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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**RESEARCH OF THE INTERACTION BETWEEN SURFACE
AND GROUNDWATER IN THE
OGUZ-GABALA ZONE**

Speciality: 5406.01 – Hydrology

Field of science: Geography

Applicant: **Iftikhar Adil Ayyubov**

Baku – 2025

The work was conducted at the Department of “Land hydrology and water resources” of the Institute of Geography named after Academician Hasan Aliyev, Ministry of Science and Education of the Republic of Azerbaijan.

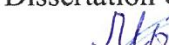
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GENERAL CHARACTERISTIC OF THE WORK

The actuality of the topic and level of research on the subject. In modern times, the intensive development of all sectors of the economy in our republic, population growth and the constant increase in demand for water require a correct assessment of water resources and current changes in their quantitative indicators.

In order to meet the demand for water, potential natural water sources in various regions should be studied and ways to use them efficiently should be scientifically and technically justified.

Currently, the surface and groundwater resources of the Oguz-Gabala region are widely used for water supply and irrigation purposes . Therefore, there is a great need to study the interaction of the surface and groundwater of the region and the impact of anthropogenic factors, as well as climate change.

Taking into account the above, using data from hydrometeorological observation stations in the area, studying the flow regime of surface waters, the interaction of surface and groundwater in the lower and upper parts of the basin, and the efficient use of the area's surface and groundwater resources and their integrated management are of significant scientific and practical importance.

The relevance of the chosen topic from a scientific and practical point of view is determined by the great need to study the interaction of surface and groundwater in the Oguz-Gabala zone under the complex influence of natural and anthropogenic factors.

Object and subject of research. The relevance of the chosen topic from a scientific and practical point of view is determined by the great need to study the interaction of surface and groundwater in the Oguz-Gabala zone under the conditions of the complex influence of natural and anthropogenic factors.

Purpose and objectives of the study. The main aim of the research work is to evaluate the operational efficiency of the water intake facility of the Oguz-Gabala-Baku water pipeline, taking into account the interaction of surface and groundwater in the Oguz-Gabala zone during it consists of studying the hydrological processes that may occur in the basin.

The following tasks were set in the research work to determine the

interaction of surface and groundwater in the Oguz-Gabala zone:

- to analyze the average annual water consumption series of three months using statistical methods;
- assess the impact of modern changes on river flow;
- to investigate the role of surface waters in groundwater recharge;
- identify ways to optimize the feeding regime of the Oguz-Gabala-Baku water pipeline;
- to explore ways to efficiently use surface and groundwater.

Research methods. In order to carry out the research work, in addition to geographical-hydrological, mathematical statistics, hydrological similarity, zonal landscape, comparative analysis and other evaluation methods, experimental research methods were also used. At the same time, in the analysis of primary data, cartographic (AutoCad 2024, Microstation V8i, ArcGIS, SPSS statistic, Stock stat software processing methods) methods were applied to transfer data to the map. During mathematical-statistical calculations in the research work, MS Excell and its Xlstat software processing methods were used. The parameters of the water consumption series Q_{average} , Q_{max} , Q_{min} were calculated using the method of moments.

The main provisions provisions to be defended:

1. To comprehensively analyze the average annual water flow series of rivers using statistical methods;
2. Assessment of the impact of modern changes on river flows; a) the impact of climate change on river flows; b) the impact of anthropogenic factors on river flows;
3. To determine experimentally the recharge of groundwater from surface waters;
4. To identify ways to efficiently use surface and groundwater to optimize the feeding regime of the Oguz-Gabala-Baku water pipeline;
5. To propose empirical formulas that allow for the calculation of groundwater recharge volumes based on atmospheric precipitation and river flow volumes for the study area.

Scientific novelty of the research. As a result of the study of the interaction of surface and groundwater in the Oguz-Gabala zone, the following scientific innovations were obtained:

- The impact of modern changes on the regime characteristics and

annual flow of rivers has been determined;

- The assessment of groundwater in rivers was carried out based on flow measurement studies conducted in the area's rivers and the numerical average of the base flows;

- For the first time, estimates of groundwater recharge from surface waters were made based on two scenarios - climatic indicators of the low-water and mid-water periods;

- Empirical formulas have been proposed for the study area, allowing the calculation of groundwater recharge based on atmospheric precipitation and average multi-year river flow volumes;

- The impact of surface waters on the operational regime of the Oguz-Gabala-Baku water pipeline was assessed;

- In order to prevent environmental problems that may arise as a result of groundwater use, technical proposals have been put forward for the efficient use of river waters.

- Satellite images were analyzed using Google Earth Pro, MicroStation V8i, and AutoCAD 2020 programs, and a schematic map of the rivers was compiled and used in the analysis of experimental studies.

Theoretical and practical significance of the research. The results of the study can be used in the Ministry of Ecology and Natural Resources, the Azerbaijan State Water Resources Agency, scientific research institutes engaged in this field, and in various international and national project works implemented in the country. The results of the study can also be used in the assessment of surface and groundwater and the study of their mutual influence, in the assessment of the impact of natural and anthropogenic factors on the water resources of the territory, and in solving the issues of efficient use of water resources.

Appropriation and application of the research. The main content and results of the research work were presented at scientific forums and conferences held at the international and republican levels: “Caspian International Water Technologies” conference (Baku, 2013), Republican scientific conference dedicated to the 70th anniversary of the Department of “Physical Geography” and the 40th anniversary of the Department of “Hydrometeorology” (Baku, 2013), “II Caspian International Water Technologies” conference (Baku, 2014), “Modern

Problems of Water Use and Its Management in Azerbaijan” scientific-practical conference (Baku, 2015), “ Water Resources, Hydrotechnical Facilities and Environment” scientific-practical conference dedicated to the 100th anniversary of the “Shollar-Baku Water Facilities Complex” (Baku, 2017), “The Development of the Water Sector of Azerbaijan is Connected with the Name of the National Leader Heydar Aliyev” scientific-practical conference (Baku, 2023), "Development of modern science and education: relevant issues, achievements and innovations" X International scientific-practical conference (Penza, 2023), "IX International European Conference on Interdisciplinary Scientific Research" (Valencia, 2024), "Climate change, sustainability and international cooperation conference" (Duzce, 2024), "Khudafar International scientific research conference" (Baku, 2024), Materials of international scientific-practical conference The topic: "Sustainable management of water resources - the basis of the decision of the strategic goal of food safety in the conditions of a changing climate" dedicated to the World Water Day (Dushanbe, 2024), the materials of the 1st Belarusian Geographical Congress for the 90th anniversary of the Faculty of Geography and Geoinformatics of the Belarusian State University and the 70th anniversary of the Belarusian Geographical Society (Minsk, 2024) were reported.

19 scientific articles and 12 conference materials have been published on the topic of the dissertation .

The name of the organization where the dissertation work was implemented. The dissertation work was performed at the Department of “Land Hydrology and Water Resources” of the Institute of Geography named after Academician Hasan Aliyev of the Ministry of Science and Education of the Republic of Azerbaijan.

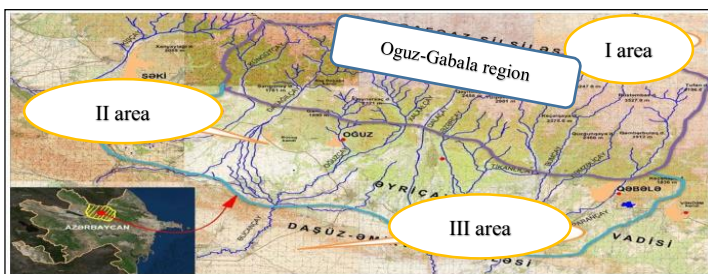
The name of the organization where the dissertation work was implemented. The dissertation work consists of an introduction, 4 chapters, a conclusion and a list of references. The volume of the work includes 37 tables, 23 figures, 22 graphs a list of 134 references and a total volume of 151 computer pages. Introduction – 5 pages, Chapter I – 50 pages, Chapter II – 32 pages, Chapter III – 24 pages, Chapter IV – 20 pages, conclusion – 3 pages, list of references – 14 pages. It consists of 176236 characters without tables, graphs, figures and a list of references.

A BRIEF SUMMARY OF THE DISSERTATION

The **introductory** part presents the relevance and degree of development of the topic, goals and objectives, research methods, main provisions put forward for defense, scientific innovations , theoretical and practical significance of the research, its approval and application. In general, 6 research projects based on 6 rivers were carried out for the implementation of the research work . Data from the hydrological observation station were used.

