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THE EFFECT OF AKSAI RIVER WATER HARDNESS ON HYDROBIONTS

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Abstract

The study "The Effect of Aksai River Water Hardness on Hydrobionts" aims to investigate the impact of water hardness in the Aksai River on aquatic organisms. The research employs a comprehensive analysis of hydrobionts' response to varying water hardness levels, focusing on their physiological and ecological adaptations. The investigation utilizes field surveys, water quality analyses, and laboratory experiments to gather data on hydrobiont populations and their health in relation to water hardness. Preliminary results indicate a correlation between elevated water hardness and adverse effects on hydrobionts, emphasizing the need for further monitoring and potential mitigation strategies. The comprehensive data obtained from organoleptic, chemical, and microbiological assessments contribute to a better understanding of the habitat conditions for fish, especially the valuable Caucasian trout. The findings emphasize the importance of considering water quality parameters for sustainable aquatic ecosystems and the preservation of diverse hydrobionts. Further research and monitoring efforts may be necessary to ensure the continued well-being of the Aksai River and its aquatic inhabitants.

Keywords: Hidrobionts, ions, organoleptic analysis, rigidity, turbidity, water hardness

1. Introduction

The Aksai River (Figure 1) originates on the northern slope of the Andi Ridge and flows into the Aksai Reservoir, connected to the Aktash River by a channel, 144 km long and with a catchment area of 1390 km²

The character of the river changes with altitude - in the upper reaches it is mountainous, and in the lower reaches it becomes flat. The Aksai is mostly fed by groundwater. The river is characterized by a flood regime in the warm part of the year and a low winter low-water. The natural water regime downstream the village of Gerzel-Aul is distorted by intensive water intake for irrigation (Fatkhi & Seidinov, 2021; Vysotsky & Golovatenko, 2020). The lower reaches of the river are characterized by high sediment load.
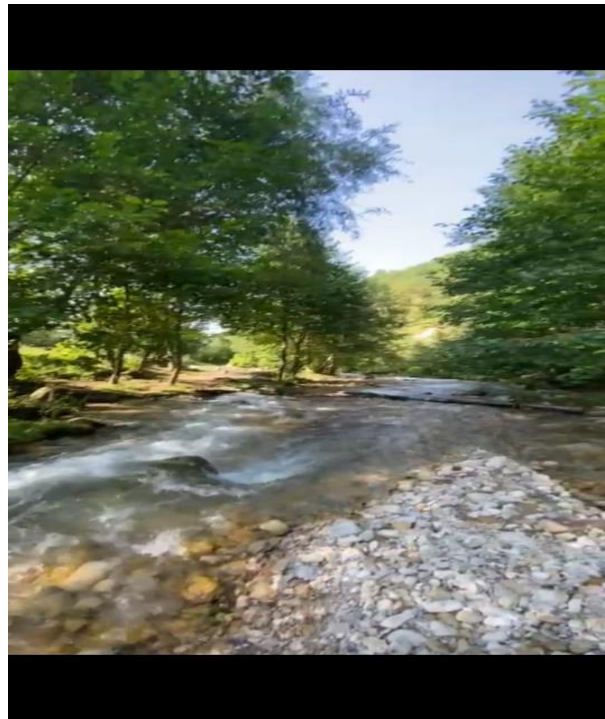

Figure 1. Aksai river

The Aksai River, like almost all the rivers of the Republic, has a pronounced mountain character, originating on high ridges from springs. Aksai has a rapid rapid flow and impressively vivid power, the regime of the river during the year is subject to great changes, depending on the conditions of its habitat, in particular, is characterized by sharp rain floods in the summer (Report of the Office of the Federal Agency for Cadastre of Real Estate Objects in the Chechen Republic, 2009).

The water of rivers, in contact with other substances, dissolves them and travels with them everywhere, picking up new constituent elements along the way or dissolving some and releasing others (Khramov et al., 2019; Krasnoperova, 2022). Thus, during its long journey among the rocks water is enriched with various minerals, in particular salts of calcium and magnesium. It is their content that determines its property, such as hardness: the more calcium and magnesium salts in water, the harder it is (Saidova et al., 2014).

Total water hardness is an extremely important parameter for the physiological state of hydrobionts. Some of the fish species prefer soft water, others - medium hardness, others - hard.

The most of the fish species are quite capable of adapting to changing conditions, including unfamiliar hardness (or, conversely, softness) of water.

