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Monitoring the State of Waterbodies and Taking into Account Anthropogenic Impact

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ABSTRACT

The study aimed to monitor the various watercourses affected by similar technogenic impacts and select controlled hydrochemical parameters. Sampling and testing were performed in accordance with GOST 31861-2012 standards, with a focus on wastewater from a coal mine and natural water from receiving water bodies. However, we observed significant seasonal variations in water quality, with certain pollutants like manganese, sulfates, and suspended solids surpassing the maximum permissible concentrations (MPC) in both spring and fall. The study also revealed that pollutants could accumulate in the bottom layers of water bodies and resurface during different periods, potentially leading to seasonal increases in pollution levels. The findings indicate that the wastewater treatment at the coal mining site generally meets regulatory standards. However, observed the significant seasonal variations in water quality, with certain pollutants like manganese, sulfates, and suspended solids surpassing the maximum permissible concentrations (MPC) in both spring and fall. The study also revealed that pollutants could accumulate in the bottom layers of water bodies and resurface during different periods, potentially leading to seasonal increases in pollution levels. It is important to consider the cumulative effect of pollutants in the bottom layers, which can resurface during different periods. Data on pollutants in sediments can help predict pollution increases in different seasons. Additionally, the monitoring network should include sampling points above the anthropogenic object to account for upstream pollution from industrial, municipal, and agricultural sources.

Keywords: Water bodies; Pollution; Anthropogenic factor; Monitoring; Monitoring program

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INTRODUCTION

The issue of water bodies deteriorating, leading to degradation, is acute in regions with increased anthropogenic load (Alekseev et al., 2022). Pollution of watercourses determines not only the problems of water management, but also the overall decline in the biosphere functions of rivers and wastewater receivers (Asadulagi et al., 2024). The level of influence of the technosphere can be determined by the number of sources of negative impact, the emergence of the system, that is, a set of external factors that form a qualitatively new negative effect (Novikova et al., 2020).

Monitoring the qualitative and quantitative chemical composition of water in the water body directly in the impact zone, the zone of transit sections of the watercourse, and background zones is important for monitoring and regulating anthropogenic impact on hydrosphere objects, as well as ensuring compliance with the standards for discharged runoff (Ansabayeva & Akhmetbekova 2024). Within the framework of implemented monitoring programs, monitoring and tracking imply constant control, efficiency, and reliability (Apergis et al., 2023).

We can use the information we got at the sampling points (in the gates) to find out not only how a certain technological source affects the area we're looking at, but also how other factors, like residential areas, natural leaching processes, and others, affect it (Bugubayeva et al., 2024).

The use of the regulatory framework and the results of field studies are linked to the scrutiny of pollution through systematic monitoring observations (Mustafin et al., 2023). A comparison of the results allows us to determine the water quality class and draw conclusions about the state of each object's water ecosystems.

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For regions with a well-developed hydrological network, monitoring studies on various water bodies is an important element in the system of monitoring the ecological state of the entire hydrosphere (Korotkih et al., 2024). The increased anthropogenic load on individual components of the hydrological network affects the state of the main waterway to one degree or another (Markhayeva et al., 2023).

In industrially developed territories, the states of aquifers, both surface and underground, are subject to significant technogenic impacts. This means that a monitoring system needs to be made that takes into account the type of technological load and how complicated the relationships are between the technosphere and nature (Hwang et al., 2008; Nieuwenhuijsen et al., 2009; Kharionovsky & Danilova, 2017).

A standard monitoring program lets us check the type and amount of wastewater that is dumped directly into bodies of water, as well as the effect on those bodies of water that are directly connected to the source of human-made load (about 500 m downstream from the source) (Plotnikov et al., 2023). The list of controlled indicators mainly consists of 15 parameters: pH, color, smell, transparency, The list includes elements such as boron, sulfates, chlorides, suspended solids, phosphates, ammonium ions, nitrites, nitrates, mineralization, iron, and surfactants.