The first chapter of the dissertation is devoted to **“River flows of the Oguz-Gabala region and the impact of modern changes”**. Here, first of all, the impact of the physical and geographical conditions of Azerbaijan on the formation of river flows in the region is studied. Research in this direction was carried out by S.H. Rustamov (1960), R.M. Qashqai (1978), M.A. Mammadov (1989) and was performed by.

We are researching covers the physical and geographical features of the Ganikh-Ayrichay valley, starting from Dashagilchay in the northwest and ending in Damiraparanchay in the east , between 450 and 800 m of absolute altitude. The rivers of the area include Dashagilchay, Alijanchay, Turyanchay, Tikanlichay, Damiraparanchay and their tributaries (Figure 1) ¹.



Source: Claimant using Microstation Vi8 and satellite map
Compiled by I.A. Eyyubov.

Figure 1. Map of rivers flowing through the Oguz-Gabala region

¹ Eyyubov I.A. The role of the water permeability of the soil cover in the formation of river flow // “Caspian International Water Technologies” conference, – Baku: – 2013 , – pp. 459-466 .

Starting from the low mountains of the Greater Caucasus, the amount of precipitation increases up to a certain altitude. However, as the altitude increases, precipitation begins to decrease after a certain altitude. Thus, the relief of the Oguz-Gabala zone is mountainous, starting from the highlands of the southern slope of the Greater Caucasus in the northern part, covering the east of the Ganikh-Ayrichay valley in the central part, and the upper parts of the Ajinohur frontal highlands in the southern part.

The catchment area of the rivers flowing through the Oguz-Gabala region is characterized by steep slopes, sharp fragmentation of the terrain, deep and narrow valleys, and strong denudation. In the mountainous part, the river basin is narrow and the slopes are steep, so most of the atmospheric precipitation is spent on the formation of surface flows².

In this section of the study, the characteristics of the main elements of the climate (air temperature and atmospheric precipitation) affecting the formation of the river flow are also given based on the observation data of the Sheki, Oguz, Gabala, Goychay and Shamakhi meteorological stations. Atmospheric precipitation is unevenly distributed over the territory. Thus, precipitation falling in the warm period of the year on the southern slopes of the Greater Caucasus constitutes 60-75% of the annual precipitation.

The rivers of the Oguz-Gabala region are mainly formed by the combination of a number of springs and surface waters that form at an altitude of 3000-4000 m in the Greater Caucasus. The rivers of the region belong to the type of rivers with spring floods and autumn floods according to their flow regime. The spring floods begin in late March, early April and continue until May-June. From late June to September, the period of decreasing flow in the rivers begins.

The study conducted a statistical analysis of the average annual water discharge series of the regional rivers, assessed the characteristics of the rivers' feeding sources and water regime, river water use, and also assessed anthropogenic changes in flow.

Based on the average multi-year flow data of the rivers flowing

² Geography of the Republic of Azerbaijan: Physical Geography [Volume I] / ed. RMMammadov. – Baku: Avropa, – 2015. – p. 530.

through the Oguz-Gabala region, genetic and statistical analyses were conducted using statistical methods . The calculation of the coefficients of variation and asymmetry of the determined flow rates was carried out using the “Stok Stak” program and the method of moments. The average annual water discharge data of the rivers used in the study covers the observation period from 1960 to 2017. The homogeneity of all series was assessed using the Student and Fisher criteria. The asymmetry coefficient of the flow at individual hydrometeorological stations in the rivers flowing through the region ranged between 0.15-1.63, and the mean square error of the flow rates ranged between 3.6-4.3%. The coefficient of variation of the average annual water discharge series in the analyzed rivers is less than 0.37.

To assess the modern changes in the flow of rivers in the study area, statistical, water balance and comparative methods were mainly used. River flows Scientific and methodological literature sources were also used during the analysis and research.

Most of the hydrological stations on the rivers of the Oguz-Gabala region are located in the transition zone from mountainous areas to foothills and have natural flow. In the rivers studied, 60-70% of the annual water flow occurs in the spring-summer season, and up to 30-40% in the autumn-winter season it happens ³.

The assessment of flow changes in the rivers flowing through the area was performed for the average annual flow. The values of the flow rate of the area's rivers for the years 1960-1990 were compared with the values of the flow rate for the years 1991-2017 (table 1)⁴.

³ Eyyubov I.A. Analysis of the hydrological regime characteristics of the rivers of the Oguz-Gabala region // – Baku: Water problems , science and technologies, – 2016. No. 3 , – p. 47-57.

⁴Eyyubov I.A. Assessment of modern changes in the flow of rivers in the Oghuz and Gabala regions // – Baku: Water Problems , – 2023 . No. 2 (22) . – pp. 85-97.

Table 1

Annual flow in the main rivers in the Oguz-Gabala regions
distribution (during 1961-2017)

Rivers and of the station name	1960-1990 average over the years perennial water consumption, m ³ /s	1991-2017 average over the years perennial water consumption, m ³ /s	Comparison with the second period, Q, m ³ /s	Comparison with the second period, Q, %
	First period	Second period		
Dashagilchay-Baş Dashag v.	3.02	2.98	-0.04	-1.3
Alijanchay-Gayabashi v.	6.12	5.56	-0.56	-9.2
Turyanchay-Su junction m	7.65	8.74	+1.09	14.2
Tikanlıchay-Tikanlı v.	3.40	3.45	+0.05	1.5
Damiraparanchay-Gabala c.	5.10	6.15	+1.05	20.6
Goychay - Buynuz v.	8.58	9.02	+0.44	5.1

Source : Compiled by the applicant I.A. Ayyubov based on archival data of the National Hydrometeorological Service.

The analyses conducted show that, compared to the flow rate of the rivers in the study area in 1960-1990, there were slight changes in the flow rate values for 1991-2017. The largest increase was observed in the annual flow rate values of Demirparanchay and Turyanchay. Although the annual flow of the Damiraparan River has increased, the summer flow has decreased.

Compared to the flow rate of 1960-1991, the flow rate of the Damiraparanchay River increased by 20.6% or 1.05 m³/s in 1991-2017, and the flow rate of the Turyanchay River increased by 14.2% or 1.09 m³/s. This can be explained by the geographical conditions of the river basin, relief, vegetation cover, etc. factors ⁵.

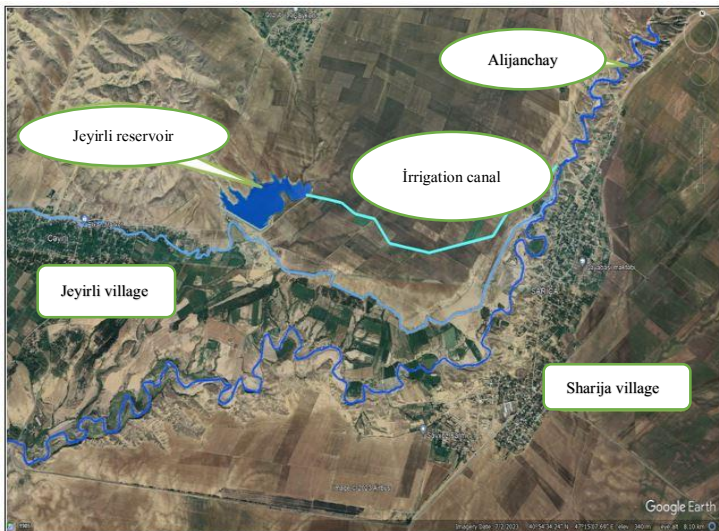
A slight negative trend decrease for the flow series of the rivers was recorded in Dashağılchay and Alijanchay. Although the decrease in the average annual flow rate of Dashağılchay is 1.3% or 0.04 m³/s,

⁵ Eyyubov I.A. Changes in the monthly and seasonal flow of rivers in Azerbaijan (Oguz-Gabala district) // - Almaty : Geography and water resources , - 2023. No. 4 , - p . 3-13 .

it is not a large amount and can be explained by the precipitation falling in the basin .

