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ANALYSIS OF ECOLOGICAL CONDITION OF THE NURA RIVER ACCORDING TO THE BASIC BIOGENIC ELEMENTS

Abstract. The Nura River is an important water artery of Central Kazakhstan, feeding the network of lakes of the Korgalzhyn Nature Reserve, normal functioning of which depends on the quality of incoming Nura river waters, since the river flows through the territory of two regions undergoing technogenic and anthropogenic pollution.

Assessment of quality of waters flowing into lakes is an important element in monitoring studies.

The article assesses the ecological state of the Nura River by biogenic elements in three observation points - the village of Romanovka, the village of Sabyndy, the village of Korgalzhyn during the period from 2015 to 2018. An analysis of the dynamics of receipt ofbasic biogenic elements, such as ammonium salt, nitrite nitrogen, nitrate nitrogen, and phosphates was carried out. The results of the analysis indicate pollution of the river in all the investigated points with ammonium salts and nitrite nitrogen. The content of nitrate nitrogen and phosphates does not exceed the maximum permissible concentrations (MPCs). The main source of pollution can probably be nearby settlements, the main activity of which is related to agriculture. The main periods of pollution are the summer seasons in all years. The investigated points on the degree of pollution belong to a moderate level of pollution.

Keywords: the Nura River,environmental monitoring, pollution, biogenic elements.

The Nura River is an important water artery of the Tengiz-Korgalzhyn depression, feeding the network of lakes inscribed in the UNESCO's World Heritage List in Kazakhstan and Central Asia - “Saryarka - Steppe and Lakes of Northern Kazakhstan”.

Nura is the river in Central Kazakhstan, the largest of the rivers of the Nura-Sarysu basin. Most of the Nura river runoff belongs to the internal drainage Aral-Caspian basin. In some high water years, part of the runoff overflows into the river Ishim, then in the river Irtysh, and further to the Ob River, which flows into the Kara Sea. The Nura River originates from the western spurs of the Kyzyltas mountains and flows into Lake Tengiz, where the Korgalzhyn Nature Reserve is located, normal functioning of which depends on the flow of the Nura River waters[1]. The length of the river is 978 km, the catchment area is 58.1 thousand km^2, and it flows within the Kazakh Upland [2]. The terrain relief varies from low-mountain to plain with some swamps.In the floodplain near the settlements, there are plantings of garden and melon crops; varieties of willow and rose grow near riverbed zone.Thewidthofthechannelis 15-80 m. The average water consumption is 19.5 m^3/s. The Nura River is characterized by sharp fluctuations in the level and consumption of water. High water occurs in the upper and middle reaches from mid-April, in the downstream - in May, duration is 1.5-3.5 months; a depth in this period is 3.1 m.

Mineralization of the NuraRiver water varies in the upper and down reaches from 0.2-1.6 mg/dm^3 to 0.2-1.2 mg/dm^3. During a period of high water, upstream water is characterized by hydrocarbonates, in the lowwater period – by sulfate-sodium composition, ranging from 0.1-0.3 mg/dm3 to 2 mg/dm^3.The sum of salts of the middle and down reaches varies in the range of 0.5-4.0 mg/dm^3.Thus, the composition of salts ensures softness of water in high water period and hardness in low water period [3].

Analysis of literature data on the quality of surface waters of the Nura River basin has revealed the presence of technogenic pollution associated with wastewater discharges by industrial and agricultural enterprises and settlements [4, 5]. Anthropogenic impact on river waters is provided by municipal and industrial effluents of cities and enterprises along the Nura river [3]. Pollution by manganese, iron, chlorides, phenols, nitrogen-containing substances and the most dangerous pollutants – mercury and its compounds occurs along with wastewater [6-10].

The purpose of our research is to analyze an ecological state of surface waters of the Nura River by the content of biogenic elements. Biogenic elements are part of organisms, formed in water and included in the process of life; ensure the existence of living organisms. An insufficient or excess amount of biogens in water reduces the biological productivity of aquatic biogeocenoses. Exceeding the MPC values for biogens is a sign of eutrophic pollution that causes water flowering and development of cyanobacteria that release toxic substances, which leads to poisoning of people and animals, killing of aerobic organisms due to oxygen deficiency and degradation of aquatic ecosystems in general [11, 12].

