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ASSESSMENT OF THE LEVEL OF POLLUTION OF THE UI AND ZHELKUAR RIVERS

Annotation. In order to assess the water quality of the Ui and Zhelkuar rivers, which are transboundary rivers, the hydrochemical indicators obtained between 2018 and 2024 were used to determine the water pollution index. As a result, the final water pollution index was calculated based on the pollution index of each year. Among the hydrochemical indicators, components such as synthetic surfactants, iron, oil products, phenol, BOD₅, copper, zinc, manganese and nickel were taken. Among the presented components, it can be seen that manganese, nickel, zinc and oil products exceed the MPC every year, and the impact of technogenic load on the water ecosystem is somewhat noticeable.

The results of the study indicate that the water quality of the Ui and Zhelkuar rivers is at a moderate to high level of pollution, proving the need for continuous environmental monitoring and integrated management measures aimed at reducing pollution for transboundary water bodies.

Keywords: Water quality, maximum permissible concentration, water pollution index, hydrochemical indicators, Ui, Zhelkuar.

Introduction

The quality of surface river waters is a key indicator of the ecological state of aquatic ecosystems and directly affects public health, agriculture and the economic development of the region [1].

Currently, the composition of natural waters is greatly influenced by anthropogenic influences. Various pollutants entering the environment can undergo various changes, which in turn increases their toxic effect [2].

The Ui River is a left-bank tributary of the Tobol River. The Ui and Zhelkuar rivers are transboundary water bodies. The Uy river originates in the territory of the Republic of Kazakhstan and then flows into the territory of the Russian Federation, therefore its hydrological and ecological state is formed by the combined influence of natural and anthropogenic factors between the two states. Its length is 462 km. The upper reaches of the river are located in the village It passes through areas of agricultural activity [3]. The Ui and Zhelkuar Rivers are important water bodies in the region, providing water to settlements and supporting local ecosystems. The Zhelkuar River is a left-bank tributary of the Tobol River and is formed by the confluence of the Bersuat and Syntasty rivers. The catchment area of the Bersuat, Syntasty and Zhelkuar Rivers up to the dam is 4,317 km² [4]. The Ui River is distinguished by the length and area of its drainage basin, while the Zhelkuar is a smaller river that acts as a stream and a local water source. Both rivers are affected by economic activities, which makes it important to constantly monitor their water quality [5,6].



The Ui and Zhelkuar Rivers play an important role in providing water to settlements and industrial facilities, as well as in preserving biological diversity. In recent years, due to the development of industry, agriculture and urbanization, an increase in anthropogenic load on water bodies has been observed [7,8]. This leads to changes in the chemical composition of water and the accumulation of pollutants, which requires constant monitoring of hydrochemical indicators [9].

The purpose of this work is to assess the water quality of the Ui and Zhelkuar Rivers for the period 2019-2024 based on the calculation of the final pollution index of water bodies based on hydrochemical indicators. The analysis conducted allows us to identify trends in water quality changes, identify the main sources of pollution, and provide recommendations for the rational use and protection of water resources.

Research materials and methods.

The final index of water pollution (WPI) is a comprehensive indicator that allows assessing the level of water pollution, taking into account several hydrochemical parameters [10]. The degree of pollution of the waters of the Ui and Zhelkuar Rivers was assessed using data from quantitative hydrochemical water analyses in accordance with established methodologies [11]. A study on water quality in the Uy and Zhelkuar rivers examined data collected by Kazhydromet over six years, from 2019 to 2024. To understand the extent of water pollution, a special index (WPI) was calculated based on an analysis of nine key chemical parameters (Table 1). These parameters were then compared with established standards (MPCs) [12].

Based on the generally calculated WPI values, water quality is assessed using the following classes : I-very clean (WPI ≤ 0.3); II-clean (WPI 0.3-1); III - moderately polluted (WPI 1-2.5); IV - polluted (WPI 2.5-4); V-dirty (WPI 4-6); VI -very dirty (WPI 6-10); VII-the dirtiest (WPI >10) [13]. Maximum permissible concentration (MPC) standards developed for fisheries were used to assess hydrochemical parameters (Table 1) [14] .

Class I: This class includes water bodies that are least susceptible to negative human impact. Their chemical and biological characteristics are close to those found naturally in the area.

Class II: This class includes water bodies that have exhibited some changes compared to their original state. However, these changes have not yet disrupted the overall ecological balance.

Class III: This class includes water bodies that are experiencing anthropogenic impacts that are approaching the sustainability limit of their ecosystems.

