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HYDROLOGICAL JUSTIFICATION OF THE ARTIK RESERVOIR VOLUME

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Abstract

The river flow within the territory of Armenia is distributed rather unevenly across space and time. The predominant portion of the river flow is generated during spring, primarily due to snowmelt and precipitation. From this perspective, it becomes necessary to store the river flow generated in spring for its use during the low-water periods of summer and autumn, ensuring water supply for irrigation and other purposes. Considering this, it is proposed to reconstruct the Artik reservoir on the river Artikjur with a capacity of up to 1.2 million cubic meters.

Keywords: *water resources, climate change, hydrological observation point, river flow, water discharge, dam.*

Introduction

Under the conditions of global climate change, a decline in river flow is observed in the South Caucasus. The projected increase in demand for freshwater in future, coupled with its inefficient use, necessitates the development and implementation of fundamental measures and plans to enhance the efficiency of water resource and water system management. These projects must be based on the capability to manage and plan the quantitative and qualitative characteristics of water resources and their variations.

According to the RA Government Decision № 1902-N, dated November 18, 2021, within the frame of the Government's Action Plan for 2021-2026, it is envisaged to construct 15 reservoirs in the country by 2026, with a total volume of 206 million m^3, including the Artik reservoir with a volume of 1.7 million cubic meters.

The Artik reservoir is planned to be constructed on the territory of the former reservoir, located to the northwest of Artik city, on the Artikjur which is left tributary of Karkachan river. According to long-term observation data of the Artik meteorological Station, the average annual temperature is 6.3°C. The warmest months are July and August, with average monthly temperatures of 18.3 and 18.4°C, respectively. The coldest month is January, with an average monthly temperature of -7.0°C:

The absolute minimum temperature recorded was -26.3°C, and the absolute maximum temperature was 35.9°C.

The annual precipitation is 554 mm, moreover 141 mm of that is falling between November and March and 413 mm between April and October. The highest precipitation is recorded in May, while the lowest occurs in January [1]. The length of Artikjur river is 26 km, and it flows into Karkachan river 19 kilometers upstream from its mouth. It originates from the northwestern slope of Mount Aragats. The catchment area is 77.0 km², and the average elevation of the catchment basin is 2,350 meters. Due to the collapse of the Artik reservoir dam, the design of the new reservoir required enhancement of all morphometric data of Artikjur River, as well as the data of two ravines on the left bank of the river Karkachan, from where water is planned to be transferred to the Artik reservoir. Based on the above, all hydrological characteristics were recalculated, and actual measurements of water discharge were conducted.

The calculations were based on the observational data of Karkachan river from 1942 to 2022 [2].

Conflict Setting

In conditions of climate change, managing the spatiotemporal variation of river flow is crucial for water resource planning, as well as for forecasting and prevention of water-related disasters in Armenia. Hereby, through storing spring runoff in reservoirs and using it during the low-water periods in summer and autumn for water supply in various economic sectors, the risks associated with water scarcity for irrigation and water supply are reduced on the one hand and on the other - material costs are minimized.

Based on the afore stated the need for the construction of the Artik reservoir and its volume has been substantiated, considering circumstances related to climate change.

Research Results

As already mentioned, the Artik Reservoir is to be constructed on the Artikjur tributary of the Karkachan river, on the site of the former reservoir (Fig. 1).