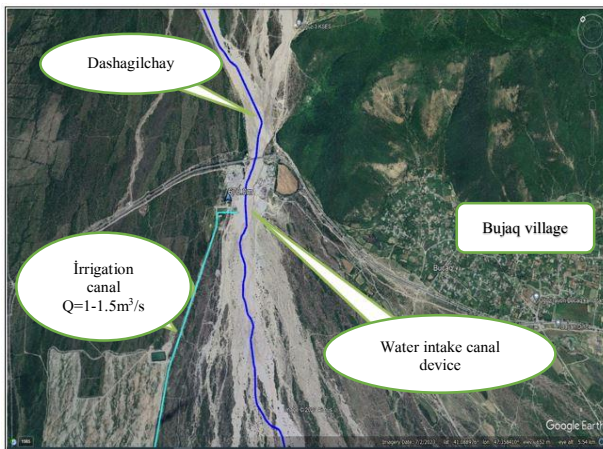
The decrease in the average annual flow rate of the Alijanchay River can be explained by the increase in the use of the river's water for agricultural purposes. The decrease in the average annual flow rate in the river was 9.2% or 0.56 m³/s. During the vegetation period, the flow of the Alijanchay River is widely used for irrigation. Q=1.5 m³/s of water is taken from the river to fill the arable land and the Jeyirli reservoir.

The decrease in the average annual flow rate of the Dashağılchay can be explained by the increase in the volume of use of the river flow for water management purposes. The intake facility of the river is located near the village of Bucag, and the Dahna irrigation canal was built from there Q=1.0-1.5m³/s of water is taken from the Dashağılchay for irrigation of a number of villages of the Sheki region (Figure 3). For this reason, during the vegetation period of plants, the flow of the Dashağılchay is used more for irrigation.



Source: Compiled by the claimant I.A. Ayyubov using Google Earth Pro and Micrystation Vi8 and satellite map.

Figure 2. Schematic plan of the Alijanchay-Gayabashi settlement

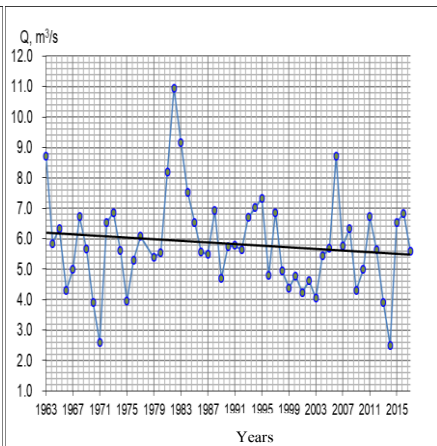
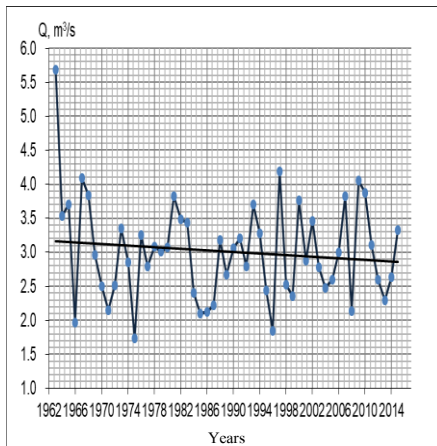


Source: Compiled by the claimant I.A. Ayyubov using Google Earth Pro and Micristation Vi8 and satellite map.

Figure 3. Schematic plan of Dashağılchay near Bucag village

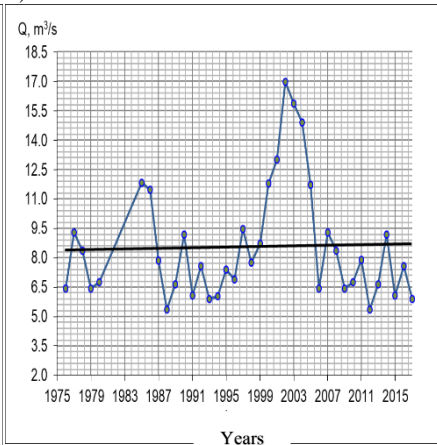
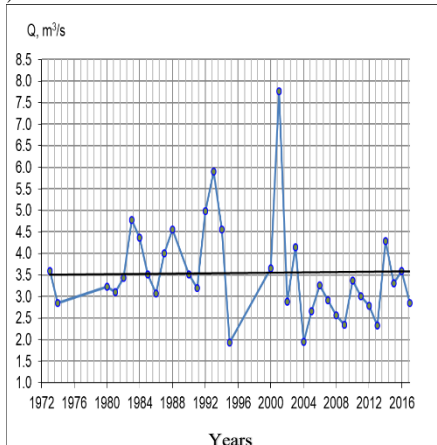
On the contrary, a positive trend increase was recorded for the average annual water discharge of the Damiraparanchay and Turyanchay. The increase in the annual flow of both rivers was due to the increase in the amount of annual precipitation falling in the basin. A positive trend line was recorded for the precipitation series at the Gabala meteorological station, which is consistent with the distribution of water discharge in Damiraparanchay.

For the rivers of the study area for 1960-2017, graphs of the dynamics of multi-year flow changes were constructed (Graph 1).



a)

b)



c)

d)

Source: Compiled by the applicant I.A. Ayyubov based on the archival materials of the National Hydrometeorological Service.

Graph 1. During 1961-2020 a) Dashağılchay Bash Dashağıl, b) Dynamics of water consumption changes at the Gayabaşı points of Alijançay, c) Tikanlı of Tikanlıçay, d) Turyançay water junction points

The study area for 1960-2017 (graph 1) thus, the analysis of linear trends based on data on average annual water consumption covering a multi-year period showed that a slight negative trend decrease was recorded for the water consumption series in Dashağılchay and Alijançay⁶.

The largest rivers in the area are the Alijançay and Turyançay rivers. The hydrological observation points of both rivers are located in the lower reaches of the rivers and in the area where irrigation is developed, and the flows of the rivers up to these points are widely used for water management purposes.

June and August, 35-40% of the average annual flow of the Alijançay and Turyançay rivers is used for various purposes, mainly irrigation and domestic purposes. The main water users are agricultural areas in the Oghuz, Sheki and Yevlakh regions .

The Turyançay intake facility was built 96.5 km upstream of the mouth of the Turyançay. The intake facility was built to transfer water from the river to the main canal. The Turyançay is also The average multi-year water flow below the water junction is 7.30 m³/s, and together with the flow of the canals, it is close to 15.0 m³/s.

Long-term observations conducted in Alijançay and confirms the decrease in annual flow in Dashağılchay. These decreases can be mainly explained by the influence of anthropogenic factors and climate change. The decrease in flow can also be caused by water intake facilities, filtration, etc. Since the climate of the lower parts of the territory is arid the rivers have greater economic importance. Dashağılchay, Alijançay Turyançay and the flow of the Damiraparanchay is widely used for irrigation, mainly in the middle and lower reaches.

Some information about the use of water resources in Azerbaijan, including the rivers flowing through the Oghuz-Gabala region, can be found in studies conducted by

⁶ Еуубов І.А. Оценка современных разменения стока рек на територији Ширвана (Республика Азербарина) // Astana : Гидрометеорология и Екология , – 2023. № 4 , – с. 25-33 .

A.J.Ahmadzadeh, Z.S. Fendiyev, Y.M. Eyvazova and others .

Climate change over the past 100 years shows that there are changes in climate indicators in Azerbaijan, as in the whole world. Extensive research has been conducted in this direction by S.H.Safarov, R.N.Mahmudov, R.X.Abbasov, R.H.Verdiyev and etc.

As a study, in order to assess the extent to which the flow quantities of the rivers of the Oguz-Gabala zone have been subject to any fluctuations in the last 5-7 years, the average monthly and annual temperature, precipitation and water consumption indicators for the years 1991-2017 were compared with the corresponding average quantities for the years 1961-1990. In order to assess the extent to which the temperature has been subject to changes in the Oguz-Gabala region, Shamakhi, Goychay, Sheki, The average seasonal, annual and average monthly temperatures of Oghuz and Zagatala stations for 1991-2017 were compared with the corresponding average values for 1961-1990⁷.

The research concludes that the average annual temperature in Shamakhi, Goychay, Sheki and Zagatala districts increased by 0.4-1.4⁰ C between 1991 and 2017 compared to 1961-1990.

To assess whether precipitation has changed in several locations in the Greater Caucasus, the average seasonal, annual, and monthly precipitation indicators for 1991-2017 were compared with the corresponding average values for 1961-1990.