Class III: Water bodies in this class are characterized by impaired ecological parameters. Their condition is assessed as ecological degradation [15,16] .

Each hydrochemical indicator was compared with its permissible limit (MPC) and calculated. The following formula was used for this:

$$K_i = C_i / C_{MPC}$$

where, C_i - the actual amount of substances in water, C_{MPC} - the maximum permissible amount of a given indicator

The final water pollution index was calculated as the arithmetic mean of the ratios of actual concentrations of pollutants to their maximum permissible concentrations.

Table 1 - Hydrochemical composition of chemical and biogenic substances in river water indicators

Names	BOD ₅	Fe	petroleum products	phenol	synthetic surfactants	Cu	Zn	Mn	Ni
Year	3	0.1	0.05	0.001		0.001	0.01	0.01	0.01

МРС					0.1				
2019	30.03	3.048	0.258	0.01	0.005	0.00166	0.003	0.01966	0.0625
2020	10.26	3.8516666	0.11	0.039	0	0.001666667	0.003	0.01966	0.0625
2021	35	2.42	0.175	0.0417	0.0002	0	0.003	0.02933	0.0371666
2022	19.9	1.95	0.083	0.0025	0.0007	0.00166	0.0020	0.04058	0.0615
2023	16.2	2.79	0.007	0.19	0.008	0	0.003	0.0299	0.0769
2024	15.6	1.97	0.12	0.02	0	0.01	0.00283333	0.0245	0.04558333

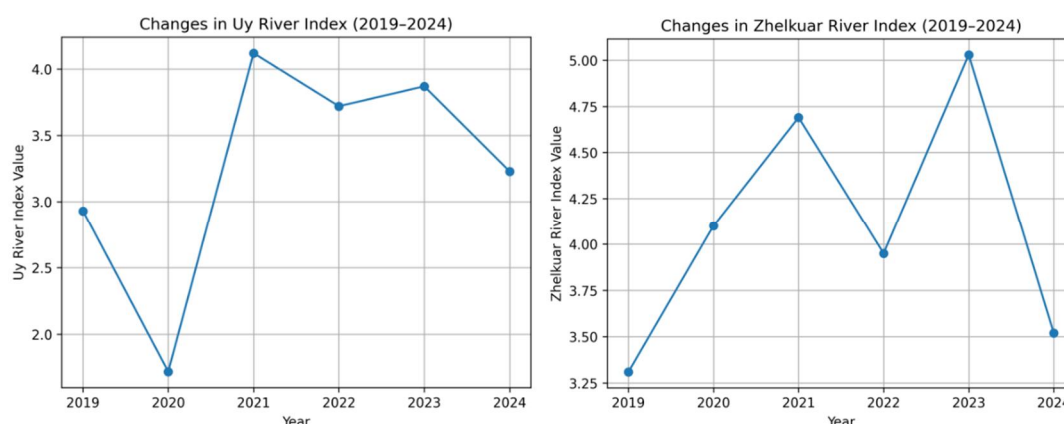
Results

During the study, a comprehensive assessment of the water quality of the Ui and Zhelkuar Rivers was conducted in 2019–2024. To assess water quality, an integrated water pollution index (WPI) was calculated, and the results were analyzed in accordance with the current ecological classification of water quality.

The changes in the water pollution index of the Ui and Zhelkuar Rivers over the years and the corresponding water quality classes determined as a result of the study are shown in Table 2 and Figure 1.

Table 2 - Final values of the water pollution index of the Ui and Zhelkuar Rivers

Years	Ui river (WPI)	Water quality classes	Zhelkuar River (WPI)	Water quality classes
2019	2.93	III- moderately polluted	3.31	III- moderately polluted
2020	1.72	III- moderately polluted	4.10	IV- contaminated
2021	4.12	IV- contaminated	4.69	IV- contaminated
2022	3.72	III- moderately polluted	3.95	III- moderately polluted
2023	3.87	III- moderately polluted	5.03	IV- contaminated
2024	3.23	III- moderately polluted	3.52	III- moderately polluted



Figs 1 - Dynamic analysis of water quality pollution in the Ui and Zhelkuar Rivers for 2019-2024

As shown in Table 2 and Figure 1, it can be seen that the integrated WPI values for the Ui River water ranged from 1.72 to 4.12 during 2019-2024, which indicates that the water quality corresponds to classes III-IV. In 2019-2020, moderate pollution of river waters was observed ($WPI < 3$). In 2021, the pollution index reached a maximum value of 4.12, which corresponds to polluted water (class IV). The increase in the water pollution index was due to a significant increase in concentrations of manganese, nickel, zinc, and petroleum products. From 2022 to 2024, water quality remained stable, within Class III. This represents a slight



improvement, but also points to ongoing anthropogenic impacts.