Sections of the Nura River with a length of 432 km, in three observation points – a village of Romanovka, a village of Sabyndy, and a village of Korgalzhyn, located outside the industrial zone, were analyzed (table 1).

Table 1 – Coordinates of investigated points

#	Investigated point	N	W
1	Romanovka Village	50°49'28.3"	71°21'31.6"
2	Sabyndy Village	50°49'43.8"	70°33'53.9"
3	Korgalzhyn Village	50°35'42.7"	70°01'04.1"

The Romanovka Village (Tselinograd district, Akmola region) is located on the left bank of the Nura River, a population is 1680 people, key economic sectors are meat and dairy production.

TheSabyndy Village (Korgalzhyn district, Akmola region), the population is 1775people. There are 40 enterprises of agroindustrial complex (ten limited liability partnerships (LLP), including seven agricultural, eight livestock, and 22 farms).

TheKorgalzhyn Village (Korgalzhyn district, Akmola region),the left bank of the Nura River, the population is4034people. There are 44 agricultural enterprises in the livestock and crop sectors: 4 LLPs, 2 social entrepreneurship corporations, 38 peasant farmings (figure 1) [13].

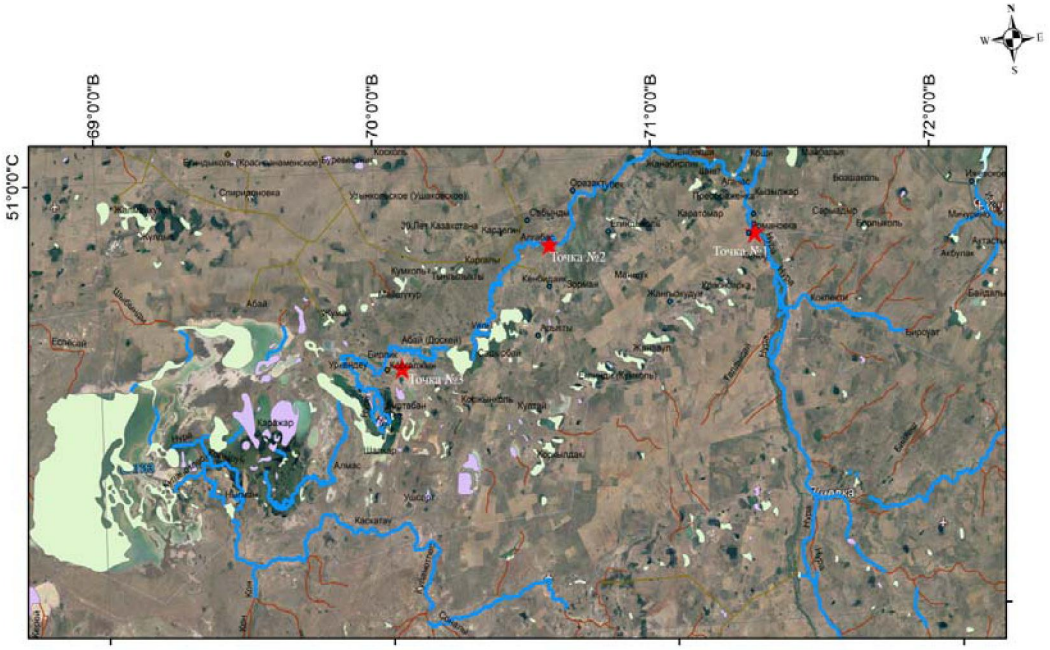

Figure 1 – Map-scheme of the study area:
1st point - Romanovka Village, 2nd point - Sabyndy Village, 3rd point - Korgalzhyn Village