2.   Problem Statement

The problem addressed in this study revolves around the impact of water hardness in the Aksai River on hydrobionts, particularly trout fish. The Aksai River, located in the Chechen Republic, exhibits variations in water hardness along its course, with softer, muddier water found where the river intersects with blue clay, inhabited by Barbel fish. Conversely, trout, known as the "King fish" of the salmon family, favor ecologically clean and crystal-clear water, avoiding polluted or muddy conditions. This study aims to explore how changes in water hardness affect the distribution and health of hydrobionts, particularly trout, in the Aksai River ecosystem. Through field observations, water quality analyses, and ecological assessments, the research seeks to understand the physiological and ecological responses of hydrobionts to varying water hardness levels. By elucidating the relationship between water hardness and hydrobiont populations, the study aims to provide valuable insights for the conservation and management of aquatic ecosystems in the region.

The Aksai River flows on the territory of the Chechen Republic in the village of Dargo, Vedeno District. The mouth of the Aksai River is inhabited by trout fish. And where the river comes in contact with the blue clay, the water becomes soft and muddy, inhabits the Barbel fish. It is the change of one hydrobiota to another comes to change water hardness (Kurdyukova & Timofeeva, 2022; Nushtaeva, 2019).

Trout is the most valuable freshwater fish, also called "King fish" of the salmon family (Salmonidae). In the Caucasus inhabits a particular species of trout - the Caucasian trout - Oncorhynchuscaucass or also called brook trout, which differs from other salmon fish by its caution and shyness, which makes it difficult to catch in their natural habitat. Trout are omnivores and greedily grab all live small insects that fall into the water. Larger trout fish eat snails and frogs. Trout do not live in polluted, muddy water, they prefer only ecologically clean and crystal clear water. This is most likely the reason why its meat is so delicious and tender, white, pinkish or yellow depending on the composition of water and fish nutrition, and it just melts in the mouth. Trout, which is found in streams and mountain rivers of the Caucasus, is considered the most valuable and most delicious fish (Nazarov et al., 2016).

Aksai is a river that flows through the territory of the Chechen Republic and Dagestan, the length of the river is 144 km. The basin area is 1,390 km². The river begins on the slope of the Andi Ridge and flows into the Aksai Reservoir, which is connected with the Aktash River by a canal. The character of the river changes as its altitude changes (Figure 2).
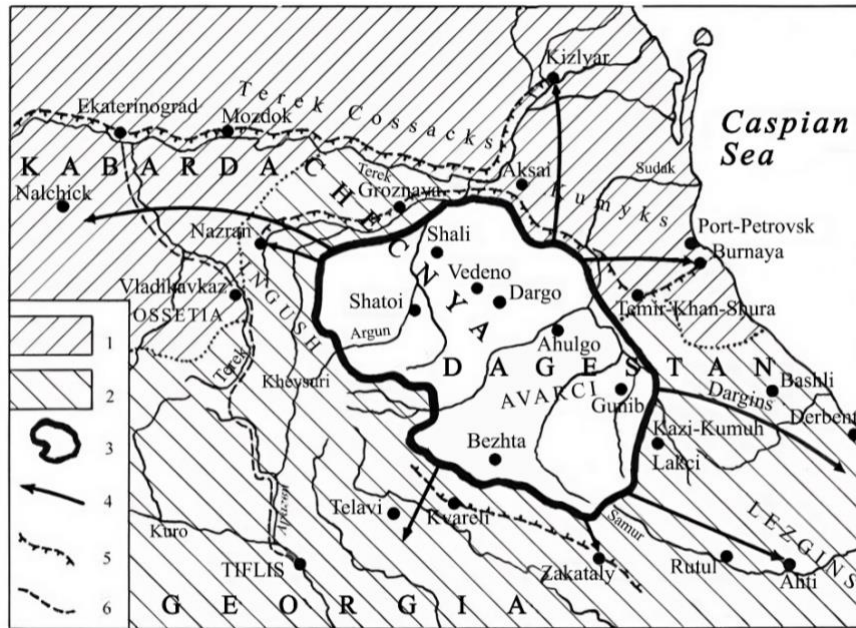
Figure 2. Aksai River water sampling points

3.   Research Questions

In this study, the research questions aim to comprehensively assess the Aksai River's water quality and its impact on hydrobionts, particularly trout and barbel fish. Organoleptic factors, chemical parameters related to sanitary and hygienic standards, and bacteriological and parasitological composition are examined to provide a thorough understanding of water conditions. Additionally, the study acknowledges the potential influence of temperature variations, both in the water and air, during the sampling process. The goal is to explore the correlations between water hardness, environmental factors, and the health of hydrobionts in the Aksai River, with a specific focus on the habitat preferences of trout and barbel fish.

