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The Impact Of Climate Change On Groundwater In The Northern Fergana River Basins

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Abstract. This article analyzes the effects of climate change on the groundwater regime within the river basins of Northern Fergana, focusing on their relationship with hydrological factors. The study primarily investigates the dependence of groundwater levels in the Kosonsoy and G‘ovasoy basins on variations in river discharge. It also evaluates the impact of atmospheric precipitation on these basins by analyzing average decadal river flow values. Seasonal variations in both river flow and groundwater levels are assessed to understand the overall dynamics.
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Key words: river basin; climate change; groundwater; groundwater level; river discharge; observation wells; water resource assessment; atmospheric precipitation.

1. Introduction.

In recent years, climate change observed on a global scale has significantly affected various components of the natural environment, particularly water resources. Rising atmospheric temperatures, uneven distribution of precipitation, and intensified evaporation processes are altering the dynamics of water resources, influencing both river basin flows and groundwater levels. Additionally, fluctuations in groundwater levels, changes in soil moisture, and disturbances in the water balance have a direct impact on soil fertility. Given these conditions, the scientific analysis of groundwater level fluctuations in relation to climatic and hydrological factors has become a topic of critical importance.

2. Material and Methods.

Climate change is studied and monitored by the World Meteorological Organization (WMO). The issue of climate change has been analyzed by numerous foreign scholars, such as S.A.Arenus, J.Hansen, and R.Voeyet; Russian scientists including E.P.Borisenkov (1988), M.I.Budyko (1997), G.I.Marchuk (1986), A.S.Monin (2005); and Uzbek researchers such as V.E.Chub (2007), M.L.Arushanov (2010), T.A.Ososkova (2005), T.R.Spektorman, S.P.Nikulina, G.E.Glazirin, S.R.Grupper, B.A.Kamolov, and I.R.Soliyev (2018), among others.

The characteristics of groundwater in specific parts of the Fergana Valley have been comprehensively studied by researchers such as O.K.Lange (1947), V.A.Geynus (1967), A.N.Sultonkhodjaev (1972), N.N.Khojiboev (1976), L.Z. Sherfedinov (2015), B.D.Abdullayev (2008), I.U.Boyboboyev (2008), R.M. Begmatov (2008), Q.A.Isaboyev, and T.Y.Avulchayev (2008), among others.

However, the relationship between groundwater level fluctuations and climatic as well as hydrological factors in the river basins of Northern Fergana has not yet been analyzed as an independent research subject.

In this study, a basin-based approach was adopted, utilizing principles of historicity, complexity, geographical comparison, and statistical analysis as the main research methods.

3. Results.

From this perspective, climatic and hydrological conditions play a crucial role in the Northern Fergana region. The climate of this area is shaped by its remoteness from oceans and seas, its enclosure by mountain ranges, and the influence of radiative and atmospheric circulation processes. As a result, the region is characterized by a dry and sharply continental climate.

Due to the influence of Arctic, temperate, and tropical air masses, the region experiences strong seasonal contrasts. In particular, during autumn and winter, the intrusion of Arctic air masses leads to a significant drop in air temperatures and an increase in precipitation. In summer, the inflow of temperate and tropical air masses results in hot and dry weather conditions.

The impact of climate change on the hydrological system-especially on groundwater levels-is intensifying. Global warming, changes in precipitation patterns, and the retreat of glaciers are contributing to fluctuations in groundwater levels. For instance, according to the World Meteorological Organization (WMO), global temperatures have increased by 1.1°C over the past 50 years. This has had a particularly adverse effect on the water balance in glacier-rich river basins.

Research indicates that between 1957 and 1980, the area covered by permanent glaciers in the Aral Sea basin decreased by 20%. Consequently, this has led to a reduction in river inflows and a decline in groundwater levels. In certain regions of Uzbekistan, groundwater levels have dropped by 3 to 5 meters over the past two decades.

This article presents a scientific and theoretical analysis of the impact of climate change on both surface and groundwater in the river basins of Northern Fergana-specifically, the Kosonsoy and G‘ovasoy basins. The study explores the interrelationship between atmospheric precipitation, river discharge, and groundwater levels, shedding light on changes in water resource regimes.

Under the conditions of climate change, the average annual temperature in the Northern Fergana region has been steadily increasing since 1976. Based on trend values, it can be concluded that between 1921 and 2020, the annual temperature rose by approximately 2–3°C. A decline in precipitation, which began in the mid-20th century, continued in the Northern Fergana region until around 1989. Since the 1990s, however, precipitation levels have shown a gradual increase.

There are 16 rivers and streams, as well as numerous seasonal streams in Northern Fergana. The region’s available water resources have long held significant economic importance, especially in support of traditional irrigated agriculture. Although the region has a relatively high level of water availability compared to other parts of Uzbekistan, the rivers and streams of Northern Fergana carry relatively low water volumes compared to other parts of the Fergana Valley.