For economic entities that contribute to the pollution of heavy metals and other specific substances, the control schedule also includes the determination of heavy metals such as zinc, copper, nickel, chromium, and lead (Kalashnikov et al., 2023). Controlled heavy metals may include others (arsenic, mercury, cadmium, aluminum, manganese, etc.), as well as specific substances (phenol, cyanides, fats, etc.). Such programs can serve as a foundation for the development and implementation of individual programs.

The purpose of this study is to monitor the state of various watercourses exposed to technogenic effects of a similar nature and to select controlled hydrochemical parameters.

MATERIALS & METHODS

We carried out sampling and composition testing for the predominant type of polluting components in accordance with the standards (GOST 31861-2012). The objects of the study were waste water from one of the coal mines and natural water from the water objects-receivers of effluents.

We monitored the sources of waste water pollution at two discharge points: outlet No. 2 and outlet No. 4, as well as the qualitative and quantitative composition of watercourses and waste water receivers from a coal mine. The open-pit coal mining enterprises treat the effluents before discharge. At BfuskA No. 2, a hydraulic dump serves as the treatment facility, sequentially depositing wastewater into a sump and a hydraulic dump for wastewater treatment. Additionally, the dam structure enclosing the dump filters water for cleaning. The effluents undergo no reagent treatment or disinfection. The receiver of treated effluents is a surface water body—the Bolshaya Korovikha River (50.805168, 83.643546), whose source is located in the immediate vicinity of the bottom of the hydraulic dump's enclosing dam. The runoff toinlet A No. 4 is treated by successive sedimentation in a sump. The effluents do not undergo reagent treatment or disinfection. The Yerunakovka River is a surface water body that receives treated wastewater. Rivers are part of the Tom River hydrological network, which allows these watercourses to be included in the monitoring network's list of mandatory objects (Skobelev et al., 2020; Ivetich & Gorelkina, 2020; Smirnov et al., 2018; Radovic et al., 1997).

The discharge receivers receive the effluent throughout the year. Even in the winter months, we do not distribute waste water volumes; we exclude discharge for output No. 2, and significantly reduce it for output No. 4 from October to January. The Fig. 1 and 2 represent the effluent volumes.

According to Podkościelny and Nieszpore (2011), the authors took samples and parameters to obtain a set of data with subsequent analysis of contamination of both runoff and the composition of watercourses.

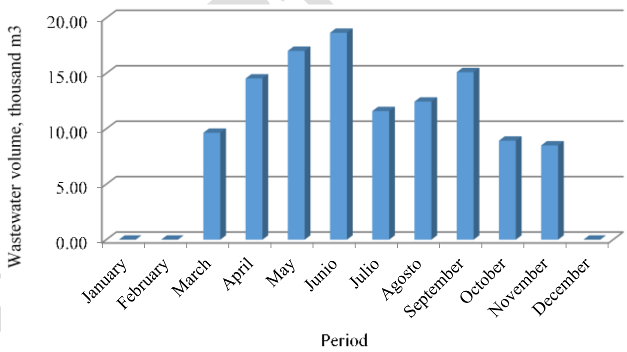

Fig. 1: Changes in the volume of wastewater discharged to water bodies at outlet No. 2

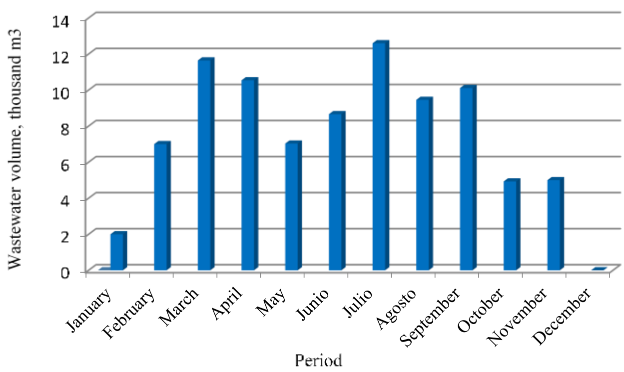

Fig. 2: Changes in the volume of wastewater discharged to water bodies at outlet No. 4

RESULTS & DISCUSSION

The obtained data allows us to assess the degree of wastewater treatment and compliance with regulatory requirements, as well as the impact of open-pit wastewater from a coal mine on the level of water pollution in drain receivers. Table 1 displays water quality indicators from various points.