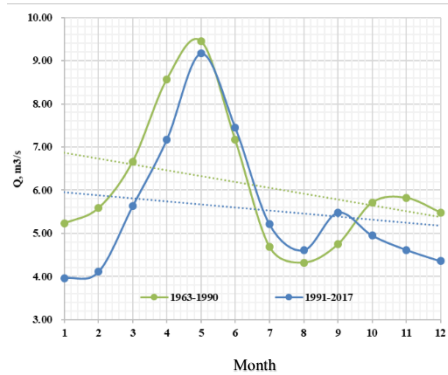
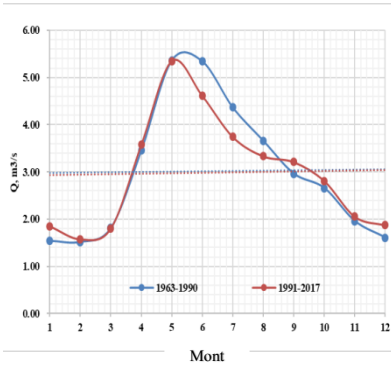
The research concludes that the annual precipitation indicators in the Alibay, Zagatala, Oghuz and Gabala districts increased by 23-107 mm between 1991 and 2017 compared to 1961-1990. The largest decrease was observed in the Oguz settlement in the spring and summer at 71 mm.

Graphs of the multi-year dynamics of changes in the average monthly flow of the rivers of the study area for the years 1960-

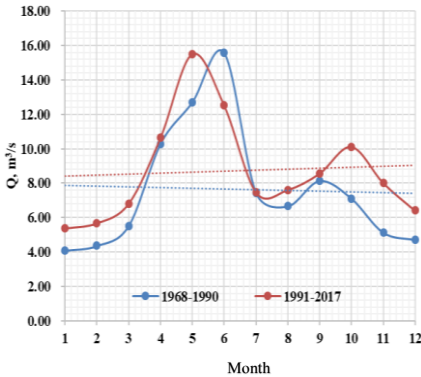
⁷Mammadov A.Sh., Eyyubov I.A. Assessment of the impact of climate change on the water resources of the rivers of the Greater Caucasus // – Baku: Geography and natural resources , – 2018. No. 1 , – p. 28-34.

1990 (period I) and 1991-2017 (period II) were constructed (Graph 2).

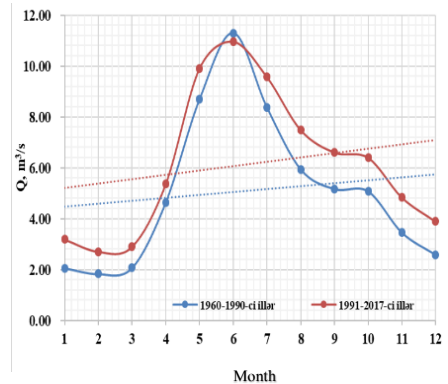
The main purpose of compiling graph 2 is to show the dynamics of the multi-year change in the average monthly flow of the rivers of the study area in Period I and Period II, and to show what changes the flow has undergone .



a) Dashağılchay Main Dashağıl Station



b) Gayabashi settlement of Alijanchay



c) Tikanli station of Tikanlichay

e) Gabala settlement of Damiraparanchay

Source: Based on archival data from the National Hydrometeorological Service
Compiled by the plaintiff I.A. Eyyubov.

Chart 2. Water consumption in rivers during 1961-2017 dynamics of change

The decrease or increase in the flow of some rivers in the Oguz-Gabala region creates conditions for the occurrence of dangerous events. Thus, the greatest increase in the flow of rivers is observed in April-May, which is due to the rapid melting of snow in the mountains against the background of rising temperatures and an increase in the water content of the rivers during that period. This, in turn, causes floods and mudflows in the rivers during that period.

It should be noted that the increase or decrease in water flow in rivers can be explained, in addition to climatic processes, by the increase in the amount of precipitation falling on the territory, the diversity of physical, geographical, and hydrogeological conditions, as well as direct anthropogenic impacts on rivers.

Scientific works devoted to the impact of climate change on river flow, we see that the increase in winter flow and the decrease in summer flow are observed, and such issues are also reflected in our research. We also believe that the reason for the increase in winter flow is explained by the fact that part of the precipitation falls in the form of rain and part of the snow melts against the background of the increase in temperature in that season.

In the study area, there was a decrease in flows during the summer season. This can be mainly explained by the decrease in precipitation during that period, and the increase in temperature and evaporation rates.

The results we obtained during the research are fully consistent with the studies of a number of researchers in Azerbaijan, including R.N. Mahmudov (2018), F.A. Imanov (2018), R.H. Verdiyev (2006), etc. on changes in the river flow regime taking into account the impact of climate change⁸.

dedicated to **“Evaluation of groundwater flow in rivers flowing through the Oguz-Gabala region”**. Research in this direction was carried out by H.Q.Suleymanov, V.A.Liestengarten (1972), A.B.Alekperov (2008), F.A.Aliyev (2000) and others .

According to hydrogeological zoning, the northern part of the

⁸ Mahmudov RN Modern climate changes and dangerous hydrometeorological phenomena / RN Mahmudov. – Baku: MAA publication, – 2018. – p. 231.

study area, covering the Greater Caucasus mountain-fold zone above 700-800m absolute altitude, belongs to the Greater Caucasus pore-fracture water basin, and the central part, with an absolute altitude of 380-800m, belongs to the Ganikh-Ayrichay pore-layer water basin of the Kura-Araz plain geostructural region⁹.

The Ganikh-Ayrichay valley is one of the secondary groundwater basins of the Kura depression, isolated from other groundwater basins both structurally and practically.

Dashagilchay, Tikanlichay, Demiraparanchay and other rivers flowing through the study area flow from the high mountainous area to the plain, after an absolute height of 800-700 m, forming alluvial cones by depositing alluvial deposits. This part is the area where the rivers enter the Ganikh-Ayrichay valley. Here the riverbed becomes wider and the depth of the rivers is much smaller than their width. A certain zonation is observed in the lithological composition of the rocks distributed in the Ganikh-Ayrichay valley.

Groundwater in the Ganikh-Ayrichay valley is formed under natural conditions as a result of precipitation and river water percolating into underground layers, condensation of water vapor in the aeration zone, and partly as a result of underground flows.

In order to investigate the relationship between surface and groundwater, field research was carried out at different times in the Dashagilchay basin. Field research was carried out in the Dashagilchay basin at the 1-1, 2-2, 3-3 and 4-4 sections that we conditionally selected. Flow parameters were compiled in all sections of the Dashagilchay, at a distance of approximately 7200 m (Table 2).

Table 2 shows the river water underground the results of the assessment of the amount of water used have been compiled. The results of the field studies conducted indicate that river waters feed groundwater.

⁹ Alakbarov A. B. Exploration of groundwater and assessment of exploitation resources / A. B. Alakbarov – Baku : Nafta-Press, –2014. – p. 180.

Table 2

Results of field research work on Dashagilchay

Settings	Conventional measurement cuts			
	1-1	2-2	3-3	4-4
b_{average} – average width, m	2.2	2.1	2.3	2.0
h_{middle} -middle height, m	0.32	0.31	0.29	0.30
v_{or} - middle speed, m/s	0.9	0.9	0.85	0.85
Q, consumption, m ³ /s	0.630	0.590	0.560	0.520
h_{max} , m	0.47	0.43	0.35	0.36
$v_{\text{average speed}}$, m/s	1.1	1.1	1.0	1.0
In the cut cuts height above ground, m	680	606	508	450
i- average inclination	0.037	0.0392	0.0215	
ℓ -length of the river between cuts, m	2000	2500	2700	
F, the watercourse of the river area, m ²	4400	6000	5400	
ϑ_{fil} - water from the river underground filtration flow, m/s	0.00009	0.000005	0.000007	

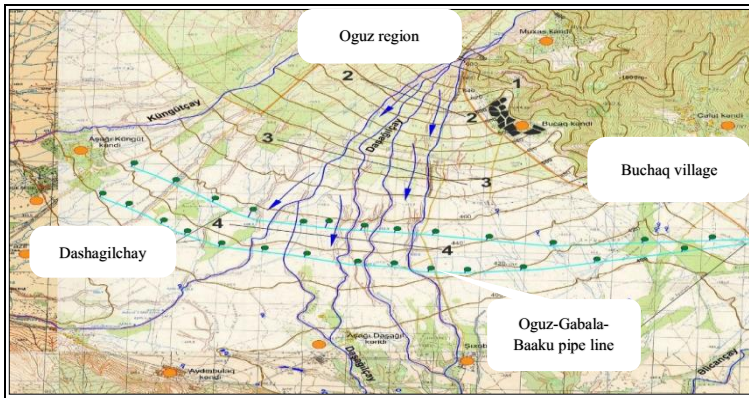
Source: Compiled by the claimant I.A. Ayyubov based on the results of research conducted in the area¹⁰.

