

PROTECTION OF BIODIVERSITY IN BERGUSHAD AND HAKARY RIVERS

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Abstract. The water resources formed in the territory of the liberated Karabakh region have special importance in the sustainable water supply of the republic. By using these water resources effectively and comprehensively, it is possible to reliably supply water to the population located in the territory of the liberated Karabakh and East Zangezur economic regions. It is necessary to efficiently use the water resources of these rivers, which are very loaded in autumn and spring. It is possible to fully meet the electricity demand of the population living in these economic regions by building hydraulic engineering devices for various purposes on these rivers and create large fishing farms by using the water resources that will be collected in the reservoir basins. In the article, the issues related to the management of the water resources of the Barghushad and Hekari Rivers, which have great hydropower and biological potential. Only the hydropower potential of the Okhchu River, which is located in the area and extremely polluted by Armenia, can be used. The water of the Okhchu River, which is extremely toxic and polluted with heavy metals, poses a serious threat to the fish stock of the Khudafar reservoir built on the Araz River.

Keywords: *Water supply, river, water resources, reservoir, channel.*

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1. Introduction

The water resources formed in the territory of the Eastern Zangezur region liberated from occupation have a special importance in the sustainable water supply of the republic. By efficiently and comprehensively using these water resources, the fertile lands located in the liberated Karabakh and East Zangezur economic regions can be connected to the agricultural cycle and the population can be settled quickly. These rivers have a huge energy potential and by building hydro-technical facilities of various purposes on them, it is possible to fully meet the electricity needs of the population living in these economic regions (Museyibov, 1998; Hasanov & Zamanov, 1973; Mammadov, 2002; Rustamov & Kashkai, 1989). Protection of biodiversity and water resources of the transhybrid waters of the South Caucasus, including the Araz River and its tributaries, is possible only with the effective use of international standards in this field. The neighbouring country (Armenia) is exposed to pollution as the Araz River and its tributaries.

Okhchu River, which is 83 km long and has a water catchment area of 1175 km² originates from Kapticic Mountain (3285 m) of the Zangezur Range. The annual water reserve of the Okhchu River is 317.0 million cubic meters. Average water consumption

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is 10.0 m³/sec. The river enters the territory of our republic at an absolute level of 630.0 meters and after 30 km flows into the Araz River at an absolute level of 300.0 meters. Between Armenia and Naxchivan MR (Surenavan village of Sadarak) in the water of Araz, phenols are 220-1160 times, heavy metal salts are 36-44 times (copper, polypden, etc.), nitrogen phosphorus salts are 26-34 times, chlorides are 28 times, hydrocarbons of petroleum origin are 73-113 times higher than the harmful contribution.

One of the most polluting rivers of the region is Okhchuchay. Hundreds of thousands of tons of wastewater, heavy metal salts and other wastes from the Mehri, Gajaran, Gafan and Datsikert mining (metal refining) complexes pollute Okhchuchay excessively. At different times, the amount of copper in the water was 25-50 times higher and the amount of phenols was regularly 6-15 times higher than the normatives. Aluminium, zinc, manganese, titanium and other polluting elements are found in Okhchuchay.

The city of Zangilan and the settlement of Minjivan of Azerbaijan are also located on the banks of this river. The annual hydropower potential of the river is 130 million kWh. The water of this river, which is a large water resource of the region, has been polluted for many years by the industrial waste generated in the copper-molybdenum mines located around the cities of Gafan and Gajaran in the territory of Armenia. The pollution of the river exceeded all norms and became extreme and its fauna was completely destroyed. Currently, Okhchu River is included in the list of the most polluted rivers in the world. River water is not used for water supply and irrigation.

In January-March 2021, water samples taken from Okhchuchay were found to be highly contaminated with heavy metals. According to the report of the Ministry of Ecology and Natural Resources of Azerbaijan, the amount of copper-molybdenum compounds in the water is twice the norm, the amount of iron is four times and the amount of nickel is seven times more. Water samples taken from Okhchuchay show that there is a serious threat to the environment. The water of the river is coloured either white or yellowish from time to time. Using only the hydropower potential of this river is considered more appropriate from an economic and ecological point of view (Rustamov & Kashkai, 1989; Geography of Karabakh and Eastern Zangezur, 2021; Mammadov *et al.*, 2023a; Mammadov *et al.*, 2023b; Majidli, 2023).