The results of the study of water samples presented in the table allow us to speak about a sufficient degree of wastewater treatment at a coal mining enterprise,

Table 1: Quality indicators of selected water samples at outlet No. 2

Indicators	Unit measurement	of MPC	Issue No. 2 in the Bolshaya Korovikha river.	Bolshaya Korovikha 500 m below issue No.2	Issue No. 4 in the Yerunakovka river	The Yerunakovka river. Erunakovo 500m below issue No. 4
the Smell at 200With*	score	0	2	2	0	3
Manganese, dissolved,	mg/dm^3	0.01	0.0066	0.013	0.0098	0.054
Ammonium ions	mg/dm^3	0.5	less than 0.10	less than 0.10	0.50	less than 0.10
Becolne	mgo2/dm^3	3.0	2.70	1.9	2.4	6.5
Suspended solids	mg/dm^3	10.0	9	7.2	eleven	420
Nitrate ions*	mg/dm^3	40	0.29	0.13	38	83
Nitrite ions*	mg/dm^3	0.08	less than 0.003	0.003 less than	0.04	0.13
Sulfate ions*	mg/dm^3	100	103	139	100	454
solids	mg/dm^3	1500	625	1580	1381	1393
Iron	mg/dm^3	0.1	0.105	-	0.09	-
Calcium	mg/dm^3	180.0	111	95	251	181
Magnesium	mg/dm^3	40.0	40.7	47	39.5	145
Manganese	mg/dm^3	0.01	0.006	-	0.01	-
Zinc	mg/dm^3	0.01	0.0059	-	0.0101	-
Zinc, dissolved,	mg/dm^3	0.01	less than 0.005	less than 0.005	0.0101	0.0056

Table 2: Quality indicators of selected water samples at outlet No. 4

Indicators	Unit of measurement	MPC	p Big Corovica 500 m below issue No. 2	
			FALL	SPRING
Smell at 20°C*	score	0	1	2
the Smell at 60°C*	score	0	0	0
Manganese, dissolved,	mg/dm^3	0.01	0.055	0.013
Ammonium ions*	mg/dm^3	of 0.5	less than 0.1	less than 0.10
Becolne*	mgO_2/dm^3	3.0	1.54	1.9
pH value*	units/pH	6.5-8.5	8.3	7.98
Suspended solids	mg/dm^3	10.0	128	7.2
Oil products,	mg/dm^3	0.05	less than 0.02	less than 0.02
Nitrate ions*	mg/dm^3	40	0.13	0.13
Nitrite ions*	mg/dm^3	0.08	less than 0.003	0.003 less
Sulfate ions*	mg/dm^3	100	132	139
solids	mg/dm^3	1500	547	580
total Phosphorus*	mg/dm^3	0.2	less than 0.025	less than 0.1
Phenol	mg/dm^3	0.001	0.0001 less	0.00038
Color*	the degree of color	20	5.50	3.3
Iron	mg/dm^3	of 0.1	-	-
Iron dissolved	mg/dm^3	0.1	0.14	less than 0.05
Calcium	mg/dm^3	180.0	79.3	95
Magnesium	mg/dm^3	40.0	41.0	47
Manganese	mg/dm^3	of 0.01	-	-
surfactants(anion-active)	mg/dm^3	of 0.5	less than 0.01	less than 0.01
Chloride ion*	mg/dm^3	of 300.0	16.6	16.6
total Chromium	mg/dm^3	0.02	-	-
Chromium, total dissolved	mg/dm^3	0.02	less than 0.001	less than 0.001
Zinc	mg/dm^3	of 0.01	-	-
Zinc dissolved	mg/dm^3	to 0.01	less than 0.005	less than 0.005