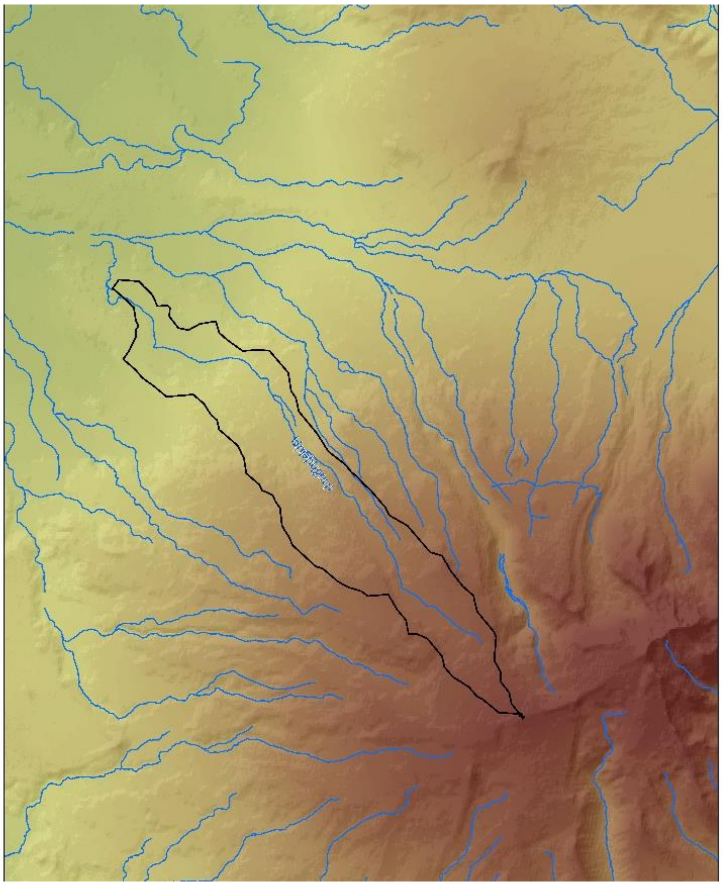

Fig. 1. Catchment basin of the river Artikjur
at the vertical cross section of the Artik reservoir.

The hydrological calculations for the Artikjur river were carried out using data from the Karkachan-Gharibjanyan hydrological observation point for the period 1942-2022, the latter taken as an analogous object [3], as no studies have been conducted on the water regime of the river Artik (tab. 1).

Table 1

The main hydrographic descriptors of the Karkachan-Gharibjanyan hydrological observation point

Name of the observation point	Distance from the estuary, km	Elevation, m	Catchment basin area, km^2	Mean elevation of the catchment basin in the observation point, m
Karkachan-Gharibjanyan	2,5	1461,37	1020	2020

To obtain the annual flow volume in the estimated vertical cross section of the river Artik, a transfer coefficient was used, equal to the ratio of the catchment areas of the calculated and analogous cross sections. The river's average monthly and annual data were calculated based on the 80-year observational data series [4].

The catchment area of the Artikjur river at the reservoir cross-section is 65.4 km². The values of the long-term average monthly calculated discharges of Artikjur river at the reservoir cross-section are presented in tab. 2.

Table 2

The long-term average monthly calculated discharges of Artikjur river at the reservoir cross-section

Name	Average monthly discharges, m^3/s												Annual average
	1	2	3	4	5	6	7	8	9	10	11	12	
Reservoir vertical cross section	0.047	0.050	0.072	0.10	0.12	0.076	0.039	0.036	0.042	0.056	0.054	0.048	0.062

According to the calculation results, the long-term average annual flow volume of the Artikjur river at the reservoir cross-section is 1.96 million m³. Subsequently, the main hydrological characteristics of the average flow of the River Artikjur at the reservoir cross-section were estimated (tab. 3).

Table 3

The main hydrological descriptors of the average flow of Artikjur river at the reservoir cross-section

Name	Catchment basin area, km^2	Mean elevation, m	Annual flow rate, m^3/s	Annual flow module, $l/s.km^2$	Variation coefficient, Cv	Asymmetry coefficient, Cs
Reservoir vertical cross section	65.4	2365	0.062	0.95	0.31	2.5Cv

In hydrological calculations, particularly when estimating reservoir volumes, it is crucial to determine the values of annual average discharges for different percentiles [3]. These calculations are presented in tab. 4.

Table 4

The main hydrological descriptors of the average flow of Artikjur river at the reservoir cross-section

Name	Percentile, %										Annual average, m^3/s
	1	5	10	25	50	75	90	95	97	99	
Reservoir vertical cross section	0,15	0,11	0,10	0,08	0,06	0,04	0,03	0,03	0,02	0,02	0.062

The intra-annual distribution of the Artikjur River's flow has a distinctly seasonal nature, with the majority of the flow occurring from April to June.