2. Name of the section

The water resources of the Hekari River, which is located in Eastern Zangezur and is mainly formed in the territory of the republic, are currently not being used efficiently. The water of this river fully meets drinking water standards in terms of quality and is of great importance in ensuring the safety of the water supply for the population of the republic. Khochaz and Shalva tributaries of the river are formed as a result of the melting of springs and glaciers located in the mountain range of the Lesser Caucasus and are not subject to any pollution. The location of the main part of the water catchment basin of the river on a higher terrain gives a wide opportunity to use its hydropower potential to get electricity and to use the water in the self-flowing mode in the water supply of the big cities of the republic. Currently, the construction of the “Zarisli” water reservoir at the absolute level of 670.0 m is underway on the Hekari river. The water reserve that will be collected in this reservoir, which will have a volume of 30.0 million cubic meters, will be used to irrigate the surrounding areas. “Zarisli” reservoir is located 36 km above the

confluence with the Bargushad river (Geography of Karabakh and Eastern Zangezur, 2021, Mammadov *et al.*, 2023a; Mammadov *et al.*, 2023b).

Bargushad River is one of the most prosperous rivers of the Eastern Zangezur region. Up to 85% of the water resources of this river are formed in the territory of Armenia, 4 dams and hydroelectric power stations have been built on the river in the territory of Armenia and its annual flow is fully regulated and enters the territory of the republic. Currently, the construction of the “Bakhtiyarli” reservoir with a volume of 70.0 million cubic meters is underway in the course of the Bargushad River, above the city of Gubadli, at an absolute level of 540.0 m. “Bakhtiyarli” reservoir is located 27 km above the confluence with the Hekari river. Hekari and Bargushad rivers merge near Karalar village of Gubadli district and after 12.5 km enter Khudafar reservoir. Thus, the movement of fish in these two rivers takes place between the three existing reservoirs. It should be noted that no fish transfer devices were built around the dams of the “Zabukh” and “Bakhtiyarli” reservoirs.

The entry of highly polluted waters from the Okhchu River into the Araz River has a serious negative impact on its wildlife, which indirectly affects the fish stocks of the Hekari and Bargushad rivers as well. The research conducted by the biologists of the Islamic Republic of Iran in the Khudafar reservoir shows that, due to the influence of the Okhchu River, there is a mass killing of fish in the reservoir from time to time (Geography of Karabakh and Eastern Zangezur, 2021, Mammadov *et al.*, 2023a; Majidli, 2023).

Proposals regarding the use of hydropower potential of Okhchuchay. Protecting the ecosystem of the Okhchu River and using its hydropower potential can be solved within the framework of one project. For this, at the place where the river enters the territory of the republic, a regulatory dam with a volume of 5-6 million cubic meters should be built at the level of 630 meters and highly polluted river water entering the territory should be removed from the channel. For this, at the place where the river enters the territory of the republic, a regulatory dam with a volume of 5-6 million cubic meters should be built at the level of 630 meters and highly polluted river water entering the territory should be removed from the channel. The river water collected in this reservoir will be transferred to the “Zangilan-1” HPP, which will be built near the city of Zangilan at a level of 470 meters, with a total installed capacity of 9.0 MW, by diverting it from the channel by means of a derivation pipe with a diameter of DN 2200 mm and a length of $L=13.0$ km. It will be possible to produce 70 million kilowatt hours of electricity per year through this HPP.

The river water from the first HPP will be diverted from the channel by means of a derivation pipe with a diameter of DN 2200 mm and a length of $L= 17.0$ km and will be transferred to the “Zangilan-2” HPP, which will be built at the level of 300 meters on the bank of the Araz river, with a total installed capacity of 6.5 MW. It will be possible to produce 80 million kWh of electricity per year by means of this Hydroelectric Power Station (Figure 1). It is possible to provide more than 120,000 people with uninterrupted Green Energy by using the electricity produced in both HPPs.

Transferring the river water out of the channel and transporting it in transit will create ample opportunities for the protection of the ecosystem of the river channel. The course of the river will mainly contain clean water originating in the territory of the republic, which is of great importance for the protection of underground water. With the implementation of the planned project, it is possible to achieve substantial mitigation of the environmental disaster around the course of the Okhchu River and to obtain a sufficiently large amount of electricity.