The conducted researches it was found that after 750-600 m absolute heights, rivers deposit their sediments in a wide area. This part is the part where the rivers enter the Ganikh-Ayrichay valley. Here the riverbed widens and the river flow in the area feeds the groundwater. This is explained by the geological structure of that part, the lithological composition of the rocks etc (Figure 4).

This part is the zone where river runoff accumulates, and the runoff here is more suitable for filtering young and surface flows¹¹.

¹⁰ Eyyubov I.A. Study of the relationship between surface and groundwater in the Dashagylchay basin // – Baku: News of the Azerbaijan Engineering Academy – 2018. No. 3, – pp. 125-130.

¹¹ Mammadov A.Sh., Eyyubov I.A. Assessment of groundwater recharge by surface waters and its use prospects // – Baku: Scientific works of the Azerbaijan Technical University, Technical sciences, – 2017. No. 1, – pp. 70-75.



Source: Compiled by the claimant I.A. Ayyubov using Google Earth Pro and Micrystation Vi8 and satellite map

Figure 4. Field survey sections in Dashağilchay map scheme

Conducted at various times in the area According to the results of hydrological studies, approximately 21% of the total discharge from the river bed is used to recharge groundwater (Table 3).

Table 3

The hydrological studies we conducted in Dashagilchay results

History of field research	Q start , m ³ /s	Q end , m ³ /s	Q filtration , m ³ /s	Q filtration , %
07 -08 .09.2015	1.51	1.24	0.37	25.0
08-09.11. 20 15	2.08	1.60	0.49	24.0
13-14.01. 20 16	0.633	0.518	0.115	18.0
13 -14 .03.2016	2.35	1.96	0.39	17.0
25 -26 .03. 20 16	3.91	2.95	0.96	25.0
26 -27 .08.2017	1.90	1.60	0.30	15.8
Medium	2.1 0	1.65	0.465	21.0

Source: Compiled by the claimant I.A. Ayyubov, based on the results of research conducted in the area ¹².

The second chapter of the dissertation is dedicated to "**Evaluation of groundwater flow in rivers flowing through the**

¹² Eyyubov I.A. , Dadashova FS . River waters of groundwater Assessment of nutrition with // – Baku: Azerbaijan Water Problems Science and Technologies , – 201 8 . No. 1(11) . – pp. 61-70.

Oguz-Gabala region." The issues of studying the water balance of the territory of Azerbaijan were reflected in the studies of S.H.Rustamov and R.M.Qashqai, etc. When studying the water balance of the country, S.H.Rustamov and R.M.Qashqai preferred the hydrological method and used data from 4 different years of waterlogging for each observation point. As a result of their studies, elements of the water balance, including the distribution patterns of underground flows, were determined for individual river basins, natural regions and altitudinal zones of Azerbaijan.

The mechanism of formation of underground flows in rivers and their separation in the hydrograph were studied by F.A.Imanov, I.S.Aliyeva, A.R.Maharramova and others. Hydrological, hydrogeological and hydrological-hydrogeological methods have been developed to assess underground flows in rivers. Among these methods (Kudelin, 1949), (Popov, 1964), (Dobroumov, 1972), (Amusya, 1975; Sokolov, Sarkisyan, 1981), etc., can be cited. The joint analysis of all these methods is combined into 3 groups: hydrological, hydrogeological and hydrological-hydrogeological. These methods differ in the initial observation data used and the technologies for their use¹³.

Hydrological methods are mostly used to estimate groundwater flow into rivers. As such, calculations are performed based on flow characteristics (minimum flow, low-water period flow, base flow, depletion curves, etc.). Therefore, these methods are relatively simple.

Hydrological-hydrogeological methods are considered more promising, but their application requires information about groundwater in addition to river waters. For the first time, such a method was proposed for mountain rivers in 1947 (Makarenko, 1947). Hydrogeological methods include hydrodynamic analysis of data on groundwater flow and the level regime of these waters in calculations. In this case, hydrological data are not used. Hydrogeological methods are used very rarely in mountainous areas.

¹³ Imanov F.A., Aliyeva I.S., Maharramova A.R. Mechanism of formation of underground flow into rivers and its separation in the hydrograph // – Baku: Baku State University News, natural sciences series, – 2016. No. 2, – pp. 109-119.

This is because both the monitoring network for groundwater levels is very poorly developed and reliable information on the hydrogeological parameters of river basins is insufficient.

In the research work, the study of base flow, its calculation, changes in the area and multi-year fluctuations of the base flow were studied. To calculate the base flow, the average annual flow series were summed up. In this case, the values less than the average annual water flow were taken as the average annual water flow, and the values more than the average annual water flow were taken as the average annual water flow and calculated. In order to investigate the relationship between base flow and groundwater flow in the area, the relationship between the various characteristics of both concepts was examined. These analyses were carried out in the following sequence.

Using multi-year river flow data, the values of different water supply years (low-water, medium-water and high-water years $P=95\%$, $P=50\%$, $P=20\%$) of water resources were found (table 4).

Table 4

Years with different water levels in rivers

Rivers and stations	Different wet periods and water consumption					
	Low water P=95%	Q, m ³ /s	Midwater P=50%	Q, m ³ /s	highwater P=20%	Q, m ³ /s
Dashagılıchay-Bash Dashagılı v.	1966	1.97	1969	2.96	1993	3.70
Alijanchay-Gayabashi v.	2013	3.90	1969	5.67	1973	6.86
Tikanlıchay-Tikanlı v.	1955	2.33	2006	3.26	1956	4.29
Turyanchay-Su junction v.	1970	4.83	1992	7.57	1997	9.48
Damiraparanchay-Gabala c.	1964	3.44	1968	5.64	2000	7.25

Source: Compiled by the claimant I.A. Ayyubov, based on the results of research conducted in the area.

Empirical supply values were calculated according to the Kritsky-Menkel formula ¹⁴. In addition, hydrographs were constructed for each river's s-critical years (low-water, high-water

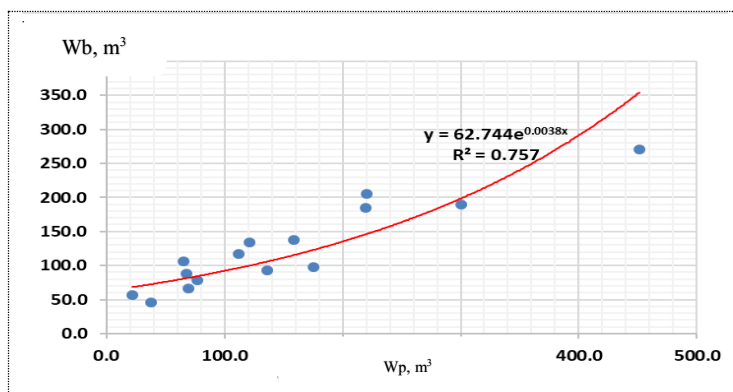
¹⁴ Mammadov M.A. River flow and hydrological calculations . Methodological instructions / M.A. Mammadov. RNMahmudov, F.A.Imanov –Baku. –1995. pp. –320.

and medium-water), base flow values were calculated and the results were compared with the groundwater flow ¹⁵.

Base flow and groundwater flow, the relationships between various characteristics of both concepts were examined.

The assessment of groundwater in rivers was carried out as follows. Since the base flow is mainly formed by groundwater, it was analyzed comparatively with the quantities of base flow (natural regulation coefficient of flow) and groundwater (groundwater recharge coefficient). Genetic decomposition of the hydrograph for the low-water, medium-water and high-water periods of the 5 main rivers flowing through the study area was carried out, and groundwater flow volumes (W_p) were found. Then, to determine the base flow volumes, base flow discharges (Q_b) were found. Since the base flow is mainly formed by groundwater, the quantities of base flow and groundwater recharge coefficient were analyzed comparatively.