To evaluate the volume of reservoirs, it is also important to know the annual volume of potential evaporation from the water surface. The volume of evaporation from the water surface was estimated using an empirical method [5] and amounts to 0.063 million m^3.

The intra-annual distribution of the average flow in the cross-section of the river Artikjur was also assessed based on water availability. For a low-water year (with 75% discharge percentile), the annual flow volume is estimated at 1.19 million cubic meters.

Conclusion

As previously mentioned, calculations indicate that the annual flow volume of the river Artikjur in the reservoir's cross-section, with the exceedance probability of 75% is 1.19 million cubic meters. Besides this, hydrometric measurements were conducted [6, 7] during the spring and summer months of 2023 and 2024 in the Artikjur river's reservoir cross-section with the aim of assessing the available water resources therein more accurately. For example, during the hydrometric measurements conducted in April 2024, a discharge rate of 0.092 m^3/s was recorded.

Considering the vulnerability assessments of river flow in Armenia [8] under the pessimistic RCP8.5 emissions scenario in the context of climate change, i.e., projecting reductions of 8.3% by 2040, - 13.2% by 2070, and -19.8% by 2100—the flow volume of the river Artikjur is expected to decrease from 1.19 million cubic meters to 0.95 million cubic meters by 2100. As a result, by 2100, the river inflow volume into the Artik reservoir is projected to be 0.96 million cubic meters. Under an optimistic scenario, the construction of a reservoir with a capacity of 1.2 million cubic meters would be fully justified, whereas the water supply for a reservoir with a capacity of 1.7 million cubic meters would be highly risky.

Based on the analysis of calculated and observed data, it is recommended to refrain from reconstructing the Artik reservoir with a capacity of 1.7 million cubic meters. Instead, it is deemed more appropriate to implement the project with a capacity of up to 1.2 million cubic meters.

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ԱՐԹԻԿԻ ՋՐԱՄԲԱՐԻ ԾԱՎԱԼԻ ՀԻԴՐՈԼՈԳԻԱԿԱՆ ՀԻՄՆԱՎՈՐՈՒՄԸ

Է.Է. Միսակյան, Վ.Հ. Թոքմաջյան, Գ.Լ. Հայրիյան, Գ.Հ. Մարտիրոսյան
Ակադեմիկոս Ի.Վ. Եղիազարովի անվան Ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Հայաստանի տարածքում գետային հոսքը տարածության և ժամանակի մեջ բաշխված է խիստ անհավասարաչափ: Գետային հոսքի հիմնական մասը ձևավորվում է գարնանը ձնհալքով և տեղումներով պայմանավորված: Այս տեսանկյունից անհրաժեշտություն է առաջանում ամբարել գարնանը ձևավորված գետային հոսքը ամառ-աշնանային սակավաջուր ժամանակահատվածում այն ոռոգման և այլ նպատակներով ջրամատակարարման նպատակով: Հաշվի առնելով դա առաջարկվում է Արթիկջուր գետի վրա վերակառուցել Արթիկի ջրամբարը մինչև 1,2 մլն մ^3 ծավալով:

Բանալի բառեր. գետային հոսք, ջրային ռեսուրս, կլիմայի փոփոխություն, հիդրոլոգիական դիտակետ, ջրի ելք, ջրամբար:

ГИДРОЛОГИЧЕСКОЕ ОБОСНОВАНИЕ ОБЪЕМА АРТИКСКОГО ВОДОХРАНИЛИЩА

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Речной сток на территории Армении распределен весьма неравномерно в пространстве и времени. Основная часть речного стока формируется весной за счет таяния снегов и осадков. С этой точки зрения необходимо сохранять образовавшийся весной речной сток с целью орошения и подачи воды на другие цели. С учетом этого предлагается реконструировать Артикское водохранилище на реке Артикюр объемом до 1,2 млн м^3.

Ключевые слова: речной сток, водные ресурсы, изменение климата, гидрологический наблюдательный пункт, расход воды, водохранилище.

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