which is required in accordance with the Order of the Ministry of Agriculture of the Russian Federation No. 552 of December 13, 2016, for wastewater discharged into water bodies for fishing purposes. Compounds discharge their poison at either a pre-threshold concentration or slightly above the standard (Isakov, 2023). However, studies of water from the wastewater receiver's actual water source show that there are too many regulatory indicators for a large number of substances on the program's list of substances that need to be monitored. The ingress of wastewater from other sources, including coal enterprises located geographically near the site, likely contributes more to the accumulation of pollutants in rivers than the wastewater under study. There are no localities within the site's boundaries. The nearest industrial centers are 35 km south and 30 km away but the area is sparsely populated. The catchment area's territory is heavily anthropogenic and borders coal mining enterprises in both open and closed ways. It is also important to consider the natural catchment area formed by precipitation, so studying the seasonal component is necessary (Timoshchuk, 2016).

We conducted water quality comparisons in different seasons at issue No. 2 of the object under study. Table 2 illustrates that the hydraulic dump exceeds the standards for odour, BOD, and manganese (both total and soluble) during the off-season. Compared to autumn, the BOD indicators for this facility increased from MPC to 1.00–5 MPC, as well as suspended solids from 0.28 MPC to 1.00–2 MPC. We have noted a decrease in the total manganese content. According to these indicators, the total iron content decreased from 1.00–3 MPC to 0.94 MPC and the zinc content decreased from 1 MPC to 0.74 MPC, improving the water quality. The smell indicators for this item have not changed (Corwin, 2011).

Analysis of water after discharge No. 2 into the Bolshaya Korovikha River showed that the qualitative composition of water in the watercourse, regardless of the season, does not meet the standards for the following indicators: smell (at 20°C), manganese, sulfates, magnesium. This is in contrast to the seasonal improvements documented in studies such as those conducted by Adnan et al. (2024), wherein focused remediation efforts resulted in transient decreases in particular contaminants. The results of this study highlight the need for more strict and continuous monitoring and treatment interventions because they demonstrate that continuous discharge from sources like coal mining activities can maintain excessive pollutant levels in the absence of adequate treatment or remediation.

Compared to autumn, the smell indicators have worsened, while those for sulfates and magnesium have remained almost unchanged (the discrepancy does not exceed the determination error).

The concentration of suspended solids and dissolved iron in the samples taken in spring decreased (for explosives, from 12.8 MPC to 0.72 MPC, and for iron, from 1.4 MPC to 0.5 MPC).

Compared to other studies, the observed drop in dissolved iron and suspended solids during the spring is similar to what Krasnova et al. (2017) found. They also found similar seasonal drops because of the diluting effect of higher water flow during meltwater periods. Boroumand and Razmjou (2024) found that adsorption processes consistently lower metal concentrations in warmer months. However, this study reveals a more intricate interplay of factors, including the potential absorption of metals into bottom sediments, a concept Raji et al. (2023) also discussed. These findings suggest that while seasonal variations play a significant role, the specific conditions of the catchment area, including the nature of the pollutants and their interaction with sediment, must also be considered when predicting and managing water quality. An increase in watercourse volume, or iron and manganese absorption on the bottom silt surface, may lower their content.

Conclusion

The resulting set of research data allows us to make some assumptions about the state of the studied water bodies. The selection of hydrological indicators, in line with the list established by standard standards programs, accurately reflects the level of contamination in the watercourse and the anthropogenic object's contribution to pollution. At the same point, we must consider that the presence of pollutants in the watercourse, even at pre-threshold concentrations, can have a cumulative effect on the river's bottom layers, causing them to wash out in different periods. Data on the presence of pollutants in the bottom sediments will allow us to most accurately predict the increase in the level of water pollution in different seasons, for example, during the summer low-water period. Additionally, we need to enhance the monitoring network by adding sampling points above the anthropogenic object. This will enable us to consider the anthropogenic component, which arises above the object under consideration along riverbeds. This component includes wastewater discharges from industrial, municipal, and agricultural enterprises, as well as the elimination of dissolved and suspended impurities from agricultural land, arable land, pastures, fertilized areas, and abandoned territories.