Since the 1970s, the expansion of land development across the foothills, piedmont plains, and hilly areas of Northern Fergana has significantly reduced the flow of these rivers and streams to the Syrdarya River-except during spring and summer flood periods. The majority of the water from these rivers and streams is entirely used for irrigation. Major mountain rivers and streams in the region include Chodaksoy, G‘ovasoy, Rezaksoy, Kosonsoy, Namangansoy, Podshootasoy, and Chortoqsoy.

G‘ovasoy originates from the southern slopes of the Chatkal Range. Its basin covers an area of 344 km² and it flows through deep gorges on the Angren Plateau. There are two lakes located at elevations of 2600–2700 meters, contributing about 10% of the river’s flow. The average annual discharge of the G‘ovasoy River is 5.08 m³/s. It is mainly fed by snow and glacial meltwater. The annual precipitation in the river valley is about 474 mm. Approximately 21% of the river’s water originates from groundwater (springs). Between March and August, 87% of the river's total annual flow occurs, which is considered the high-water season. The river provides irrigation water for agricultural enterprises in Chust District.

Kosonsoy begins in the Chatkal Mountain Range under the name Chilquduqsoy and flows in a southeastward direction. Its total length is 154 km, and the area of its basin is 1650 km². Two-thirds of the basin is composed of soft rock formations, while one-third consists of unstable rock masses. The average elevation of the basin is 2347 meters. The upper stream of the Kosonsoy River lies within Kyrgyzstan and is fed by snow, glaciers, and rainwater. Its average annual discharge is 9.81 m³/s, with an average flow modulus of 5.94 L/s·km². About 58% of the river’s flow occurs from March to September, while the remaining 42% occurs between October and February. In the Ortato‘qay depression, the largest reservoir in Northern Fergana-the Kosonsoy Reservoir-was constructed between 1941 and 1947, and it currently has a water storage capacity of 1600 million m³.

Table 1. The article includes a comparative analysis of the average decadal flow rates (m³/s) of the G‘ovasoy and Kosonsoy rivers.

G‘ovasoy						Kosonsoy				
Deca des	Sp ring	Sum mer	Autu mn	Win ter	Annual	Sp ring	Sum mer	Autum n	Win ter	Annual
1981-1990	9,15	7,23	1,54	1,01	4,82	10	12	3	2	6

1991-2000	11,97	10,02	2,09	1,51	6,52	9	14	3	1	7
2001-2010	13,92	10,25	2,25	1,69	7,08	6	8	4	2	5
2011-2020	11,75	8,44	1,95	1,66	5,96	2	4	3	2	3

Table 1 was compiled by the authors based on data from the Namangan Regional Hydrometeorological Department.

Since the period of 1981–1990, the flow of the G‘ovasoy River increased steadily up to 2001–2010. The average annual flow of G‘ovasoy rose to 7.08 m³/s**.** During this period, an increase in river discharge was observed in all seasons. However, in the 2011–2020 period, the river flow began to decline significantly. This decrease is evident in all seasonal and annual values (*see Table 1*).

The data in the table show that the annual discharge of the Kosonsoy River increased by 1 m³/s in 1991–2000 compared to 1981–1990, but it decreased by 2 m³/s in each of the following decades. Similar trends were observed in atmospheric precipitation (*see Table 1*).

The slight increase in river discharge during 1991–2000 compared to 1981–1990, followed by a steady decline in subsequent decades, is also characteristic of the summer season. In summer, it can be noted that the discharge in 2011–2020 decreased by 4 m³/s compared to the previous decade. This figure is 50% less than in 2001–2010 and 66% less than in 1981–1990.

During spring, river flow has consistently declined across all decades compared to 1981–1990. Specifically, in the last decade, spring discharge dropped by 4 m³/s**,** falling to just 2 m³/s.

Table 2. Seasonal and Annual Changes in Groundwater Levels of the G‘ovasoy and Kosonsoy Rivers (m.)

Decades	Observation Well 2M located in the G‘ovasoy Basin					Observation Well 6MB located in the Kosonsoy Basin				
	Spring	Summer	Autumn	Win ter	Annual	Spring	Summer	Autumn	Winter	Annual
1981-1990	5,50	5,70	6,48	5,65	5,73	-0,24	-0,69	-0,23	0,24	-0,23
1991-2000	2,39	2,30	2,21	2,08	2,33	0,47	0,26	0,36	0,46	0,39
2001-2010	2,11	1,92	2,52	2,14	2,40	0,72	0,94	1,01	0,84	0,88
2011-2020	2,75	3,31	3,81	2,66	3,13	1,36	1,45	1,48	1,46	1,44

The table was compiled by the authors based on data from the Namangan Hydrogeological Station.

