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PHYSICOCHEMICAL CHARACTERISTICS OF THE MAIN RIVERS OF THE CENTRAL PART OF THE CHUI REGION OF KYRGYZSTAN

This article examines the physicochemical characteristics of the main rivers in the central part of the Chui region, which is important for assessing the state of water resources in the region. The analysis includes the study of the chemical composition of water, pollution levels, as well as physicochemical parameters such as pH, temperature, dissolved oxygen content, mineralization, etc. The results of the study allow us to identify trends in water quality changes depending on anthropogenic load and climatic factors. The physico-chemical analysis of the main rivers in the central region of Chui oblast revealed that the concentration of heavy metals is below the maximum permissible concentration (hereinafter referred to as the MPC). The concentration of cadmium was found to be relatively high in the Ala-Archa river. With regard to cation concentration, the maximum allowable concentration (MAC) of magnesium was exceeded in the Sokuluk-2 river (9.39 mg/l, 03.18). The water samples from the Alamedin River and the Sokuluk River exhibited relatively elevated levels of sodium. The Sokuluk River. The Sokuluk River exhibited relatively elevated calcium concentrations. The concentration of hydrocarbonates, fluorides, chlorides, nitrates and sulphates in the river waters of Chui oblast analysed in this study was below the maximum allowable concentration (MAC). Fluoride levels were found to be elevated in both the Sokuluk River and the Chui River. The Sokuluk River and the Ala-Archa River. In conclusion, the findings of this study provide a foundation for further environmental assessments and the formulation of water management strategies.

Key words: physicochemical characteristics, ions, heavy metals, Sokuluk river, Alamedin river, Ala-Archa river, Chui Region, Kyrgyzstan.

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Қырғызстанның Шу облысы орталық бөлігінің негізгі өзендерінің физика-химиялық сипаттамасы

Бұл мақалада Шу облысының орталық бөлігіндегі негізгі өзендердің физика-химиялық сипаттамалары зерттеледі, бұл аймақтың су ресурстарының жағдайын бағалау үшін маңызды. Талдау судың химиялық құрамын, ластану деңгейін, сондай-ақ pH, температура, еріген оттегінің мөлшері, тұздылық және т.б. сияқты физикалық-химиялық параметрлерді зерттеуді қамтиды. Зерттеу нәтижелері антропогендік жүктеме мен климаттық факторларға байланысты су сапасының өзгеру тенденцияларын анықтауға мүмкіндік береді. Шу облысының орталық аймағындағы негізгі өзендердің физика-химиялық талдауы ауыр металдардың концентрациясы шекті рұқсат етілген концентрациядан (бұдан әрі – ШРК) төмен екендігі анықталды. Ала-Аршада кадмийдің салыстырмалы түрде жоғары деңгейі байқалды. Катиондар концентрациясы бойынша Сокулук-2 өзенінде магнийдің шекті рұқсат етілген концентрациясынан асып кетуі байқалды (9,39 мг/л,

03,18). Судағы натрийдің салыстырмалы жоғары мәндері Аламедин өзенінде және Соқулық өзенінде анықталды. Салыстырмалы түрде жоғары кальций мәндері Сокулук өзенінде тіркелді. Шу облысында зерттелген өзен суларында гидрокарбонаттардың, фторидтердің, хлоридтердің, нитраттардың және сульфаттардың мөлшері ШРК төмен деңгейде байқалды. Сокулук өзенінде және Ала-Арча өзенінде фторидтердің жоғарылауы байқалды. Осылайша, осы зерттеудің нәтижелері одан әрі экологиялық бағалауға және су ресурстарын басқару стратегияларын әзірлеуге негіз бола алады.

Түйін сөздер: физика-химиялық сипаттамалар, иондар, ауыр металдар, Сокулук өзені, Аламедин өзені, Ала-Арча өзені, Шу облысы, Қырғызстан.

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Физико-химические характеристики основных рек центральной части Чуйской области Кыргызстана

В данной статье исследуются физико-химические характеристики основных рек центральной части Чуйской области, что имеет важное значение для оценки состояния водных ресурсов региона. Анализ включает в себя изучение химического состава воды, уровня загрязнения, а также физико-химических параметров, таких как pH, температура, содержание растворенного кислорода, минерализация и т.д. В ходе изучения физико-химических показателей основных рек центральной части Чуйской области выявлено, что концентрация тяжелых металлов ниже предельно допустимой концентрации (далее – ПДК). Относительно высокие уровни кадмия отмечены в Ала-Арче. По концентрации катионов, превышение ПДК магния отмечено на реке Сокулук-2 (9,39 мг/л, 03.18). Относительно высокие значения натрия в воде были определены в р. Аламедин и Сокулук. Относительно высокие значения кальция зафиксированы в р. Сокулук. Содержание гидрокарбонатов, фторидов, хлоридов, нитратов и сульфатов в исследованных речных водах Чуйской области наблюдалось ниже ПДК. Повышенное значение фторидов отмечено в р. Сокулук и в р. Ала-Арча. Таким образом, результаты данного исследования служат основой для дальнейших экологических оценок и разработки стратегий управления водными ресурсами.

Ключевые слова: физико-химические характеристики, ионы, тяжелые металлы, река Сокулук, река Аламедин, река Ала-Арча, Чуйская область, Кыргызстан.

Introduction

River waters vary in their chemical composition. Water quality is influenced by the hydrogeological and hydrochemical characteristics of the river basin. Water composition is influenced by precipitation, snowmelt and tributaries flowing into a larger river, groundwater and anthropogenic influences.

Industrial development, agricultural intensification, urban growth and a careless attitude towards nature are leading to an increase in the mineralisation and pollution of freshwater sources. As a result, natural waters in certain parts of watercourses may not meet the legal requirements for their intended use. A necessary condition for their use is the compliance of the qualitative and quantitative composition of waters with the standards for waters of their intended purpose (Giri S., 2021).

The arid climate zone in which Kyrgyzstan is situated is one of the factors that, in modern Kyrgyz society, has led to an increasing recognition of water resources as a significant national asset.