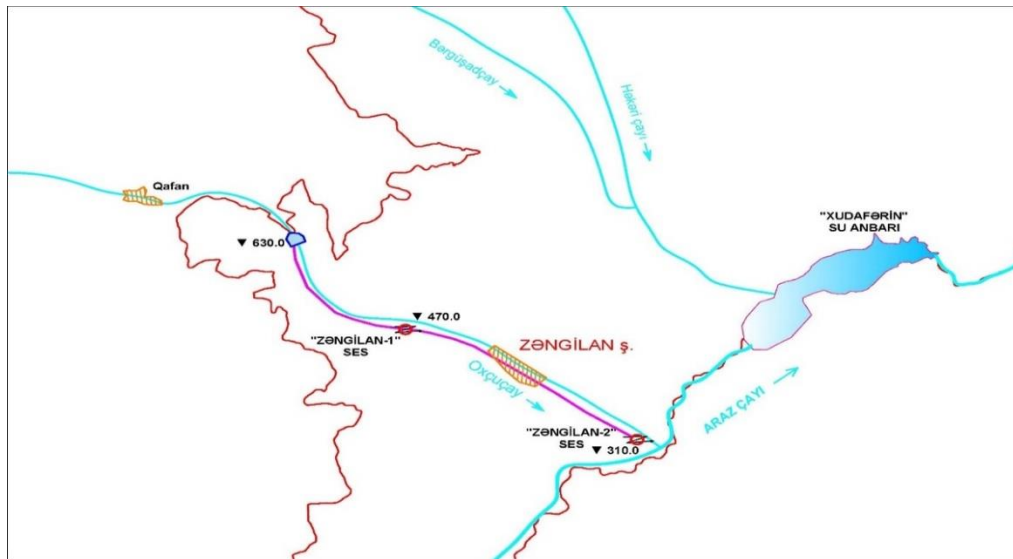


Figure 1. The location plan of HPPs planned to be built on Okhchu River

Integrated use plan of water resources of Barghusad and Hekari rivers.

Currently, the water resources of the Hekari and Barghusad rivers are used sparingly. According to the hydrological point where the rivers merge, the annual water reserve of the Barghusad River is estimated at 500 million m^3 (except for 250 million m^3 used in the territory of Armenia) and the annual water reserve of the Hekari River is estimated at 500 million m^3 . Thus, a total of 1.0 billion m^3 of flow enters the Araz River every year through these rivers. According to the agreement concluded with the Islamic Republic of Iran on the joint use of the water resources of the Araz River, 50% of the water resources of this river are to be used proportionally for each republic. According to this agreement, we can use only 500 million m^3 of the flow volume entering the Araz River through the Barghusad and Hekari Rivers.

The Bargushad River, which is 178 km long and has a basin area of 2711 km^2 , originates from the Zalkha Lake located at an altitude of 3040 m, on the northern slope of the Zangezur range. Bargushad River enters the territory of our republic near Eyvazlar village of Gubadli district merges with Hekari River near Karalar village of the district and flows into Araz. At the place where it flows into the Hekari River, the average annual water consumption of the river is 24.0 m^3/sec . 2.0 m^3/sec part of this flow is formed after the border of Armenia. The multi-year average water consumption of the river in Eyvazlar district is 22.0 m^3/sec . The main part of the river flows in the territory of Armenia. On the territory of Armenia, the annual flow volume has been fully regulated by building 4 reservoirs with a total volume of up to 300.0 million m^3 and several HPPs on the Bargushad River.

As we mentioned above, the Bargushad River is mainly regulated in the territory of Armenia and enters the territory of the AR and therefore the flow of the river has very little bottom and suspended sediments and the flow enters the territory of the republic in a clear state. In the river, spring and autumn rushes are mostly not felt. Using the water resources of the Bargushad River in the following form can create an opportunity for the rapid development of the economy in the region:

- Construction of the “Bakhtiyarli” water reservoir, which will have a volume of up to 70 million cubic meters, near the village of Bakhtiyarli in the course of the river;
- Construction of “Bakhtiyarli-1” HPP with a capacity of 10.5 MW using the 120.0 m drop in the river between Eyvazli village and Bakhtiyarli reservoir;
- Measures related to ecosystem protection and irrigation use of up to 250.0 million m³ of the river's total water resources locally and downstream of the reservoir;
- Measures related to diverting up to 250.0 million m³ of water resources of the river to irrigate agricultural fields of the Zangilan and Jabrayil regions.