The calculated base flow volume (W_b) and groundwater flow volume (W_p) is as follows (graph 3).



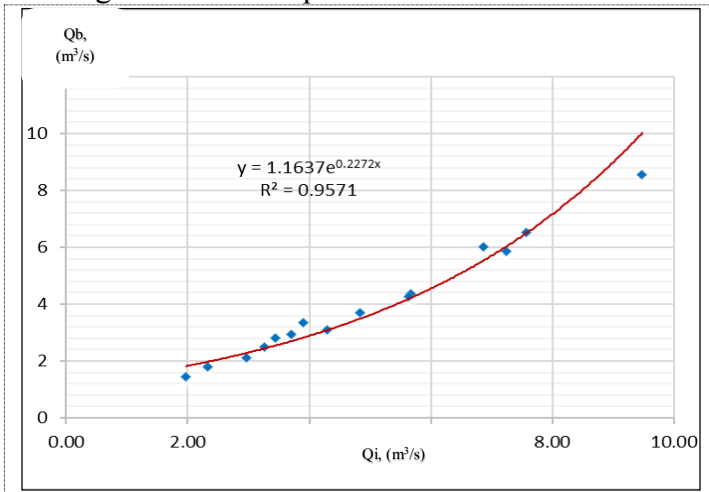
Source: Compiled by the applicant I.A. Eyyubov, based on the results obtained during the assessment of groundwater flow.

Graph 3. Relationship graph between annual groundwater flow volume (W_p) and base flow volume (W_b)

¹⁵ Eyyubov I.A. Assessment of groundwater flow in the rivers of Shirvan // – Baku: Water Problems Science and Technologies International peer-reviewed scientific journal , – 2022 . No. 1(19) . – pp. 35 - 49.

The consistent change in base flow and groundwater flow volumes once again shows that groundwater flow plays a major role in the formation of base flow. Then, the relationship between base flow discharge Q_b and average annual water discharge Q_i was analyzed, and the ratio of base flow to average multi-year water discharge was calculated.

The relationship between the calculated base flow and the average annual water consumption is as follows (graph 4). As can be seen from the figure, the change in the base flow values is in line with the average annual flow quantities.



Source: Compiled by the applicant I.A. Eyyubov, based on the results obtained during the assessment of groundwater flow.

Graph 4. Relationship graph between base flow and average annual water consumption

In the next stage of the analysis, the percentages of groundwater flow in the total flow found based on the average annual values of the natural regulation coefficient were compared with the multi-annual percentages accepted. Therefore, the calculated groundwater flow volume was used for the genetic decomposition of the hydrograph and the average values of the volumes were found. Based on the ratio of the average annual groundwater flow volumes found

to the average annual water volume values, the average annual groundwater flow coefficient was found.

The groundwater recharge coefficient was used to determine the amount of groundwater contributing to the generation of base flow in the study rivers.

According to the results of our study, the groundwater recharge coefficient of rivers varies between 0.21-0.43. The difference between the natural flow regulation coefficient and the groundwater flow coefficient is on average 0.4. This means that on average, about 40% of surface water participated in the formation of the base flow, while the amount of groundwater was 60%. As a result of the study, it was found that the participation of surface water in the formation of the base flow is quite large. This indicates that the use of base flow is inconvenient when studying the vertical structure of the flow in rivers based on the annual values .

The third chapter of the dissertation "**Study of the interaction of surface and groundwater in the area**" dedicated to. In the research work In the Alijanchay basin, the assessment of groundwater recharge by surface waters and its use prospects have been determined according to the medium and low water periods .

Currently, the groundwater of the Ganikh-Ayrichay valley is used for water supply of the region, as well as the city of Baku and surrounding settlements. For this purpose, 3.5-4.0 m³/s of groundwater is transported from the area through subartesian wells via the Oguz-Gabala-Baku water pipeline .

During the season when climatic parameters of the low-water or medium-water period are observed in the area. For example , if climatic parameters of the low-water period are observed in the area for several years, that is, if a drought occurs, it is not known what process will occur at the groundwater level. For this reason, the calculation of groundwater recharge by surface water in the study area was carried out according to two scenarios:

- a) based on average multi-year climate parameters;
- b) based on the climatic parameters of the low-water period .

The purpose of conducting the study under two scenarios is to compare the volume of groundwater use in the area with the volume of

groundwater recharge from surface water¹⁶. The main source of groundwater recharge is the filtration water from the tributaries of Alijanchay, Dashağılchay, Oguzchay, Khalkhalchay and other rivers, and the precipitation falling on the unit surface of the basin. and condensation waters. The groundwater recharge regime was calculated using expression (1).

$$G_{\text{earth. water nutrients.}} = W_{\text{river.filter.}} + Y_{\text{rain.}} + Q_{\text{cond. waters}} - B_{\text{it}} \quad (1)$$

where, $W_{\text{river.filter.}}$ - filtration from river flows in the area, Y_{rain} - water filtered from precipitation falling into the basin, $Q_{\text{cond. water}}$ - condensation water feeding groundwater, B_{it} - losses from evaporation.

The report on the recharge of groundwater by precipitation in the Alijanchay basin was determined based on the results of the research conducted by E.G.Asgarbeyli and the experimental studies conducted by the Complex Hydrogeology and Engineering Geology Expedition¹⁷.

As a result of the calculations, it was found that the annual recharge of groundwater in the study area during the medium-water period is 4.26 m³/s, and during the low-water period it is 1.51 m³/s. Currently, this region, which has the most abundant groundwater resources, has the potential to benefit other regions of the republic. used in water supply. As a result of the study, it was found that if the hydrometeorological parameters of the Alijanchay basin correspond to the climatic parameters of the Mesozoic era, serious changes in the recharge of groundwater will not occur, because the amount of water used from groundwater reserves is less than the amount of water spent on the formation of groundwater.

¹⁶ Eyyubov I.A. Assessment of groundwater recharge by surface waters in the Alijanchay basin and its prospects for use // Scientific and practical conference on “Water resources, hydrotechnical facilities and the environment” dedicated to the 100th anniversary of the “Shollar-Baku Waterworks Complex”. – Baku : – March 15-16, 2017. – p. 240-247.

¹⁷ Askerbeyli E.K., Kasparova N.L. Underground waters of the south-western slope of the Greater Caucasus and prospects for their use for water supply // - Baku : Works "Problems of Engineering Hydrogeology and Hydrotechnics", issue XIV. - 1977. – p. 50-110 p.

Chapter four of the dissertation It is dedicated to **“Usage of groundwater resources and its impact on surrounding areas”**. **This chapter discusses the use** of groundwater resources, their impact on surrounding areas, minimizing these impacts, and groundwater Issues such as increasing the water level and balance, etc. were considered .

In order to improve the drinking water supply of the settlements of the Absheron Peninsula from the groundwater of the study area, the Oguz-Gabala-Baku water pipeline was built and put into operation. The length of this water pipeline is 252 km, the diameter is 2000 mm, and the productivity is 5.0 m³/s. The water intake facilities of the Oguz-Gabala-Baku water pipeline are mainly located in the catchment cones of the Dashağilchay, Khalkhalchay and Oguzchay¹⁸.

The dissertation analyzed the level data of the observation wells of the Oguz-Gabala-Baku water pipeline and found that as a result of the use of groundwater in the basin , the water level in the observation wells decreased by an average of 15-20 m over 10 years . In addition , another example of the decrease in the groundwater level is the decrease in the groundwater level in the sections where the river confluences were deposited after the Oguz-Gabala-Baku water pipeline was put into operation. Thus, drainage lines were built in that area in order to lower the groundwater level. Currently, there is no need to operate the drainage lines.