At present, the Kyrgyz Republic utilises a mere 12-17% of its total water resources, with 90% of this amount being allocated to irrigation. A considerable proportion of the extracted water is lost during utilisation as a result of the substandard technical condition of irrigation and water distribution systems, equipment deterioration, the absence of water-saving technologies and the lack of drainless water supply systems (Nuralieva N.M., 2022; Raimbekov K. et al., 2023).

The most significant environmental concern is the contamination of surface and groundwater in the Chui Valley and industrial areas of the southern region. This is due to the lack of centralized sewerage systems and treatment facilities in many small towns and regional centers across the country. Local pollution of open water bodies is caused by an increase in the discharge of pollutants, insufficient attention to the methods of storage, processing, and disposal of industrial and household waste, and a lack of awareness regarding agricultural production practices.

The relevance of this topic is due to the growing threats associated with climate change and increasing anthropogenic load on water resources. The central part of the Chui region is an important ecosystem region, where rivers play a key role in maintaining biological diversity and providing the population with water. Understanding the physical and chemical characteristics of rivers is necessary for developing water management strategies, protecting ecosystems and improving the quality of life of the local population.

Methodology

The research methodology includes an integrated approach combining field and laboratory methods. During the field studies, water samples were collected from the main rivers of the region in different seasons to account for seasonal changes. Laboratory analyses were carried out to determine the main physicochemical parameters, such as pH, dissolved oxygen content, total hardness and concentration of pollutants. Statistical methods were used to analyze the data, which made it possible to identify relationships between various factors and assess the degree of pollution of water bodies.

The water quality indicator was the compliance of the values of physical characteristics and the content of chemical elements with the maximum permissible values (MPV) and concentrations (MPC) in accordance with the Law of the Kyrgyz Republic of May 30, 2011 No. 34 "Technical Regulations "On the Safety of Drinking Water" as amended by the Law of the Kyrgyz Republic of April 28, 2017 No. 67, and the Hygienic Standards "Maximum Permissible Concentrations of Chemicals in the Water of Water Bodies for Domestic, Drinking, and Cultural and Domestic Water Use" (approved by the Resolution of the Government of the Kyrgyz Republic of April 11, 2016 No. 201) (Law of the Kyrgyz Republic, 2011). The requirements of the World Health Organization (WHO) (World Health Organization, 2017) and standards of other countries (Hygienic standards, 2003; Hygienic standards, 2016; The Sanitary Rules, 2003) were used for comparison.

Results and discussions

Physicochemical characteristics of the Sokuluk river, the Alamedin river, and the Ala-Archa river. It is notable that critical environmental situations, which are typically characterised by salinisation, pollution and the depletion of water resources and soils, are prevalent across the majority of the territory of the republic. The principal causes of these issues are the increase in the quantity of untreated wastewater discharged into the environment, the inadequate recycling of industrial and domestic waste, the decline in agricultural production practices, and the unsatisfactory conditions for the storage and processing of residual pollutants.

The Sokuluk, Alamedin and Ala-Archa rivers represent significant waterways within the Chui region. The rivers serve as a source of potable water for the region and are utilised for irrigation purposes. The findings of the water sampling and subsequent quality analysis of these rivers are presented in the following tables (Table 1-3).

At the sampling point Sokuluk (1): The specific conductivity does not exceed the MAC, the maximum is 169.0 μS/cm, and the minimum is 64.0 μS/cm. The dissolved oxygen does not exceed the MAC, the maximum is 8.80 mg/l, and the minimum is 1.57 mg/l. The total hardness does not exceed the MAC, the maximum is 114.32 mg/l, and the minimum is 41.96 mg/l.

At the sampling point Sokuluk (2): The specific conductivity does not exceed the MAC, the maximum is 278.0 μS/cm, and the minimum is 148.0 μS/cm. The dissolved oxygen does not exceed the MAC, the maximum is 9.54 mg/l, and the minimum is 0.61 mg/l. The total hardness does not exceed the MAC, the maximum is 162.24 mg/l, and the minimum is 72.67 mg/l.

At the sampling point Alamedin (1): The specific conductivity does not exceed the MAC, the maximum is 187.8 μS/cm, and the minimum is 70.0 μS/cm. The dissolved oxygen does not exceed the MAC, the maximum is 7.81 mg/l, and the minimum is 1.14 mg/l. The total hardness does not exceed the MAC, the maximum is 91.83 mg/l, and the minimum is 47.54 mg/l.

At the sampling point Alamedin (2): The specific conductivity does not exceed the MAC, the

maximum is 236.7 μS/cm, and the minimum is 84.0 μS/cm. The dissolved oxygen does not exceed the MAC, the maximum is 9.30 mg/l, and the minimum is 1.75 mg/l. The total hardness does not exceed the MAC, the maximum is 125.92 mg/l, and the minimum is 53.68 mg/l.

Table 1 – Physicochemical characteristics of the Sokuluk river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Temperature, ^{0}C	Specific conductivity, μS/cm	Dissolved oxygen, mg/l	Turbidity	Total hardness, mg/l	Hydrogen index (pH), pH units
Sokuluk (1)	05.16	6,62	169,0	8,80	clean	82,12	8,41
Sokuluk (1)	05.17	13,75	166,0	1,57		101,69	7,69
Sokuluk (1)	08.17	10,49	64,0	1,88	clean	41,96	8,99
Sokuluk (1)	03.18	4,16	136,0	8,13	clean	114,32	8,22
Sokuluk (2)	05.26		263,0	8,96	cloudy	132,92	7,90
Sokuluk (2)	05.17	21,46	278,0	0,61	cloudy	141,43	7,90
Sokuluk (2)	08.17	19,22	148,0	1,8	cloudy	72,67	8,20
Sokuluk (2)	03.18	5,83	205,0	9,54	cloudy	162,24	7,93