4.   Purpose of the Study

The study utilizes a multidisciplinary approach, combining organoleptic, chemical, bacteriological, and parasitological analyses to comprehensively assess the quality of water in the Aksai River. Water samples were collected from various points along the river in the Vedeno district of the Chechen Republic, and laboratory tests were conducted to evaluate parameters such as pH, turbidity, dissolved oxygen levels, microbial contamination, and the presence of parasites. Additionally, the study considers environmental factors such as temperature variations, which may impact water quality and the habitat suitability for hydrobionts. The findings provide insights into the overall health of the Aksai River ecosystem and its potential implications for fish populations, particularly trout and barbel fish (Ataeva, 2018).

5. Research Methods

The study employed various analytical tools and equipment, including the Ecotest-2000 liquid analyzer, VLTE-500 laboratory scales, PVF-35/EB vacuum filtration device, TS-1/80 SPU and TSvL 80 SPU thermostats, KFK-3 photometer, Unico-2800 spectrophotometer, and ShSS-80p drying and sterilizing cabinet. Standardized methods outlined in GOST (State Standard) and other regulatory documents were utilized for sample preparation and analysis. These methods include GOST 31868-2012 for the determination of chromaticity, GOST 31954-2012 for the determination of hardness, GOST 31957-2012 for alkalinity and mass concentration of carbonates and hydrocarbonates, GOST 33045-2014 for nitrogen-containing substances, GOST 4245-72 for chloride content, and GOST R 57164-16 for odour, taste, and turbidity determination. Additionally, MUK 4.2.1884-04 guidelines were followed for sanitary and microbiological and parasitological analysis of water from surface water bodies (Electronic fund of legal and regulatory and technical information, 1974, 2014a, 2014b, 2014c, 2016, 2018).

The most significant organoleptic characteristics such as taste, smell, and color were assessed during the study. The pH of natural water, indicating the quantitative content of carbonic acid and its ions, was measured potentiometrically using the PND F 14.1:2:3:4.121-97 methodology. The hardness of water, attributed to dissolved calcium and magnesium salts, was determined in milligram-equivalents per decimeter cubed (mg-eq/dm³). The study considered the adverse effects of high water hardness on its household characteristics, palatability, and human health. The maximum permissible concentration (MPC) of drinking water hardness, regulated by the value of 10.0 mg-eq/dm³, served as a benchmark for assessment.

6. Study Results

The results of the study indicate that the Aksai River in the Vedeno district of the Chechen Republic exhibits varying levels of water hardness. The presence of trout and barbel fish in different sections of the river suggests a distinct change in hydrobiota due to alterations in water hardness, particularly in areas where the river interacts with blue clay (Razheva & Poezdalov, 2020).

Organoleptic assessments revealed specific characteristics of the water, such as taste, smell, and color. The chemical analysis focused on parameters like chromaticity, hardness, alkalinity, mass concentration of carbonates and hydrocarbonates, nitrogen-containing substances, and chloride content. Bacteriological and parasitological tests were also conducted to evaluate the sanitary and hygienic aspects of the water.

The temperature of both the water and air during sampling was within moderate ranges, ensuring the reliability of the findings. The study provides a comprehensive understanding of the Aksai River's water quality, shedding light on potential implications for fish habitat, particularly for the valuable Caucasian trout.

Further details and specific results obtained from the various analyses conducted during the study could provide a more nuanced understanding of the water quality in the Aksai River and its impact on hydrobionts (Table 1, Table 2).