It flows from the state border to the newly built “Bakhtiyarli” water reservoir in a 15 km long river channel, which is a sufficient hydropower potential. To effectively use the hydropower potential of the Bargushad River, which enters the territory of the AR under regulation, there is a wide opportunity to build a derivation-type HPP. It is possible to create a pressure of up to 120 meters by building a daily regulating reservoir-water receiving device in the river channel near Eyvazli village of Gubadli district, directing the river flow to the derivation pipe with a diameter of DN3000 mm and bringing it to the newly built “Bakhtiyarli” reservoir. The capacity of the derivation-type “Bakhtiyarli-1” HPP will be 10.5 MW. This HPP will be able to produce approximately 110.0 million kWh of electricity during the day, which will allow the uninterrupted supply of electricity to more than 80,000 people (Mammadov *et al.*, 2023a; Mammadov *et al.*, 2023b).

In order to use the water resources of the river more efficiently, it is planned to build the Bakhtiyarli reservoir (“Bakhtiyarli” reservoir at an absolute level of 540 m above the city of Gubadli). According to the conducted preliminary hydrological reports, it is planned to store up to 250.0 million m³ of the total water resources of the Bargushad River in the lower part of the newly built “Bakhtiyarli” reservoir for ecosystem protection and local use.

The **Hekari River**, which is 113 km long and has a basin area of 2,570 km², originates from the southern slope of the Mikhtöken ridge at an altitude of 2,580 m. Near the village of Garalar in Gubadli district (at an absolute level of 340 m), the Hekari River, with merging of Bargusad River, forms the Bazar River. At the confluence with the Bazar River, the annual water supply of the Hekari River is 500.0 million cubic meters. The annual average water consumption of the Zabukh River (Abdallar district) until it joins is estimated at 10.2 m³/sec. The main water supply of the river (up to 300.0 million cubic meters) originates from the confluence of the Shalva and Khojazsu rivers (950 m). The average annual water consumption of the Zabukh River was estimated at 5.15 m³/sec. In spring and summer, melting snow causes floods in the river. During the flood period (April-June), 60-70% of the annual flow passes through the river. The minimum water consumption in the river is observed in winter months. The average mineral level of the water is 200 mg/l. The main water regime phase of the Hekari River is the spring rush. The role of groundwater feeding in the water balance of the river is very huge. In the Abdallar district of the Hekari River, groundwater accounts for 48% of the annual flow, in the Hochazsu tributary, 63% and in the Zabukh tributary, 88%.

In order to use the water resources of the river more efficiently, it is considered appropriate to use the annual flow volume (up to approximately 270.0 million m³) formed at the confluence of the Shalva and Khojazsu rivers (at an absolute height of 950 m) within the borders of the republic as a whole for the population's water supply. In this part of the river, it is planned to build the Hekari Reservoir, which will have a volume of 70.0 million cubic meters.

About 230 million cubic meters of the river's water resources are planned to be stored in the lower part of the reservoir for ecosystem protection and local use. However, the Zabukh River, which has an annual water supply of up to 165 million cubic meters, needs to be regulated after joining the Hekari River. Taking this into account, the construction of the “Zabukh” water reservoir is underway in the course of the Hekari River, at an absolute level of 670 m.

Part of the water of the Hekari River will be collected in the “Zabukh” reservoir and used for irrigation. According to the project documents, in the lower part of this water reservoir, the river flow will remain up to 150 million cubic meters per year for the protection of the ecosystem.

Thus, after the partial regulation of the flow regime of both rivers, the total annual flow volume coming to the Araz River will be approximately 400 million m³. It is envisaged that 200 million m³ of this flow will be used for technical and irrigation purposes in the villages along the road (along both rivers) (about 20 thousand ha of cultivated land). Taking into account the release of up to 70 million m³ of sanitary flow to the Araz River for the protection of fisheries, up to 130 million m³ of flow volume will be generated at the confluence of the rivers for irrigation. This water reserve is also supposed to be used for irrigation (Mammadov *et al.*, 2023a; Mammadov *et al.*, 2023b).