Table 2 – Physicochemical characteristics of the Alamedin river in Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Temperature, ^{0}C	Specific conductivity, μS/cm,	Dissolved oxygen, mg/l	Turbidity	Total hardness, mg/l	Hydrogen index (pH)
Alamedin (1)	05.16	9,2	187,8	4,62	clean	81,75	8,56
Alamedin (1)	05.17	9,55	111,0	1,14	clean	81,16	7,33
Alamedin (1)	08.17	8,33	70,0	2,06	clean, cloudy.	47,54	9,66
Alamedin (1)	03.18	4,43	112,0	7,81	clean	91,83	7,68
Alamedin (2)	05.26	14,1	236,7	4,80	cloudy	104,41	8,00
Alamedin (2)	05.17	10,28	170,0	1,75	cloudy	118,31	7,39
Alamedin (2)	08.17	10,14	84,0	1,8	clean	53,68	8,75
Alamedin (2)	03.18	4,96	162,0	9,30	cloudy	125,92	7,85

Table 3 – Physicochemical characteristics of the Ala-Archa river in Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Temperature, ^{0}C	Specific conductivity, μS/cm,	Dissolved oxygen, mg/l	Turbidity	Total hardness, mg/l	Hydrogen index (pH)
Ala-Archa (1)	05.16	7,07	94,0	7,38		40,48	8,70
Ala-Archa (1)	05.17	9,15	65,0	0,22	clean	40,35	7,05
Ala-Archa (1)	08.17	7,09	36,0	2,09	clean	27,22	10,29
Ala-Archa (1)	03.18	2,43	57,0	6,82	clean	43,35	7,21
Ala-Archa (2)	05.26	12,28	197,0	8,76	cloudy	99,60	8,64

Continuation of the table

Sampling location	Sampling date	Temperature, ^{0}C	Specific conductivity, µS/cm,	Dissolved oxygen, mg/l	Turbidity	Total hardness, mg/l	Hydrogen index (pH)
Ala-Archa (2)	05.17	12,76	171,0	0,26	cloudy	114,98	7,36
Ala-Archa (2)	08.17	12,76	68,0	2,24	clean	41,66	8,86
Ala-Archa (2)	03.18	3,96	108,0	9,08	clean	87,62	7,76

At the sampling point Ala-Archa (1): The specific conductivity does not exceed the MAC, the maximum is 94.0 µS/cm, and the minimum is 36.0 µS/cm. The dissolved oxygen does not exceed the MAC, the maximum is 7.38 mg/l, and the minimum is 0.22 mg/l. The total hardness does not exceed the MAC, the maximum is 43.35 mg/l, and the minimum is 27.22 mg/l.

At the sampling point Ala-Archa (2): The specific conductivity does not exceed the MAC, the maximum is 197.0 µS/cm, and the minimum is 68.0 µS/cm. The dissolved oxygen does not exceed the MAC, the maximum is 9.08 mg/l, and the minimum is 0.26 mg/l. The total hardness does not exceed the MAC, the maximum is 114.98 mg/l, and the minimum is 41.66 mg/l.

Heavy metals. Of the heavy metals, the content of zinc (Zn), copper (Cu), lead (Pb), cadmium (Cd), and the toxic semimetal arsenic (As), total and hexavalent chromium (Cr) in river waters was studied. Tables 4 to 6, shows the metal content values, expressed in micrograms per liter (µg/l), with the exception of chromium, which is determined in milligrams per liter (mg/l).

Here is a brief description of the dangers associated with these metals when they are present in high concentrations in drinking water sources and when they enter the human body in excess. Excess zinc can unbalance the metabolic equilibrium of other metals. Imbalance in the zinc/copper ratio is the main causative factor in the development of coronary heart disease. Excessive consumption of zinc salts can lead to acute intestinal poisoning with nausea (Cruz M. et al., 2019).

Chronic excess copper in tissues leads to growth retardation, hemolysis, decreased hemoglobin content, and degradation of liver, kidney, and brain tissue.

Lead is considered a powerful neurotoxin and causes increased aggression. Chronic lead poisoning gradually leads to kidney and nervous system dysfunction and anemia. Lead toxicity increases with a deficiency of calcium and iron in the body.

Cadmium is very toxic. Accumulation of cadmium in the body can lead to diseases such as anemia, liver, kidney and lung damage, cardiopathy, pulmonary emphysema, osteoporosis. Excess of this element provokes and increases deficiency of selenium and zinc. Symptoms of cadmium poisoning are damage to the central nervous system, protein in the urine, acute bone pain, dysfunction of the genitals. All chemical forms are dangerous.

There are several MAC values for this chemical element, approved by legislative and regulatory documents of the Kyrgyz Republic. Thus, in the version of the Law of the Kyrgyz Republic "Technical Regulations "On the Safety of Drinking Water" dated April 28, 2017 No. 67, it is set at 0.0005 µg / l. At the same time, in the Hygienic Standards "Maximum Permissible Concentrations of Chemicals in Water Bodies of Domestic, Drinking and Cultural and Domestic Water Use", approved by the Resolution of the Government of the Kyrgyz Republic dated April 11, 2016 No. 201, the MAC of cadmium is set at 0.001 mg / l. When assessing the quality of water in the studied water bodies, we were guided by the requirements of the WHO, which defined the MAC as 1 µg / l.

Arsenic is one of the most powerful and dangerous poisons. In the presence of oxygen, it quickly forms highly toxic arsenic anhydride. In case of oral poisoning, high concentrations of arsenic are observed in the stomach, intestines, liver, kidneys and pancreas; in case of chronic poisoning, it gradually accumulates in the skin, hair and nails. Due to the inhibition of various enzymes, it disrupts metabolism. In the process of poisoning, axons are the first to suffer, which leads to peripheral neuropathy and paralysis of the limbs. Arsenic is considered carcinogenic to humans (Peña-Guerrero M.D. et al., 2020).