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Author's Contribution

Gorelkina A.K. contributed to the conceptualization, methodology, formal analysis, and original draft preparation. Timoshchuk I.V. was responsible for data curation, investigation, software development, and visualization. Mikhaylova E.S. provided resources, validated the manuscript, and participated in the review and editing. Neverov E.N. supervised the project, managed project administration and funding acquisition, and also contributed to writing, reviewing, and editing the manuscript as the corresponding author.

REFERENCES

Adnan, M., Xiao, B., Ali, M. U., Xiao, P., Zhao, P., Wang, H., & Bibi, S. (2024). Heavy metals pollution from smelting activities: A threat to soil and groundwater. *Ecotoxicology and Environmental Safety*, 274. https://doi.org/10.1016/j.ecoenv.2024.116189

Alekseev, E. V., Bogdan, V. V., Zakharova, A. N., & Dudynov, S. (2022). Regulation of environmental safety in the context of geopolitical changes. *Revista Relações Internacionais do Mundo Atual*, 1(34). http://revista.unicuritiba.edu.br/index.php/RIMA/article/view/5899

Ansabayeva, A., & Akhmetbekova, A. (2024). Biological products sway the yield and quality traits of chickpea (Cicer arietinum L.) in a continental climate. *SABRAO Journal of Breeding and Genetics*, 56(1), 45-53. http://doi.org/10.54910/sabrao2024.56.1.4

Apergis, N., Kuziboev, B., Abdullaev, I., & Rajabov, A. (2023). Investigating the association among CO2 emissions, renewable and non-renewable energy consumption in Uzbekistan: An ARDL approach. *Environmental Science and Pollution Research*, 30(14), 39666-39679. https://doi.org/10.1007/s11356-022-25023-z

Asadulagi, M.-A.M., Pershin, I.M., & Tsapleva, V.V. (2024). Research on Hydrolithospheric Processes Using the Results of Groundwater Inflow Testing. *Water*, 16(3), 487. https://doi.org/10.3390/w16030487

Boroumand, Y., & Razmjou, A. (2024). Adsorption-type aluminium-based direct lithium extraction: The effect of heat, salinity and lithium content. *Desalination*, 577. https://doi.org/10.1016/j.desal.2024.117406

Bugubayeva, A. U., Chashkov, V. N., Valiev, K. K., Kuanyshbayev, S. B., Kupriyanov, A. N., Mamikhin, S. V., Nugmanov, A. B., Shcheglov, A. V., Bulaev, A. G., Paramonova, T. A., Joldassov, A., & Uxikbayev, M. (2024). Improving the level of water quality and plant species diversity in the reservoir accumulating natural effluents from the reclaimed uranium-containing industrial waste dump. *Brazilian Journal of Biology*, 84, e282386.

Corwin, C. J. (2011). Adsorption and desorption of trace organic contaminants from granular activated carbon adsorbers after intermittent loading and throughout backwash cycles. *Water Research*, 45(2), 417-426.

Hwang, B. F., Jaakkola, J. J., & Guo, H. R. (2008). Water disinfection by-products and the risk of specific birth defects: a population-based cross-sectional study in Taiwan. *Environmental Health*, 7(1), 19-29.

Isakov, V. S. (2023). Monitoring of the ecological situation in mining operations. *Bulletin of Science*, 2(2(59)), 295-298.

Ivetich, M., & Gorelkina, A. K. (2020). Reducing water contamination to ensure the quality and safety of food products. *Food Processing: Techniques and Technology*, 50(3), 515-524.