In order to protect biodiversity and increase the fish stock in the Hekari and Barghusad rivers, it is considered appropriate to regulate their downstream flows and release them into the Khudafarin reservoir. For this purpose, the construction of the Hekari-Barghusad reservoir with a total volume of 60-70 million m³ at the confluence of the rivers, at an absolute level of 340 m, is considered acceptable from an environmental point of view. In the newly created “Hekari-Barghusad” reservoir, there will be a favourable opportunity to increase the species of fish typical for these rivers and at the same time, it will be possible to use a part of the volume of flow collected in this reservoir during the year for irrigation. The General Plan for the use of the water resources of the Barghusad and Hekari rivers for the development of fisheries is given in Figure 2.

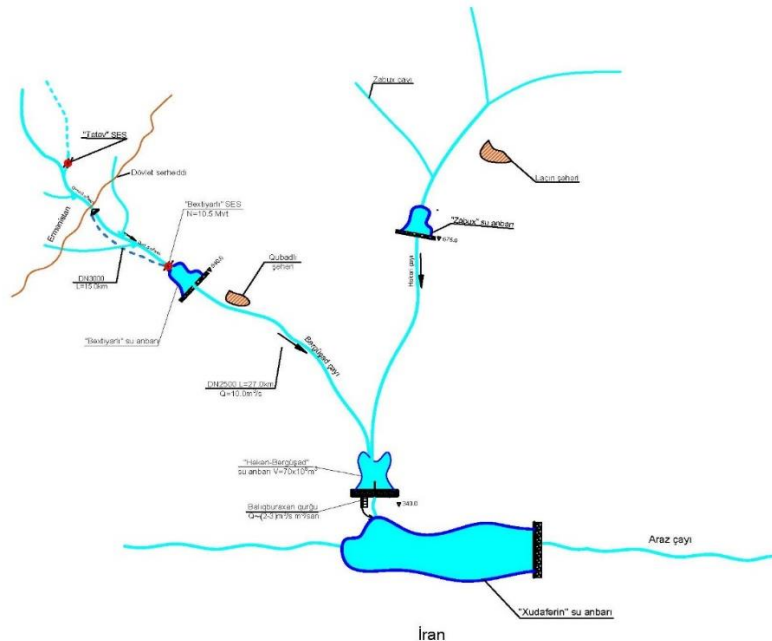


Figure 2. General Plan of using the water resources of Barghusad and Hekari rivers for fishing purposes

It is planned to build a fish-releasing facility to connect the fish breeding plant to be created in the water reservoir in the confluence zone of the Hekari and Barghusad rivers with the Khudafarin reservoir. This facility will allow the migration of fish by releasing up to 60-70 million cubic meters of water from the new reservoir to be built into the Khudafarin reservoir. The system of facilities to be created in this way will create an opportunity to protect and develop the biodiversity of the Hekari and Barghusad rivers. The system of devices will allow to prevent the impact of highly polluted waters entering from Okchuchay into the Hekari and Barghusad rivers, caused by the massive fish kill observed in the Khudafarin reservoir from time to time.

3. Conclusion

Main results

1. Since the flow of the Bargushad River is fully regulated in the territory of Armenia and enters the territory of the republic, the flow of the river fluctuates within the range of 11-33 m³/s during the day.

2. With the new “Bakhtiyarli” and “Zabukh” water reservoirs to be built, the flow regimes of the Bargushad and Hekari rivers will be regulated in the territory of the Republic. In order to protect biodiversity in the Bargushad river, 250 million cubic meters of water and 150 million cubic meters of water in the Hekari river are planned to be released from the reservoir.

3. After the flow regime of both rivers is partially regulated, the total annual flow volume towards the Araz River will be approximately 400 million m³. 200 million m³ of this flow volume is planned to be used for technical and irrigation purposes in the villages located along the road (along both rivers).

4. In order to protect biodiversity and increase fish stocks in Hekari and Barghusad rivers, it is considered appropriate to regulate their downstream flows and release them into the Khudafar reservoir. For this purpose, the construction of the Hekari-Barghusad reservoir with a total volume of 60-70 million m³ at the confluence of the rivers, at an absolute level of 340 m, is considered acceptable from an environmental point of view. In the newly created “Hekari-Barghusad” reservoir, there will be a favorable opportunity to increase the fish species typical for these rivers and at the same time, it will be possible to use a part of the flow volume collected in this reservoir during the year for irrigation.

5. The newly created “Hekari-Bergushad” water reservoir will allow to prevent the impact of the massive fish kills observed in the Khudafar reservoir from time to time due to the highly polluted waters entering from Okchuchay entering the Hekari and Bargushad rivers.

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