Excessive chromium content in the body is characterized by allergic reactions and inflammatory processes, ulcers on the mucous membranes, nervous disorders and disturbances in the liver and kidneys. Trivalent chromium begins to exhibit toxi-

cological effects only when consumed in extremely high doses, but to a greater extent as a gastric irritant. Hexavalent chromium is a class I carcinogen. After prolonged contact for 15-20 years with an increased content of chromates, lung tumors occur. Its effects change the body's immunological response, affect the liver, disrupt biological oxidation processes – the tricarboxylic acid cycle, cause pneumosclerosis, heart disease, gastritis, gastric and duodenal ulcers, skin lesions (ulcers, dermatitis), ulcers of the nasal mucosa (Anh N.T. et al., 2023).

Selenium and its compounds are poisonous, their increased content in the body can lead to serious poisoning, accompanied by depression, nausea, vomiting, diarrhea, damage to the central nervous system, etc.

At the sampling point Sokuluk (1): The Zinc value does not exceed the MAC, the maximum is 9.55 μg/l, and the minimum is 1.30 μg/l. The Copper value does not exceed the MAC, the maximum is 71.66 μg/l, and the minimum is 0.48 μg/l. The Cadmium value does not exceed the MAC, the maximum is 0.06 μg/l, and the minimum is 0.02 μg/l. The Lead value does not exceed the MAC, the maximum is 2.52 μg/l, and the minimum is 0.16 μg/l. The Chromium value does not exceed the MAC, 0.03 mg/l. The Chromium (VI) value does not exceed the MAC, the maximum is 0.027 mg/l, and the minimum is 0.006 mg/l. The Arsenic level does not exceed the MAC, the maximum is 5.85 μg/l, and the minimum is 1.87 μg/l.

Table 4 – Content of heavy metals and arsenic in the Sokuluk river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Zinc Zn, μg/l	Copper Cu, μg/l	Cadmium Cd, μg/l	Lead Pb, μg/l	Chromium Cr, mg/l	Chromium (VI) Cr^{+6}, mg/l	Arsenic As, μg/l
Sokuluk (1)	05.16	6,23	71,66	-	2,52	0,03	0,01	5,15
Sokuluk (1)	05.17	2,65	0,59	0,02	0,16	0,03	0,027	4,80
Sokuluk (1)	08.17	9,55	2,98	0,06	1,62	0,03	0,009	1,87
Sokuluk (1)	03.18	1,30	0,48	0,02	0,16	0,03	0,006	5,85
Sokuluk (2)	05.26	1,77	97,30	-	0,23	0,03	0,01	2,94
Sokuluk (2)	05.17	4,53	1,38	-	0,52	0,04	0,026	7,56
Sokuluk (2)	08.17	3,47	1,02	0,01	0,77	0,04	0,021	2,47
Sokuluk (2)	03.18	0,98	0,63	0,01	0,21	0,03	0,008	5,07

At the sampling point Sokuluk (2): Zinc does not exceed the MAC, maximum 4.53 μg/l, and minimum 0.98 μg/l. Copper does not exceed the MAC, maximum 97.30 μg/l, and minimum 0.63 μg/l. Cadmium does not exceed the MAC, 0.01 μg/l. Lead does not exceed the MAC, maximum 0.77 μg/l, and minimum 0.21 μg/l. Chromium does not exceed the MAC, 0.04 mg/l. The Chromium (VI) does not exceed the MAC, maximum 0.026 mg/l, and minimum 0.008 mg/l. The Arsenic level does not exceed the MAC, the maximum is 7.56 μg/l, and the minimum is 2.47 μg/l.

Table 5 – Content of heavy metals and arsenic in the Alamedin river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Zinc Zn, μg/l	Copper Cu, μg/l	Cadmium Cd, μg/l	Lead Pb, μg/l	Chromium Cr, mg/l	Chromium (VI) Cr^{+6}, mg/l	Arsenic As, μg/l
Alamedin (1)	05.16	1,56	3,06	-	0,23	0,02	0,013	2,42
Alamedin (1)	05.17	3,10	0,85	0,07	0,33	0,04	0,023	2,99
Alamedin (1)	08.17	4,21	1,64	0,02	1,48	0,04	0,018	3,19

Continuation of the table

Sampling location	Sampling date	Zinc Zn, µg/l	Copper Cu, µg/l	Cadmium Cd, µg/l	Lead Pb, µg/l	Chromium Cr, mg/l	Chromium (VI) Cr^{+6}, mg/l	Arsenic As, µg/l
Alamedin (1)	03.18	4,07	1,04	0,01	0,47	0,04	0,008	4,08
Alamedin (2)	05.26	18,71	66,98	-	3,48	0,07	0,014	4,14
Alamedin (2)	05.17	7,54	3,21	-	0,71	0,04	0,027	2,92
Alamedin (2)	08.17	5,32	1,63	0,28	1,39	0,04	0,021	3,26
Alamedin (2)	03.18	2,15	1,22	0,02	0,40	0,04	0,007	3,14

At the sampling point Alamedin (1): Zinc level does not exceed MAC, maximum 4.21 µg/l, and minimum 1.56 µg/l. Copper level does not exceed MAC, maximum 3.06 µg/l, and minimum 0.85 µg/l. Cadmium level does not exceed MAC, maximum 0.07 µg/l, and minimum 0.01 µg/l. Lead level does not exceed MAC, maximum 1.48 µg/l, and minimum 0.47 µg/l. The Chromium level does not exceed MAC, maximum 0.04 mg/l, and minimum 0.02 mg/l. Chromium (VI) level does not exceed MAC, maximum 0.023 mg/l, and minimum 0.008 mg/l. The Arsenic level does not exceed the MAC, the maximum is 4.08 µg/l, and the minimum is 2.42 µg/l.

At the sampling point Alamedin (2): Zinc does not exceed the MAC, maximum 18.71 µg/l, and minimum 2.15 µg/l. Copper does not exceed the MAC, maximum 66.98 µg/l, and minimum 1.22 µg/l. Cadmium does not exceed the MAC, maximum 0.28 µg/l, and minimum 0.02 µg/l. Lead does not exceed the MAC, maximum 3.48 µg/l, and minimum 0.40 µg/l. Chromium does not exceed the MAC, maximum 0.07 mg/l, and minimum 0.04 mg/l. The Chromium (VI) indicator does not exceed the MAC, the maximum is 0.027 mg/l, and the minimum is 0.007 mg/l. The Arsenic indicator does not exceed the MAC, the maximum is 4.14 µg/l, and the minimum is 2.92 µg/l.