Kalashnikov, A., Abduramanov, N., Kalashnikov, P., Baizakova, A., & Denisyuk, N. (2023). Regulation of hydrocyclone parameters to improve the quality of water purification on drip irrigation systems. *Caspian Journal of Environmental Sciences*, 21(4), 787-799. https://doi.org/10.22124/cjes.2023.7129

Kharionovsky, A. A., & Danilova, M. Y. (2017). Wastewater treatment at coal industry enterprises. Water Treatment. *Water Supply*, 6(114), 52-55.

Korotkih, P. S., Neverov, E. N., & Korotkiy, I. A. (2024). Assessment of carbon dioxide exchange processes between water bodies and the atmosphere. *Caspian Journal of Environmental Sciences*, 21(5), 1239-1245.

Krasnova, T. A., Timoshuk, I. V., Gorelkin, A. K., & Dugarjav, J. (2017). The choice of sorbent for adsorption extraction of chloroform from drinking water. *Foods and Raw Materials*, 2, 189-196.

Markhayeva, B., Ibrayev, A. S., Beisenova, M., Serikbayeva, G., & Arrieta-López, M. (2023). Green Banking Tools for the Implementation of a State's Environmental Policy: Comparative Study. *Journal of Environmental Management and Tourism*, 14(1), 160-167. https://doi.org/10.14505/jemt.14.1(65).15

Mustafin, M. G., Valkov, V. A., Pavlov, N. S., Vinogradov, K. P., & Bogolyubova, A. A. (2023). Monitoring of water objects by remote methods. *Bulletin of SSUGiT (Siberian State University of Geosystems and Technologies)*, 28(2), 67-75.

Nieuwenhuijsen, M. J., Grellier, J., Smith, R., Iszatt, N., Bennett, J., & Best, N. (2009). The epidemiology and possible mechanisms of disinfection by-products in drinking water. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 367(1904), 4043-4076.

Novikova, Y. A., Myasnikov, I. O., Kovshov, A. A., Tikhonova, N. A., & Bashketova, N. S. (2020). Methodological approaches to the organization of programs for monitoring the quality of drinking water. *Population Health and Habitat*, 10(331), 4-8.

Plotnikov, I. B., Korotkiy, I. A., Neverov, E. N., Korotkaya, E. V., & Plotnikova, L. V. (2023). Modernization of the mechatronic water treatment module for processing plants of the agro-industrial complex. *Eurasian Physical Technical Journal*, 20(4), 46.

Podkościelny, P., & Nieszporek, K. (2011). Adsorption of phenols from aqueous solutions: Equilibria, calorimetry and kinetics of adsorption. *Journal of Colloid and Interface Science*, 354(1), 282-291.

Radovic, L. R., Silva, I. F., & Ume, J. I. (1997). An experimental and theoretical study of the adsorption of aromatic possessing electron-withdrawing and electron-donating functional groups by chemically modified activated carbons. *Carbon*, 35(9), 1339-1348.

Raji, Z., Karim, A., Karam, A., & Khalloufi, S. (2023). Adsorption of Heavy Metals: Mechanisms, Kinetics, and Applications of Various Adsorbents in Wastewater Remediation – A Review. *Waste*, 1(3), 775-805. https://doi.org/10.3390/waste1030046

Skobelev, D. O., Mikaelsson, O., & Shirag, B. (2020). The best available technologies in the conditions of international agreements. *Bulletin of Eurasian Science*, 12(5), 1-17.

Smirnov, V. G., Dyrdin, V. V., Manakov, A. Y., Rodionova, T. V., Villevald, G. V., Ismagilov, Z. R., Mikhailova E. S., Rodionova T. V., Villevald G. V., & Malysheva, V. Y. (2018). The formation of carbon dioxide hydrate from water sorbed by coals. *Fuel*, 228, 123-131.

Timoshchuk, I. V. (2016). Technology of after purification of drinking water from organic contaminants in production of foodstuff. *Foods and Raw Materials*, 4(1), 61-69