4. Discussions.

The rise in groundwater levels during these decades corresponds to the changes in the G‘ovasoy stream. These changes indicate accelerated glacier melting in the river basin during the earlier decades. In observation well 2M, located in the G‘ovasoy basin, a decline in groundwater levels was observed during the period of 2011–2020 compared to previous decades. The decline in groundwater levels in the last decade corresponds to the reduction in the G‘ovasoy streamflow. These analyses demonstrate that the glacial area in the river basin has significantly shrunk in recent decades.

Observation well 6MB, located in the river basin, lies within the transit zone of the Kosonsoy groundwater deposit. This well monitors groundwater levels at a depth of 40-45 meters. In this section of the river basin, confined (artesian) waters are distributed at a depth of 40-45 meters, and these waters occasionally rise above the ground surface. During 1981-1991, the average annual water level was 0.23 meters above ground level. Since then, groundwater levels have consistently declined across all subsequent decades. Seasonal changes in groundwater levels also correlate with annual variations. In all seasons, during the last decade (2011-2020), groundwater levels were observed at a depth of more than 1 meter. This corresponds with the previously analyzed data on atmospheric precipitation and changes in river flow in the basin.

5. Conclusion.

Based on the above analysis, the following conclusions can be drawn:

- Under climate change conditions, the G'ovasoy streamflow increased until around 2010. In the last decade, however, the streamflow has decreased significantly. This decrease has been confirmed both annually and seasonally. The initial increase and subsequent decline in streamflow can be explained by changes in the glacier area within the basin.
- In the G'ovasoy basin, groundwater levels have declined during the last decade. The variations in groundwater levels correspond to changes in streamflow. The observed reduction in both streamflow and groundwater levels underscores the necessity of developing a consistent hydrological monitoring system in the region. Such a system would enable real-time tracking of water resources and timely identification of emerging issues.
- The annual flow of the Kosonsoy River slightly increased until the period 1991-2000 but has significantly decreased in subsequent decades. These changes correspond to the variations in atmospheric precipitation reaching the Kosonsoy basin. Moreover, there have been noticeable shifts in the seasonal distribution of the river flow: spring and summer flows have declined, while the share of autumn and winter flows has increased significantly.
- In recent years, groundwater levels in the river basin have been declining. This trend is influenced by climatic and hydrological factors. The correlation coefficient confirms the link between groundwater levels and both atmospheric precipitation and river flow. When managing and protecting groundwater resources in the Kosonsoy basin, the above conclusions must be taken into account.

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References

1. Soliyev I.R. Farg'ona vodiysi yer osti suvlari rejimiga iqlim isishi va antropogen omillarning ta'siri. Namangan. Fazilat. 2018. – 135 b.
2. Soliyev I.R., Kamolov B.A. Shimoliy Farg'ona yer osti suvlari sathining iqlim isishiga reaksiyasi // O'zMU xabarlari. – 2017. – № 3/1-son. 299–303 b.
3. Soliyev I.R., Kamolov B.A. Evaluation of changes of level of groundwater in Fergana valley under the influence of climate warming // International Journal of Geology, Earth and Environment Sciences. India. – 2018, vol. 8 (2) May–August, pp. 14–17.
4. Kamolov B.A., Soliyev I.R. Reaction of groundwater regime of river basins of south Fergana on global warming // European science review. Austria, Vienna – 2016 vol. № 9–10, pp. 32–34.
5. Kamolov B.A., Soliyev I.R. Janubiy Farg'ona yer osti suvlarining global iqlim isishiga reaksiyasi // O'zbekiston geografiya jamiyati axboroti. 2016 – 47-jild. 169–173 b.
6. Kamolov B.A., Soliyev I.R. Yer osti suvlari sathi o'zgaruvchanligini baholash (So'x va Isfara yer osti suv konlari misolida) // O'zbekiston geografiya jamiyati axboroti. 2017 – 50-jild. 198–203 b.
7. Soliyev I.R. So'x daryosi havzasidagi yer osti suvlari rejimining global isishga reaksiyasi // O'zbekiston geografiya jamiyati axboroti. 2015 – 46-jild. 194–196 b.
8. Kamolov B.A., Soliyev I.R. Yer osti suvlari sathi o'zgarishini statistik tahlil qilish usullari // Gidrogeologiya, injiniring geologiyasi, geoekologiyaning zamonaviy muammolari va ularni yechish yo'llari xalqaro ilmiy-texnik konferensiyasi materiallari, "GIDROINGEO instituti" DK – Toshkent 2015. 314–317 b.
9. Kamolov B.A., Soliyev I.R. Farg'ona vodiysi daryolari oqimi va yer osti suvlari sathi o'rtasidagi bog'liqlikni baholash // Geografiya XXI asrda: muammolar, rivojlanish istiqbollari. Respublika ilmiy-amaliy konferensiyasi materiallari. SamDU – Samarqand 2017. 104–105 b.

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