Table 6 – Content of heavy metals and arsenic in the Ala-Archa river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Zinc Zn, µg/l	Copper Cu, µg/l	Cadmium Cd, µg/l	Lead Pb, µg/l	Chromium Cr, mg/l	Chromium (VI) Cr^{+6}, mg/l	Arsenic As, µg/l
Ala-Archa (1)	05.16	5,18	2,17	-	1,50	0,04	0,011	2,49
Ala-Archa (1)	05.17	1,19	108,89	-	0,16	0,03	0,021	0,62
Ala-Archa (1)	08.17	14,53	10,36	0,54	3,14	0,04	0,015	0,28
Ala-Archa (1)	03.18	1,39	0,58	0,02	0,20	0,02	0,008	0,76
Ala-Archa (2)	05.26	2,79	7,90	-	0,22	0,02	0,015	0,58
Ala-Archa (2)	05.17	4,04	77,07	-	0,63	0,03	0,031	2,11
Ala-Archa (2)	08.17	10,32	6,41	0,02	2,70	0,03	0,016	0,80
Ala-Archa (2)	03.18	2,51	1,19	0,01	0,59	0,03	0,008	1,56

At the sampling point Ala-Archa (1): Zinc level does not exceed MAC, maximum 14.53 µg/l, and minimum 1.19 µg/l. Copper level does not exceed MAC, maximum 108.89 µg/l, and minimum 0.58 µg/l. Cadmium level does not exceed MAC, maximum 0.54 µg/l, and minimum 0.02 µg/l. Lead level does not exceed MAC, maximum 3.14 µg/l, and minimum 0.16 µg/l. Chromium level does not exceed MAC, maximum 0.04 mg/l, and minimum 0.02 mg/l. The Chromium (VI) indicator does not exceed the MAC, the maximum is 0.021 mg/l, and the minimum is 0.008 mg/l. The Arsenic indicator does not exceed the MAC, the maximum is 2.49 µg/l, and the minimum is 0.28 µg/l.

At the sampling point Ala-Archa (2): Zinc does not exceed the MAC, maximum 10.32 µg/l, and minimum 2.51 µg/l. Copper does not exceed the MAC, maximum 77.07 µg/l, and minimum 1.19 µg/l. Cad-

mium does not exceed the MAC, maximum 0.02 μg/l, and minimum 0.01 μg/l. Lead does not exceed the MAC, maximum 2.70 μg/l, and minimum 0.22 μg/l. Chromium does not exceed the MAC, maximum 0.03 mg/l, and minimum 0.02 mg/l. The Chromium (VI) indicator does not exceed the MAC, the maximum is 0.031 mg/l, and the minimum is 0.008 mg/l. The Arsenic indicator does not exceed the MAC, the maximum is 2.11 μg/l, and the minimum is 0.58 μg/l.

Concentration of main ions. The following ions were determined in the studied water samples: cations (Na^+, K^+, Ca^+, Mg^{2+} (Tables 7-9) and anions F^-, Cl^-, HCO_4^{2-}, CO_3^{2-}, SO_4^{2-}, NO_2^-, NO_3^- (Tables 10-12)). The largest quantities in natural waters are hydrocarbonates, chlorides and sulfates of alkaline earth and alkali metals; smaller quantities are their nitrates, nitrites, silicates, fluorides, phosphates and salts of other acids.

Absolutely pure water without impurities (or rather, without dissolved salts, acids, alkalis and gases) does not exist in nature. Absolutely pure water – H_2O, can only be obtained in special laboratory or factory conditions. But chemically pure water (distillate) is dead water; it is not suitable for normal life, its constant use can lead to serious diseases. For example, the absence of calcium and magnesium cations in drinking water leads to disorders of the musculoskeletal system and diseases of the cardiovascular system (Wen Y. et al., 2020).

At the sampling point Sokuluk (1): The Potassium indicator does not exceed the MAC, the maximum is 1.61 mg/l, and the minimum is 0.76 mg/l. The Sodium indicator does not exceed the MAC, the maximum is 5.85 mg/l, and the minimum is 0.70 mg/l. The Calcium indicator does not exceed the MAC, the maximum is 33.50 mg/l, and the minimum is 12.84 mg/l. The Magnesium indicator does not exceed the MAC, the maximum is 7.44 mg/l, and the minimum is 2.40 mg/l.

At the sampling point Sokuluk (2): The Potassium indicator does not exceed the MAC, the maximum is 1.96 mg/l, and the minimum is 1.10 mg/l. The Sodium indicator does not exceed the MAC, the maximum is 12.05 mg/l, and the minimum is 3.68 mg/l. The Calcium indicator does not exceed the MAC, the maximum is 49.48 mg/l, and the minimum is 22.19 mg/l. The Magnesium indicator does not exceed the MAC, the maximum is 9.39 mg/l, and the minimum is 4.19 mg/l.

Table 7 – Concentration of main cations in the Sokuluk river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Potassium K^+, mg/l	Sodium Na^+, mg/l	Calcium Ca^+, mg/l	Magnesium Mg^{2+}, mg/l
Sokuluk (1)	05.16	0,86	3,37	26,26	4,02
Sokuluk (1)	05.17	1,61	4,86	30,38	6,27
Sokuluk (1)	08.17	0,76	0,70	12,84	2,40
Sokuluk (1)	03.18	1,08	5,85	33,50	7,44
Sokuluk (2)	05.26	1,33	7,35	42,71	6,38
Sokuluk (2)	05.17	1,96	9,35	43,30	8,09
Sokuluk (2)	08.17	1,10	3,68	22,19	4,19
Sokuluk (2)	03.18	1,71	12,05	49,48	9,39

At the sampling point Alamedin (1): The Potassium indicator does not exceed the MAC, the maximum is 1.36 mg/l, and the minimum is 0.79 mg/l. The Sodium indicator does not exceed the MAC, the maximum is 4.73 mg/l, and the minimum is 0.74 mg/l. The Calcium indicator does not exceed the MAC, the maximum is 31.88 mg/l, and the minimum is 16.12 mg/l. The Magnesium indicator does not exceed the MAC, the maximum is 2.97 mg/l, and the minimum is 1.77 mg/l.