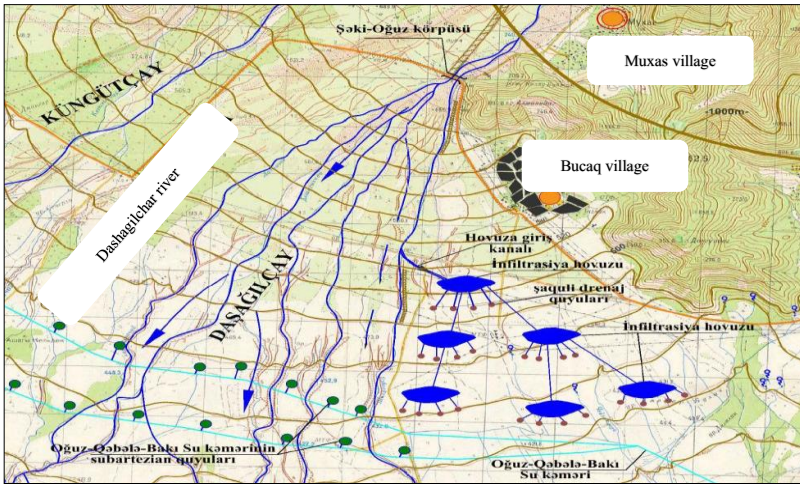
In order to approach the use of groundwater resources in the area studied in the dissertation as carefully as possible , the following recommendations were made: technical proposals have been put forward.

to 50 subartesian wells (approximately 65% of the total wells) of the water intake complex of the Oguz-Gabala-Baku water pipeline are located in the Dashağilchay catchment basin, where we conducted our research. In order to partially increase the level and balance of groundwater in the area of the water intake complex,

¹⁸Eyyubov I.A. Preparation of scientific and technical proposals for the effective use of the winter flow of the Dashagilchay //– Baku: Works of the Azerbaijan Geographical Society, Geography and natural resources, – 2021. No. 2(14). – pp. 11-14.

small-scale infiltration pools are being constructed outside the channel. It was proposed to create. Based on existing methods, a technical justification was made for the creation of small-scale infiltration pools in the Dashağılchay catchment area, outside the river's tributaries¹⁹.

Proposed to be artificially created on the banks of the Dashağılchay is provided (Figure 5).



Source: Compiled by the applicant I.A. Eyyubov, based on the results obtained during the assessment of groundwater flow.

Figure 5. Schematic plan of small-scale infiltration ponds and vertical drainage wells to be created in the river's headwaters

Underground waters another option proposed for feeding is to collect part of the river water in natural depressions of the relief (ravines, ancient river beds, dried lakes, quarries, etc.) during the low water period.

In order to eliminate possible ecological problems in the basin in the future, the rivers will be monitored for approximately 5 months

¹⁹ Mamedov A.Sh., Eyyubov I.A. Preparation of technical measures to restore the level of underground waters of the Dashagylchay basin // – Almaty : Hydrometeorology and Ecology, – 2018. №2, – p.181-191.

(november - march). By directing part of the flow to artificial infiltration pools to be created, the groundwater balance can be increased.

that the proposed small-scale infiltration ponds be operated as follows. These ponds are primarily intended to increase the groundwater balance. In order to ensure a fast and long-term infiltration process, it is proposed to collect water during the low-water periods, i.e., January-March, when the turbidity in the river is low. Part of the water flow of the Dashağılchay is mainly diverted through artificial channels during the winter months, when the turbidity is low and irrigation is not carried out. can be directed to infiltration ponds through the. The water collected here can be discharged into the vertical drainage wells and trenches through pipes. In order to prevent the ingress of large particles, debris and stone fragments that may enter the vertical drainage wells, the wells must be hermetically sealed (protective cover). This will both increase the useful working coefficient of the vertical drainage wells and allow for longer operation²⁰.

In general, the collection of water in small-scale infiltration ponds, proposed for the economical use of river water, will prevent rapid runoff from water-saturated soil and allow groundwater recharge from vertical drainage wells.

The dissertation analyzed the data on the winter flows of the rivers of the research area. It was found that 39% or 127.6 mln m³ of the average flow volumes of the three months are observed in the low-water period, and 30% or 245.7 mln m³ in the mid-water period in October-February. Preliminary studies show that river waters are not used in the winter season and the rivers flow in transit and merge into the Kura River.

By directing 50% of the winter flow of the rivers of the Oguz-Gabala zone to small-volume reservoirs, it is possible to create a water reserve of approximately 60-120.0 million m³. With this volume of water, it is possible to provide approximately 350-750

²⁰ Eyyubov I.A. Assessment of changes in the flow of Shirvan rivers against the background of global climate change // Materials of the scientific-practical conference on the topic “ The development of the water sector of Azerbaijan is connected with the name of the National Leader Heydar Aliyev ”, – Baku : – May 5, 2023 . - p. 175 - 181 .

thousand people with drinking water in an uninterrupted and sustainable manner.

RESULT

As a result of the study of the impact of modern climate change on the flow of rivers in the Oghuz-Gabala zone, it was found that there were changes in the values of the flow rate of the rivers in the study area for 1991-2017 compared to the flow rate of the rivers in the 1960-1990s. In the Damiraparanchay, an increase of 20.6% or 1.05 m³/s was observed in the flow rate of the 1991-2017 compared to the flow rate of the corresponding years, and in the Turyanchay - 14.2% or 1.09 m³/s. A slight negative trend of decrease for the flow series of rivers was recorded in the Dashagilchay and Alijanchay. The decrease in the average annual flow rate of the Dashagilchay was 1.3% or 0.04 m³/s, and the decrease in the average annual flow rate of the Alijanchay was 9.2% or 0.56 m³/s. One of the reasons for the decrease in the flow in the Alijanchay is that the population in the Gayabashi settlement is engaged in extensive agriculture. For this reason, the flow of the Alijanchay is used for irrigation during the vegetation period of plants. The rivers flowing through the area are not subject to any anthropogenic impact in the high mountainous part, but partial quantitative fluctuations are observed in the middle mountainous and foothill parts. Alijanchay and Turyanchay are more exposed to anthropogenic impacts .

2. Impact of climate change As a result, an increase in the average annual temperature indicators in the Greater Caucasus region was observed in the Shamakhi, Goychay and Sheki settlements during 1991-2020 compared to the previous period and the average increase was 0.67⁰C. A decrease of 30-93mm was observed in the precipitation indicators in the Goychay and Sheki settlements during 1991-2017 compared to the previous period .

3. The study found that in the future , the decrease in surface runoff due to climate change will lead to a decrease in the amount of water filtered into groundwater. If water resources decrease by 20%, the amount of water per person will decrease from 3230 m³ to 2580 m³ .

4. The dynamics of groundwater level changes for the part of the rivers connected to groundwater were studied, and empirical

expressions were obtained for calculating the groundwater recharge rate and the filtration coefficient, taking into account the water level heights in the riverbed and the infiltration of precipitation falling on the area.

5. According to the results of studies conducted on the Dashağılchay River, up to 17-25% of the total flow of the river goes into filtration, that is, it feeds groundwater.

6. The assessment of groundwater in rivers was carried out based on the numerical average of the base flows. The average error of the calculations is high. The groundwater recharge coefficient of rivers varies between 0.21-0.43. The difference between the natural flow regulation coefficient and the groundwater flow coefficient is on average 0.4. This means that on average, about 40% of surface water is involved in the formation of the base flow. Accordingly, the amount of groundwater flow is 60%. As a result of the study, it was found that the participation of surface water in the formation of the base flow is quite large.

7. The assessment of groundwater recharge by surface water in the study area was carried out under two scenarios: a) for the medium-water period, b) for the low-water period. It was found that the volume of water used for water supply from groundwater does not change either during the period when the climatic parameters of the low-water period are observed in the area or during the medium-water period. As a result of the calculations, it was found that the volume of groundwater recharge from surface water is less during the low-water period.

Climate change may cause a decrease in the flow of rivers in the area during June-August or their complete drying up. This, in turn, may negatively affect the feeding regime of the Oguz-Gabala-Baku water pipeline.

8. The results of monitoring conducted in 5 observation wells of the water intake complex of the Oguz-Gabala-Baku water pipeline, located in the Dashağılchay intake basin, over a period of 10 years since 2012, regarding the dynamics of groundwater movement were analyzed and it was found that the groundwater level increased by 15-20 m. It shows that the groundwater level in the basin has fallen and that this process is still ongoing. A graph has been constructed showing the

decline in groundwater levels in the basin depending on time and precipitation in the area.

9. The data on the winter flows of the rivers of the study area were analyzed and it was found that 39% or 127.6 mln m³ of the average flow volumes of the three months are observed in the low- water period, and 30% or 245.7 mln m³ in the mid-water period in October-February. Preliminary studies show that river waters are not used in the winter season and the rivers flow in transit and merge into the Kura River.

Suggestions

The following technical proposals have been put forward in order to maintain the ecological balance in the Dashağılchay catchment area and prevent a sharp decrease in groundwater levels .