Meanwhile, the integrated index of water pollution of the Zhelkuar River varied in the range of 3.3–5.0, which corresponds to classes III–IV of water quality. The most unfavorable environmental situation High levels of pollution were observed in 2023, which may be associated with increased economic activity and/or unfavorable hydrological conditions. Despite a slight decrease in the indicator in 2024, the state of the Zhelkuar River water remains environmentally tense.

The increase in the WPI was caused by nickel, manganese, zinc and cuprum, the concentrations of which systematically exceeded the MPC. In 2024, there was a slight improvement in water quality, but the level of pollution increased.

Conclusion

According to the results of calculating the integral index of water pollution, it was determined that the water quality of the Ui and Zhelkuar Rivers in 2019-2024 mainly corresponds to levels III-IV. The Zhelkuar River is characterized by an increased level of pollution and a higher frequency of transition to level IV compared to the Ui River. The main polluting components of both rivers are nickel, manganese and zinc, the concentrations of which systematically exceed the TLV. River pollution is of a stable technogenic nature, which indicates the need for constant monitoring of sources of heavy metals. The observed trend of partial improvement in water quality in 2024 is unstable and requires confirmation by further observations.

Comparative analysis shows that the Zhelkuar River is characterized by a more unfavorable ecological situation than its home river, which indicates the need to strengthen water quality monitoring and develop environmental protection measures in this river basin.

The results obtained confirm the importance of regular hydrochemical monitoring and WPI calculations for timely assessment of the state of water resources and development of measures to protect them.

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ҮЙ ЖӘНЕ ЖЕЛҚУАР ӨЗЕНДЕРІНІҢ ЛАСТАНУ ДЕҢГЕЙІН БАҒАЛАУ

Аңдатпа. Траншекаралық өзендер болып табылатын Үй және Желкуар өзендерінің су сапасын бағалау үшін 2018 және 2024 жылдар аралығында алынған гидрохимиялық көрсеткіштер судың ластану индексін анықтау үшін пайдаланылды. Нәтижесінде, судың ластануының соңғы индексі әр жылдың ластану индексі негізінде есептелді. Гидрохимиялық көрсеткіштердің ішінде ОБҚ₅, темір, мұнай өнімдері, фенол, СЖАЗ, мыс, мырыш, марганец, никель сияқты компоненттер алынды. Ұсынылған компоненттердің ішінде марганец, никель, мырыш және мұнай өнімдерінің жыл сайын ШРК-дан асып түсетінін және су экожүйесіне техногендік жүктеменің әсері біршама байқалатынын көруге болады.

Зерттеу нәтижелері Үй және Желкуар өзендерінің су сапасының орташадан жоғары деңгейге дейін ластанғанын көрсетеді, бұл траншекаралық су айдындарының ластануын азайтуға бағытталған үздіксіз қоршаған ортаны бақылау және кешенді басқару шараларын жүргізу қажеттілігін дәлелдейді.

Кілт сөздер: Судың сапасы, шекті рауалы мөлшер, судың ластану индексі, гидрохимиялық көрсеткіштер, Үй, Желкуар.

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ОЦЕНКА УРОВНЯ ЗАГРЯЗНЕНИЯ РЕК УЙ И ЖЕЛКУАР

Аннотация. Для оценки качества воды трансграничных рек Уй и Желкуар были использованы гидрохимические показатели, полученные в период с 2018 по 2024 год, для определения индекса загрязнения воды. В результате был рассчитан окончательный индекс



загрязнения воды на основе индекса загрязнения за каждый год. Среди гидрохимических показателей были учтены такие компоненты, как ОБК₅, железо, нефтепродукты, фенол, СПАВ, медь, цинк, марганец, никель. Среди представленных компонентов видно, что содержание марганца, никеля, цинка и нефтепродуктов ежегодно превышает предельно допустимую концентрацию, и влияние техногенной нагрузки на водную экосистему является достаточно заметным.

Результаты исследования показывают, что качество воды в реках Уй и Желкуар находится на уровне умеренного или высокого загрязнения, что подтверждает необходимость постоянного экологического мониторинга и комплексных мер управления, направленных на снижение загрязнения трансграничных водных объектов.

Ключевые слова: Качество воды, максимально допустимая концентрация, индекс загрязнения воды, гидрохимические показатели, Уй, Желкуар.