At the sampling point Alamedin (2): The Potassium indicator does not exceed the MAC, the maximum is 1.81 mg/l, and the minimum is 0.87 mg/l. The Sodium indicator does not exceed the MAC, the maximum is 10.00 mg/l, and the minimum is 1.34 mg/l. The Calcium indicator does not exceed the MAC, the maximum is 42.35 mg/l, and the minimum is 18.17 mg/l. The Magnesium indicator does not exceed the MAC, the maximum is 4.90 mg/l, and the minimum is 2.02 mg/l.

Table 8 – Concentration of main cations in the Alamedin river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Potassium K^+, mg/l	Sodium Na^+, mg/l	Calcium Ca^+, mg/l	Magnesium Mg^{2+}, mg/l
Alamedin (1)	05.16	0,83	2,79	29,23	2,13
Alamedin (1)	05.17	1,36	3,16	28,34	2,52
Alamedin (1)	08.17	0,79	0,74	16,12	1,77
Alamedin (1)	03.18	0,93	4,73	31,88	2,97
Alamedin (2)	05.26	1,43	5,45	36,51	3,21
Alamedin (2)	05.17	1,81	6,82	40,53	4,15
Alamedin (2)	08.17	0,87	1,34	18,17	2,02
Alamedin (2)	03.18	1,56	10,00	42,35	4,90

At the sampling point Ala-Archa (1): The Potassium indicator does not exceed the MAC, the maximum is 1.33 mg/l, and the minimum is 0.66 mg/l. The Sodium indicator does not exceed the MAC, the maximum is 4.41 mg/l, and the minimum is 0.55 mg/l. The Calcium indicator does not exceed the MAC, the maximum is 15.42 mg/l, and the minimum is 9.66 mg/l. The Magnesium indicator does not exceed the MAC, the maximum is 1.17 mg/l, and the minimum is 0.75 mg/l.

At the sampling point Ala-Archa (2): The Potassium indicator does not exceed the MAC, the maximum is 1.77 mg/l, and the minimum is 1.05 mg/l. The Sodium indicator does not exceed the MAC, the maximum is 5.75 mg/l, and the minimum is 1.47 mg/l. The Calcium indicator does not exceed the MAC, the maximum is 38.31 mg/l, and the minimum is 14.12 mg/l. The Magnesium indicator does not exceed the MAC, the maximum is 4.69 mg/l, and the minimum is 1.56 mg/l.

Table 9 – Concentration of main cations in the Ala-Archa river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Potassium K^+, mg/l	Sodium Na^+, mg/l	Calcium Ca^+, mg/l	Magnesium Mg^{2+}, mg/l
Ala-Archa (1)	05.16	0,66	3,02	15,00	0,74
Ala-Archa (1)	05.17	1,33	3,51	14,38	1,08
Ala-Archa (1)	08.17	1,24	0,55	9,66	0,75
Ala-Archa (1)	03.18	0,68	4,41	15,42	1,17
Ala-Archa (2)	05.26	1,15	3,93	34,28	3,40
Ala-Archa (2)	05.17	1,77	4,86	38,31	4,69
Ala-Archa (2)	08.17	1,25	1,47	14,12	1,56
Ala-Archa (2)	03.18	1,05	5,75	29,29	3,52

Concentration of anions. Of the anions, the concentration of hydrocarbonates (HCO_3^-), carbonates (CO_3^{2-}), fluorides (F^-), chlorides (Cl^-), sulfates (SO_4^{2-}), nitrites (NO_2^-) and nitrates (NO_3^-) in river waters was studied. Below is a brief characterisation of the hazards associated with these anions in case of their increased content in the water of drinking water supply sources and excessive ingestion into the human body. In the body, hydrogen carbonates play an important physiological role as buffer substances regulating the constancy of blood reaction.

Fluorides can be beneficial as well as harmful. Fluoride ion is an enzyme inhibitor and leads to impairment of nervous system impulses. Chlorides impair the taste of water and make it unsuitable for drinking water supply. Sulphates are not toxic to humans, but when their content is exceeded, a brackish taste appears. These substances cause gastrointestinal disorders.Nitrates are dangerous for humans. Long-term consumption of drinking water containing sig-

nificant amounts of nitrates reduces the ability of the blood to carry oxygen, leading to unfavourable consequences for the body (Carr G.M., Neary J.P., 2008).

At the sampling point Sokuluk (1): The Hydrocarbonate indicator does not exceed the MAC, the maximum is 134.32 mg/l, and the minimum is 67.92 mg/l. The Fluorides indicator does not exceed the MAC, the maximum is 0.88 mg/l, and the minimum is 0.53 mg/l. The Chlorides indicator does not exceed the MAC, the maximum is 1.42 mg/l, and the minimum is 0.32 mg/l. The Sulphates indicator does not exceed the MAC, the maximum is 28.36 mg/l, and the minimum is 11.67 mg/l. The Nitrites indicator is not detected. The Nitrates indicator does not exceed the MAC, the maximum is 3.68 mg/l, and the minimum is 2.53 mg/l.