1. A technical feasibility study was conducted to create small-scale infiltration pools outside the channel in the Dashağılchay basin;

2. In order to maintain the ecological balance in the Dashagılchay catchment area and prevent a sharp drop in groundwater levels, the operation of up to 20-30% of the subartesian wells of the Oguz-Gabala-Baku water pipeline should be suspended, and in order to ensure such productivity, it is considered appropriate to drill new subartesian wells in the basin between the villages of Tayifli and Khalkhalqishlag, which have abundant groundwater reserves (the water pipeline project envisages drilling subartesian wells in this way).

3. By diverting 50% of the winter flows of the rivers of the Oguz-Gabala zone from their course to small reservoirs in the countryside, approximately 350-750 thousand people can be provided with drinking water in an uninterrupted and sustainable manner.

Published scientific works on the topic of the dissertation

1. Eyyubov I.A. Features of the formation of surface waters in the Oguz-Gabala zone // – Baku: Ecology and water management, – 2012. No. 4, p. 48-49.
2. Eyyubov I.A. Formation of river flow in the Oguz-Gabala zone The

- role of climatic factors // – Baku : Azerbaijan Agrarian Science , – 2012. No. 4, – p. 142-144.
3. Eyyubov I.A. The role of the water permeability of the soil cover in the formation of river flow // “Caspian International Water Technologiesconference, – Baku: – April 12, – 2013 . – p. 459-466.
 4. Eyyubov I.A. Relationships between surface and groundwater in river basins and its factors // Republican scientific conference dedicated to the 70th anniversary of the Department of “Physical Geography” and the 40th anniversary of the Department of “Hydrometeorology” , – Baku: BSU,– 2013 , – p. 554-559.
 5. Eyyubov I.A. Statistical analysis of the average annual water consumption series of rivers flowing through the Oguz-Gabala territory and study of flows // “Modern problems of efficient and complex use of water resources” collection of scientific works, – Baku: – 2014 , – pp. 19-25 .
 6. Eyyubov I.A. Study of the ecological flow of rivers flowing through the Oguz-Gabala region and river protection // “II Caspian International Water Technologies Conference ”. – Baku: – 2014 , – p. 602-609.
 7. Eyyubov I.A. Study of anthropogenic impacts on the flow of rivers flowing through the Oguz-Gabala territory // – Baku: Water problems, science and technologies , – 2015, No. 2, – pp. 50-59 .
 8. Eyyubov I.A. Use of surface and groundwater resources for water supply purposes // Scientific and practical conference of young scientists, doctoral students, masters and specialists “Modern problems of water use and its management in Azerbaijan” . – Baku: – 2015, – pp. 103-104 .
 9. Eyyubov I.A. Analysis of the hydrological regime characteristics of the rivers of the Oguz-Gabala region // – Baku: Water problems, science and technologies, – 2016. No. 3 , – p. 47-57.
 10. Eyyubov I.A. Determination of groundwater flow in inter-river sections taking into account infiltration of precipitation falling on the territory // – Baku: Water problems , science and technologies, – 2016. No. 3 , – p. 72-75 . (Co-author: Ahmadov F.Sh.)
 11. Eyyubov I.A. In the Alijanchay basin Preparation of measures for groundwater restoration // – Istanbul : Republic of Turkey, water

- foundation, water center, water bulletin, – 2017. Issue 3, – 2-8 pp.
12. Eyyubov I.A. Assessment of groundwater recharge by surface waters in the Alijanchay basin and its prospects for use // Scientific and practical conference on “Water resources, hydrotechnical facilities and the environment” dedicated to the 100th anniversary of the “Shollar-Baku Waterworks Complex”. – Baku : – March 15-16, 2017. – p. 240-247.
 13. Eyyubov I.A. Surface waters of groundwater Evaluation of nutrition and prospects for use // – Baku: Scientific works of Azerbaijan Technical University, Technical sciences, – 2017. No. 1, – p. 70-75. (Co-author: Mammadov A.Sh.).
 14. Eyyubov I.A. Assessment of the impact of climate change on the water resources of the rivers of the Greater Caucasus // – Baku: Works of the Azerbaijan Geographical Society, Geography and natural resources , – 2018 , No. 1 , – pp. 28-34. (Co-author: Mammadov A.S.).
 15. Eyyubov I.A. River waters of groundwater Assessment of nutrition with // – Baku Azerbaijan Water Problems Science and Technologies, – 2018 . No. 1(11), – p. 61-70. (Co-author: Dadashova FS).
 16. Eyyubov I.A. Study of the relationship between surface and groundwater in the Dashagylchay basin // – Baku: News of the Azerbaijan Engineering Academy , – 2018. No. 3 – p. 125-130.
 17. Eyyubov I.A. Statistical analysis of the average annual water discharge series of the Shirvan rivers of the Greater Caucasus // – Baku : Scientific Works of Azerbaijan Technical University , – 2018. No. 2, – pp. 127-133. (Co-author: Mammadov A.Sh.).
 18. Eyyubov I.A. Effective use of water in Dashagyla and preparation of technical measures to increase the level of underground water // – Almaty : Hydrometeorology and ecology , – 2018. No. 2 . – pp. 181-191. (co-author: A. Sh. Mamedov).
 19. Eyyubov I.A. Preparation of scientific and technical proposals for the efficient use of the winter flow of the Dashagilchay // – Baku: Works of the Azerbaijan Geographical Society, Geography and natural resources, – 2021. No. 2(14). – pp. 11-14.
 20. Eyyubov I.A. Assessment of groundwater flow in the rivers of

- Shirvan // – Baku: Water problems, science and technologies, – 2022 . No. 1(19) . – pp. 35 - 50 .
21. Eyyubov I.A. Issues of efficient use of Shirvan rivers in winter flows // – Baku: Works of the Azerbaijan Geographical Society, Geography and natural resources, – 2022. No. 2. – pp. 24-29 .
 22. Eyyubov I.A. Assessment of modern changes in the flow of rivers in the Oghuz and Gabala regions // – Baku: Water Problems Science and Technologies, – 2023 . No. 2 (22) . – pp. 85-97 .
 23. Eyyubov I.A. Changes in the monthly and seasonal flow of rivers in Azerbaijan (Oguz-Gabala district) // - Almaty : Geography and water resources, - 2023. No. 4 , - p. 3-13 .
 24. Eyyubov I.A. Estimation of modern river flow rates in the territory of Shirvan (Republic of Azerbaijan) // - Astana : Hydrometeorology and ecology, - 2023. № 4 , - c. 25-33 .
 25. Eyyubov I.A. Assessment of changes in the flow of Shirvan rivers against the background of global climate change // Materials of the scientific-practical conference on the topic “ The development of the water sector of Azerbaijan is connected with the name of the National Leader Heydar Aliyev”, – Baku : – May 5 , 2023 . - p. 175 - 181 .
 26. Eyyubov I.A. Assessment of the influence of anthropogenic and natural factors on the annual flow of the river Alidzhanchaya // Development of modern science and education: Current issues, achievements and innovations. Collection of articles of the X International Scientific and Practical Conference. – Penza : – 2023. – p. 268-276 .
 27. Ayyubov IA Efficient use of water resources on the basis of increasing water demand // IX International European Conference on Interdisciplinary Scientific Research, - Valencia: - 19-21 January. 2024. - pp. 454 - 463.
 28. Eyyubov I.A. Impact of climate change on water resources // Climate change, sustainability and international cooperation conference, - Duzce: - February 21-22. 2024. – p. 173-180.
 29. Eyyubov I.A. Water resources in Azerbaijan are one of the important factors of sustainable development // Khudaferin International Scientific Research Conference. Special issue – Baku:

- February 24, 2024. – pp. 227-233.
30. Eyyubov I.A. Assessment of modern changes in surface and underground waters in the territory of Oguz-Gabala (Republic of Azerbaijan) - the basis of the decision of the strategic goal of food security in the conditions of a changing climate» dedicated to World Water Day. – Dushanbe : March 22 2024. – pp. 204 - 210 .
 31. Eyyubov I.A. Assessment of the influence of anthropogenic and natural factors on the annual flow of the river Alidzhanchaya (Republic of Azerbaijan) // Materials of the First Belarusian Geographical Congress for the 90th Anniversary of the Faculty of Geography and Geoinformatics of the Belarusian State University and the 70th Anniversary of the Belarusian Geographical Society. – Minsk : – April 8 - 13, 2024. – pp. 434 - 440.



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