Table 1. Aksai, where trout lives

№	The definable indicators	Units of measure	Test result	The permissible level	ND for research methods
The organoleptic analysis					
1	A smell	Score	0	No more than 3	GOST P 57164-16 item 5
2	Turbidity (by Formazin)	EMF	0	No more than 3	GOST P 57164-16 item 5
3	Taste	Score	0	No more than 3	GOST R 57164-16
4	Color	Degree	2,4±0,7	No more tnan 30	GOST 31868-2012 item 5
THE CHEMICAL RESEARCH					
1	Copper (Cu,totally)	мг/дм3	0,084±0,021	No more than 1,0	GOST 4388-72
2	Hydrogen index (pH)	ед. pH	7,670±0,015	6,0 - 9,0	PND F 14.1:2:3:4.121-97
3	Overall stiffness	º S	12,7±1,9	N 10	GOST 31954-2012
4	Permanganate oxidizability	mgO2/dm3	1,6±0,3	No more than 7,0	PND F 14.1:2:4.154-99
5	Chlorides (Cl)	mg/dm3	6,9±1,5	No more than 350	GOST 4245-72
6	Total miniralization	mg/dm3	1280±120	No more than 1500	PND F 14.1:2:4.114-97
7	Sulfates (SO4)	mg/dm3	20,6±2,1	No more than 500	GOST 4389-72
8	Marganese (Mn,totally)	mg/dm3	Less than 0,01	No more than 0,1	GOST 4974-2014
9	Ferrum (Fe,totally)	mg/dm3	Less than0,1	No more than 0,3	GOST 4011-72 P.2
BACTERIOLOGICAL TESTS					
1	Total microbial count (37)	KOE/ml	42	No more than 100	MUK 4.2.1018-01
2	Common coliform bacteria	KOE/100 ml	Not detected	Absence	MUK 4.2.1018-01
PARASITOLOGICAL TESTS					
1	Cysts of pathogenic intestinal protozoa	Number 50 1 dm3	Not detected 25 dm3	Absence 25 dm3	MUK 4.2.1884-04 p. 3.2

Table 2. Aksai is where the fish Barbel live

№	Defined indicators	Units of measure	Resolts of the test	Admissible value	ND on the methods of research
ORGANOLEPTIC ANALYSIS					
1	A smell	Score	Corresponds to ND	Less than 3	GOST P 57164-16
2	The turbidity (by Formazin)	EMF	2,5	No more than 2,6	GOST P 57164-16
3	Taste	Score	Corresponds to ND	No more than 3	GOST P 57164-16
4	Color	Degree	Less than 1	No more than 30	GOST 31868-2012,.item 5
THE CHEMICAL RESEARCH					
1	Ammonia and ammonium (By N)	mg/dm3	0,10±0,03	No more than 1,5	GOST 33045-2014 item 5
2	Hydrogen index (pH)	ed. pH	8,29±0,20	6,0 - 9,0	PND F 14.1:2:3:4.121-97
3	Total stiffness	º S	6,1±0,9	No more than 10	GOST 31954-2012

№	Defined indicators	Units of measure	Resolts of the test	Admissible value	ND on the methods of research
4	Permanganate oxidation	мгО2/dm3	2,48±0,25	No more than 7,0	PND F 14.1:2:4.154-99
5	Mn (Mn,суммарно)	mg/dm3	Less than 0,01	No more than 0,1	GOST 4974-2014
6	Ferrum (Fe,totally)	mg/dm3	Less than 0,1	No more than 0,3	GOST4011-72 item 2
7	Total mineralization	mg/dm3	1070±110	No more than 1500	PND F 14.1:2:4.114-97
8	Cl	mg/dm3	20,0±1,4	No more than 350	GOST 4245-72
9	Alkalinity	mg-экв/dm 3	5,1±0,6	No rationed	GOST 31957-2012
BACTERIOLOGICAL TESTS					
1	Total microbial count (37)	KOE/ml	42	No more than 100	MUK 4.2.1018-01
2	Common coliform bacteria	KOE/100 ml	Not detected	Absence	MUK 4.2.1018-01
PARASITOLOGICAL TESTS					
1	Cysts of pathogenic intestinal protozoa	Number 50 l	Not detected 25 dm3	Absence 25 dm3	MUK 4.2.1884-04 p. 3.2

7. Conclusion

In conclusion, the study of the Aksai River's water quality in the Vedeno district of the Chechen Republic provides valuable insights into various aspects, including organoleptic characteristics, chemical composition, and microbiological parameters. The analysis revealed differences in odor, turbidity, taste, and color at different intake points, particularly where trout inhabit. The chemical composition analysis highlighted variations in water hardness, with the transparent part of the river exhibiting excessive hardness, indicative of elevated salt levels contributing to water softness.

The comprehensive data obtained from organoleptic, chemical, and microbiological assessments contribute to a better understanding of the habitat conditions for fish, especially the valuable Caucasian trout. The findings emphasize the importance of considering water quality parameters for sustainable aquatic ecosystems and the preservation of diverse hydrobionts. Further research and monitoring efforts may be necessary to ensure the continued well-being of the Aksai River and its aquatic inhabitants.

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