The slope varies from 0.05 to 0.0025.

The detected thicknesses of pressurized waters vary from 9.5 to 319 m. The layers that separate groundwater and pressurized water consist of clays or pebbles and pebbles with clay complement. According to the data of the wells dug during the earlier geological-exploratory works in the territory of the valley, the thickness of the separating layers ranges from 5-10 m to 45 m. However, as mentioned, these separating layers do not have regional development anywhere in the Ganikh-Ayrichay valley.

Most wells drilled for pressurized water are characterized by a large flow fountain. Depending on the lithological composition of the cut in the wells subjected to the mechanical suffosis process, as a result of the strong flow of sand, these wells fail due to subsidence in the area around the well.

The seepage coefficient of rocks in dry rocks ranges from 0.1-45.1 m/day to 70-80 m/day. Water permeability is 17-65 m^2/day in the foothill zone, 12500 m^2/day in the center of Agchay's intake cone, and 1663 m^2/day around the village of Sinjan. The transmission coefficient of the piezometric level varies between 3.9x104- 1.35x107 m^2/day. Pressurized groundwater is sweet everywhere, its mineralization rate is 0.1-0.6 g/l, and its chemical composition is calcium carbonate. The quality indicators of pressurized water are suitable for drinking and household purposes. This is also confirmed by the data of the exploratory well number 2Q dug in 1990-1992 in the north of Nic village. Quaternary sediments in the 0-940 m interval, Quaternary sediments in the 940-1028 m interval - Maykop sediments were discovered through the well.

III. Results

The influence of climate changes in the Ganikh-Ayrichay valley leads to the creation of very complex unique hydrometeorological conditions, including the occurrence of anomalous atmospheric events during the year. Studies conducted on the effects of climate change on the

Ganikh-Ayrichay valley show that the increase in air temperature and evaporation eventually leads to a decrease in water resources. As a result of the decrease in precipitation, water consumption in rivers may decrease or increase. For this, determining the balance of water resources, taking into account climate change, plays a major role.

Table 1: *Parameters of wells drilled into pressurized water horizons in the Ganikh-Ayrichay foothill plain*

No	Administrative region	The number of the well issued by the drilling organization or subsequently	The depth of the well, m	Water horizon			
				Type	Geological age	Lithological composition	heel depth, m
1	Ismailli	19/42	150	pressurized	Q_{I-II}	gravel, sand	150,0
2	Ismailli	19/45	150	pressurized	Q_{I-II}	gravel, sand	150,0
3	Ismailli	19/50	150	pressurized	Q_{I-II}	gravel, sand	150,0
4	Gakh	23/10	125	pressurized	Q_{III-IV}	gravel, sand	125,0
5	Gakh	23/E-11	100	pressurized	Q_{III-IV}	gravel, sand	100,0
6	Gakh	23/67	80	pressurized	Q_{IV}	gravel, sand	80,0
7	Gakh	23/74	70	pressurized	Q_{IV}	gravel, sand	70,0
8	Gakh	23/141	125	pressurized	Q_{III-IV}	gravel, sand	125,0
9	Gakh	KX-4	185	pressurized	Q_{III-IV}	gravel, sand	185,0
10	Gabala	20/B-8	120	pressurized	Q_{III-IV}	gravel, sand	120,0
11	Gabala	20/U-10	120	pressurized	Q_{III-IV}	gravel, sand	120,0
12	Gabala	20/49	120	pressurized	Q_{III-IV}	gravel, sand	120,0
13	Gabala	20/E-4	130	pressurized	Q_{III-IV}	gravel, sand	130,0
14	Oguz	21/43	150	pressurized	Q_{III-IV}	gravel, sand	150,0
15	Oguz	21/64	150	pressurized	Q_{II}	gravel, sand	150,0
16	Oguz	21/80	150	pressurized	Q_{II}	gravel, sand	150,0
17	Shaki	22/65	150	pressurized	Q_{III-IV}	gravel, sand	150,0
18	Shaki	22/71	150	pressurized	Q_{III-IV}	gravel, sand	150,0
19	Shaki	22/75	185	pressurized	Q_{III-IV}	gravel, sand	185,0
20	Shaki	22/153	150	pressurized	Q_{III-IV}	gravel, sand	150,0
21	Zagatala	24/193	60	pressurized	Q_{IV}	gravel, sand	60,0
22	Zagatala	24/213	60	pressurized	Q_{IV}	gravel, sand	60,0
23	Zagatala	24/158	110	pressurized	Q_{III-IV}	gravel, sand	110,0
24	Zagatala	24/201	140	pressurized	Q_{III-IV}	gravel, sand	140,0

As a way out of the problem, it is necessary to use water resources efficiently. After river waters, underground waters take the second place in terms of usage. For this reason, a unified groundwater management system should be created.

Global climate change will lead to disruption of the hydrological regime of water sources, mainly to changes in the quantity and quality of water resources. As a result of climate change, a sharp increase in the degree of water mineralization in the lower parts of the rivers will become inevitable.

Analysis of available meteorological data shows that various natural phenomena, including severe and persistent drought, may occur unexpectedly. In order to be ready for it, the gradual increase of existing water resources, the creation of water-saving, techniques and technologies, the development of new agrotechnical measures and the integrated management of water resources are one of the important conditions.

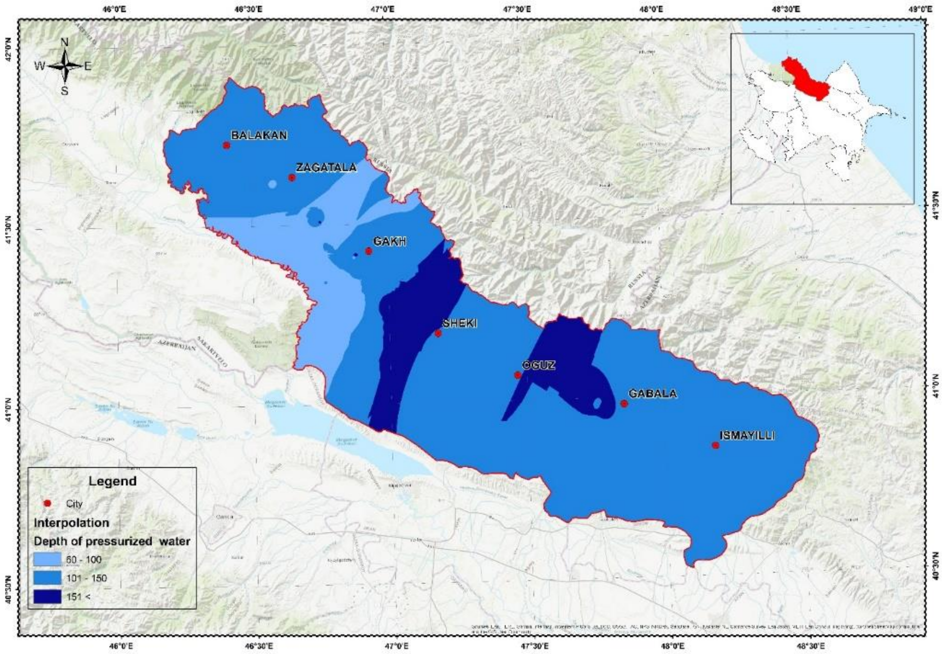

Fig. 5: *Depth map of pressure waters of Ganikh-Ayrichay valley*

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