Table 10 – Concentration of main anions in the Sokuluk river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Hydrocar bonates, mg/l	Fluorides, mg/l	Chlorides, mg/l	Sulfates, mg/l	Nitrites, mg/l	Nitrates, mg/l
Sokuluk (1)	05.16	90,11	0,69	1,01	22,42	not detected	3,26
Sokuluk (1)	05.17	134,32	0,88	1,42	26,37	not detected	3,68
Sokuluk (1)	08.17	67,92	0,53	0,32	11,67	not detected	2,53
Sokuluk (1)	03.18	120,21	0,78	1,47	28,36	not detected	3,68
Sokuluk (2)	05.26	140,88	0,54	3,02	28,20	not detected	4,51
Sokuluk (2)	05.17	197,08	0,69	4,42	31,68	not detected	5,24
Sokuluk (2)	08.17	103,50	0,54	2,08	16,90	0,02	3,45
Sokuluk (2)	03.18	172,10	0,60	6,17	36,74	not detected	6,20

At the Sokuluk sampling point (2): The Hydrogencarbonate indicator does not exceed the MAC, with a maximum of 197.08 mg/l and a minimum of 103.50 mg/l. Fluoride does not exceed the MAC, with a maximum of 0.69 mg/l and a minimum of 0.54 mg/l. Chlorides does not exceed the MAC, with a maximum of 6.17 mg/l and a minimum of 2.08 mg/l. Sulphates does not exceed the MAC, with a maximum of 36.74 mg/l and a minimum of 16.90 mg/l. Nitrite does not exceed the MAC, 0.02. Nitrate does not exceed the MAC, maximum 6.20 mg/l and minimum 3.45 mg/l.

At the sampling point Alamedin (1): The Hydrogencarbonate indicator does not exceed the MAC, the maximum is 97.59 mg/l, and the minimum is 89.54 mg/l. The Fluorides indicator does not exceed the MAC, the maximum is 0.45 mg/l, and the minimum is 0.20 mg/l. The Chlorides indicator does not exceed the MAC, the maximum is 1.64 mg/l, and the minimum is 0.42 mg/l. The Sulphates indicator does not exceed the MAC, the maximum is 26.45 mg/l, and the minimum is 12.71 mg/l. The Nitrites indicator is not detected. The Nitrates indicator does not exceed the MAC, the maximum is 3.89 mg/l, and the minimum is 2.64 mg/l.

Table 11 – Concentration of main anions in the Alamedin river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Hydrocar bonates, mg/l	Fluorides, mg/l	Chlorides, mg/l	Sulfates, mg/l	Nitrites, mg/l	Nitrates, mg/l
Alamedin (1)	05.16	90,49	0,20	1,06	22,16	not detected	3,48
Alamedin (1)	05.17	97,59	0,45	1,37	22,04	not detected	3,89
Alamedin (1)	08.17	89,54	0,27	0,42	12,71	not detected	2,64
Alamedin (1)	03.18	92,15	0,44	1,64	26,45	not detected	3,41
Alamedin (2)	05.26	121,30	0,28	2,24	25,17	not detected	4,55

Continuation of the table

Sampling location	Sampling date	Hydrocar bonates, mg/l	Fluorides, mg/l	Chlorides, mg/l	Sulfates, mg/l	Nitrites, mg/l	Nitrates, mg/l
Alamedin (2)	05.17	154,32	0,45	3,90	24,81	not detected	6,10
Alamedin (2)	08.17	89,90	0,28	0,80	13,65	not detected	2,87
Alamedin (2)	03.18	170,79	0,47	5,69	33,49	not detected	6,24

At the sampling point Alamedin (2): The Hydrogencarbonate indicator does not exceed the MAC, the maximum is 170.79 mg/l, and the minimum is 89.90 mg/l. The Fluorides indicator does not exceed the MAC, the maximum is 0.47 mg/l, and the minimum is 0.28 mg/l. The Chlorides indicator does not exceed the MAC, the maximum is 5.69 mg/l, and the minimum is 0.80 mg/l. The Sulphates indicator does not exceed the MAC, the maximum is 33.49 mg/l, and the minimum is 13.65 mg/l. The Nitrites indicator is not detected. The Nitrates indicator does not exceed the MAC, the maximum is 6.24 mg/l, and the minimum is 2.87 mg/l.

At the sampling point Ala-Archa (1): The Hydrocarbonate indicator does not exceed the MAC, the maximum is 73.57 mg/l, and the minimum is 46.04 mg/l. The Fluorides indicator does not exceed the MAC, the maximum is 1.14 mg/l, and the minimum is 0.44 mg/l. The Chlorides indicator does not exceed the MAC, the maximum is 1.00 mg/l, and the minimum is 0.26 mg/l. The Sulphates indicator does not exceed the MAC, the maximum is 12.24 mg/l, and the minimum is 4.05 mg/l. The Nitrites indicator is not detected. The Nitrates indicator does not exceed the MAC, the maximum is 3.30 mg/l, and the minimum is 2.41 mg/l.

Table 12 – Concentration of main anions in the Ala-Archa river, Chui region, data for May 2016, May 2017, August 2017, March 2018

Sampling location	Sampling date	Hydrocar bonates, mg/l	Fluorides, mg/l	Chlorides, mg/l	Sulfates, mg/l	Nitrites, mg/l	Nitrates, mg/l
Ala-Archa (1)	05.16	58,33	0,78	0,89	9,78	not detected	3,30
Ala-Archa (1)	05.17	46,04	1,03	1,00	10,80	not detected	3,20
Ala-Archa (1)	08.17	51,88	0,44	0,26	4,05	not detected	2,41
Ala-Archa (1)	03.18	73,57	1,14	0,89	12,24	not detected	2,78
Ala-Archa (2)	05.26	128,09	0,40	1,29	13,93	not detected	3,93
Ala-Archa (2)	05.17	173,63	0,59	1,55	15,01	not detected	4,99
Ala-Archa (2)	08.17	77,83	0,46	0,57	7,21	not detected	2,88
Ala-Archa (2)	03.18	103,03	0,76	1,73	20,64	not detected	3,60

At the sampling point Ala-Archa (2): The Hydrocarbonate indicator does not exceed the MAC, the maximum is 173.63 mg/l, and the minimum is 77.83 mg/l. The Fluorides indicator does not exceed the MAC, the maximum is 0.76 mg/l, and the minimum is 0.40 mg/l. The Chlorides indicator does not exceed the MAC, the maximum is 1.73 mg/l, and the minimum is 0.57 mg/l. The Sulphates indicator does not exceed the MAC, the maximum is 20.64 mg/l, and the minimum is 7.21 mg/l. The Nitrites indicator is not detected. The Nitrates indicator does not exceed the MAC, the maximum is 4.99 mg/l, and the minimum is 2.88 mg/l.

Conclusion

During the study of the physical and chemical characteristics of the main rivers of the central part of the Chui region, it was revealed that the quality of water in the rivers significantly affects the health of the population using these resources.

Concentration of heavy metals. In the investigated river waters of Chui region, the content of zinc, copper, chromium and hexavalent chromium was observed below MAC. Relatively high levels of cadmium were observed in Ala-Archa-1 (0.54 µg/l, 08.17).

Concentration of cations. The content of magnesium, potassium, sodium and calcium in the studied river waters of Chui region was observed below MAC.

The magnesium MAC was found to be exceeded at Sokuluk-2 river (9.39 mg/l, 03.18). Potassium content is significantly below the MAC. Relatively high values of sodium in water were determined at Alamedin-2 river (10.00 mg/l, 03.18) and Sokuluk-2 river (12.05 mg/l, 03.18). Relatively high calcium values were recorded in the Sokuluk-2 River (50.84 mg/l, 03.18).

Concentration of anions. The content of hydrocarbonates, fluorides, chlorides, nitrates and sulphates in the investigated river waters of Chui region was observed below MAC.

Fluorides are contained in river waters in insignificant concentrations. Their increased value was observed at Sokuluk-1 river point (0.69 mg/l, 09.17; 0.82 mg/l, 05.17; 0.78 mg/l, 03.18) and at Ala-Archa-2 river point (0.76 mg/l, 03.18).

Thus, the results of this study serve as a basis for further environmental assessments and the development of water management strategies. The results of this study provide a basis for further environmental assessments and the development of water management strategies aimed at preserving and restoring river ecosystems and ensuring sustainable use of water resources in the region. It is important to continue research work in this area to ensure a balance between economic development and environmental protection.

References

Anh N.T., Nhan N.T., Schmalz B., Le Luu T. (2023). Influences of key factors on river water quality in urban and rural areas: A review. Case Studies in Chemical and Environmental Engineering, 100424.

Carr G.M., Neary J.P. (2008). Water quality for ecosystem and human health. UNEP/Earthprint.2nd Edition. United Nations Environment Programme Global Environment Monitoring System/Water Programme.

Cruz M.A.S., Gonçalves A.D.A., de Aragão R., de Amorim J.R.A., da Mota P.V.M., Srinivasan V.S., de Figueiredo E.E. (2019). Spatial and seasonal variability of the water quality characteristics of a river in Northeast Brazil. Environmental earth sciences, 78, 1-11.

Giri S. (2021). Water quality prospective in Twenty First Century: Status of water quality in major river basins, contemporary strategies and impediments: A review. Environmental Pollution, 271, 116332.

Hygienic standards (2003). Gigienicheskie normativy GN 2.1.5.1315-03 «Predel'no dopustimye koncentracii (PDK) himicheskih veshhestv v vode vodnyh ob#ektov hozjajstvenno-pit'evogo i bytovogo vodopol'zovanija [GN 2.1.5.1315-03. Maximum allowable concentrations (MACs) of chemicals in the water of water objects used for drinking and domestic recreation purposes]. Ministry of Health of Russia, Moscow

Hygienic standards (2003). Gigienicheskie normativy GN 2.1.5.1315-03 «Predel'no dopustimye koncentracii (PDK) himicheskih veshhestv v vode vodnyh ob#ektov hozjajstvenno-pit'evogo i bytovogo vodopol'zovanija [GN 2.1.5.1315-03. Maximum allowable concentrations (MACs) of chemicals in the water of water objects used for drinking and domestic recreation purposes]. Ministry of Health of Russia, Moscow

Hygienic standards (2016). Gigienicheskie normativy GN 2.1.5.1315-03 «Predel'no dopustimye koncentracii (PDK) himicheskih veshhestv v vode vodnyh ob#ektov hozjajstvenno-pit'evogo i bytovogo vodopol'zovanija [GN 2.1.5.1315-03. Maximum allowable concentrations (MACs) of chemicals in the water of water objects used for drinking and domestic recreation purposes]. Approved by the Resolution of the Government of the Kyrgyz Republic dated 11 April 2016 No. 201

Law of the Kyrgyz Republic (2011) Law of the Kyrgyz Republic from 30 May 2011 of No. 34 Technical regulation: On the safety of drinking water (as amended by the KR Law dated 28 April 2017 No. 67)

Nuralieva N.M. (2022). Water potential of the Republic of Kyrgyzstan: problems and potentials of economic development. Arid Ecosystems, 12(2), 193-199.

Peña-Guerrero M.D., Nauditt A., Muñoz-Robles C., Ribbe L., Meza F. (2020). Drought impacts on water quality and potential implications for agricultural production in the Maipo River Basin, Central Chile. Hydrological Sciences Journal, 65(6), 1005-1021.

Raimbekov K., Moombekov S., Iliyazov J., Myrzabaev I. (2023). Assessment of wastewater impact on a natural reservoir in Kyrgyzstan. Innovaciencia, 11(1).

The Sanitary Rules (2003). Sanitarno-jepidemiologicheskie pravila i normy 2.1.4.1074-01 Voda pit'evaja. Gigienicheskie trebovanija k kachestvu vody centralizovannyh sistem pit'evogo vodosnabzhenija. Kontrol' kachestva. Gigienicheskie trebovanija k obespecheniju bezopasnosti sistem gorjachego vodosnabzhenija. [Sanitary-Epidemiological Rules and Regulations 2.1.4.1074-01

Drinking Water. Hygienic requirements for water quality of centralised drinking water supply systems. Quality control. Hygienic requirements for ensuring safety of hot water supply systems]. Ministry of Health of Russia, Moscow

Wen Y., Schoups G., Van De Giesen N. (2017). Organic pollution of rivers: Combined threats of urbanization, livestock farming and global climate change. *Scientific reports*, *7*(1), 43289.

World Health Organization (2017). Guidelines for drinking-water quality, 4th ed. World Health Organization. https://iris.who.int/handle/10665/44584

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