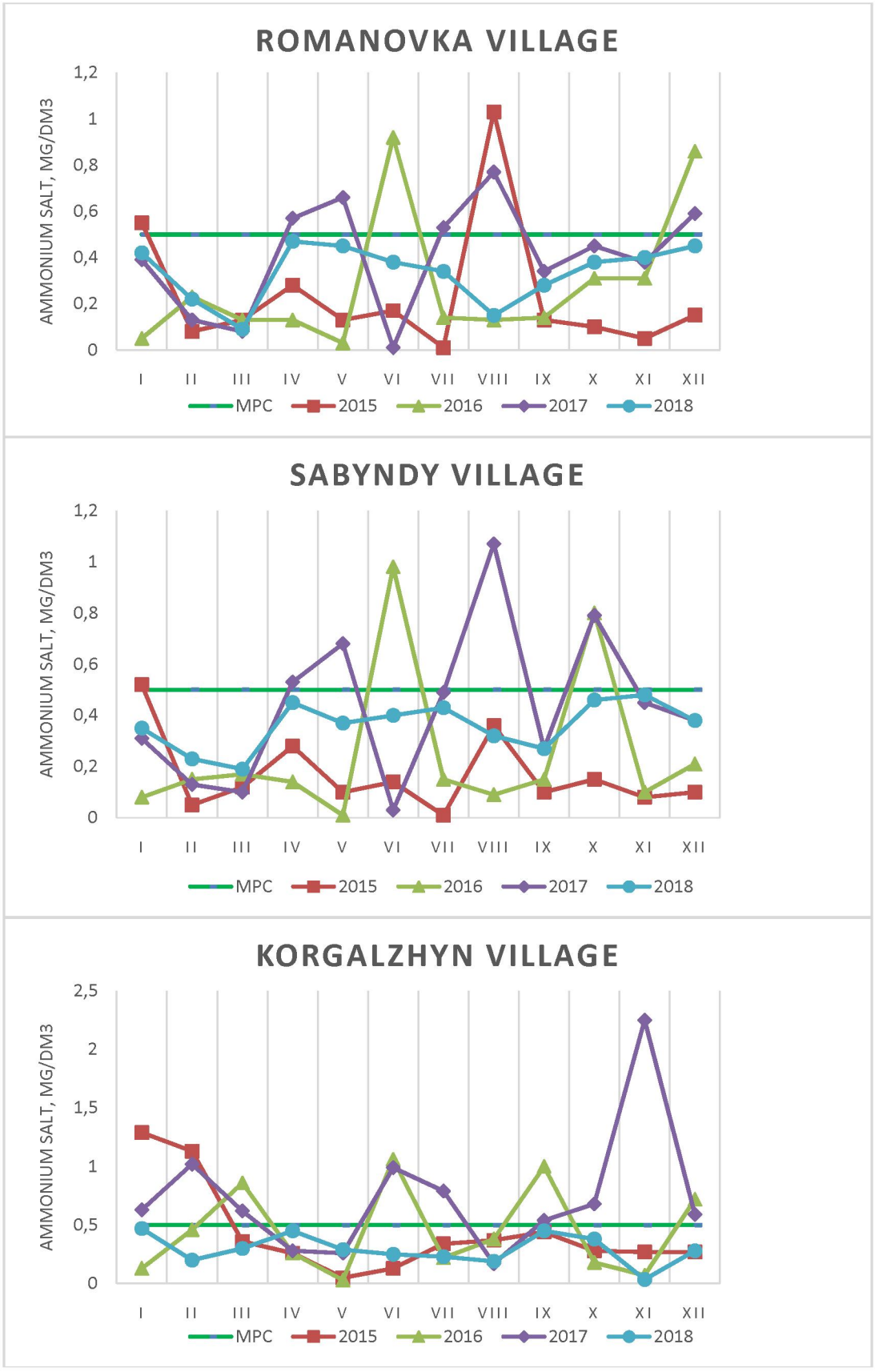

Figure 2 – Indicators of ammonium salt (NH_4^+), 2015-2018

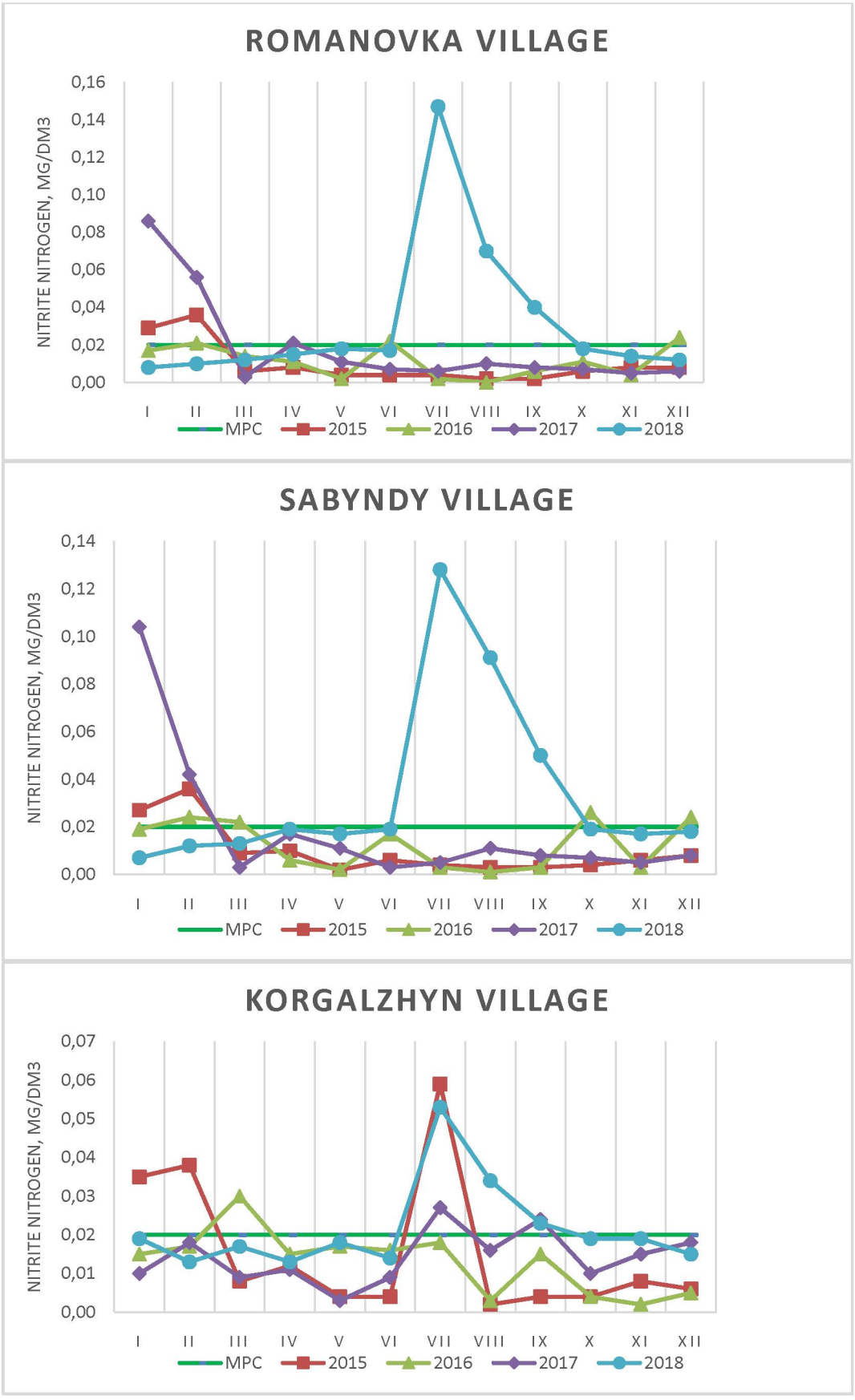

Figure 3 – Indicators of nitrite nitrogen (NO_2^-), 2015-2018

Using data from Kazhydromet, the content of basic biogenic elements: ammonium salt (NH_4^+), nitrites (NO_2^-), nitrates (NO_3^-), andphosphates (PO_4^{3-}) for the period 2015-2018,was taken into consideration [14- 17].

The results of the analysis of the content of biogenic elements at observation points are given below (figures 2, 3).

The content of ammonium salt (NH_4^+) (figure 2).

Analysis of the ammonium salt content in the Romanovka point shows the excess of the MPC values in 2015-2017. The range of indicators of the content of ammonium salt varies from 0.01 and above 1 mg/dm^3. The maximum values were noted in 2015 in August - 1.03 mg/dm^3. Also, the excess of MPC was noted in 2016 (June, December) and in 2017 (May, August). In other periods, the level of ammonium salts does not exceed the maximum permissible concentrations.

In the observation point of Sabyndy of the Nura River in 2015 and 2018, the MPC was not exceeded. Whereas in 2016 in June the excess of salt ammonia amounted to 0.9 mg/dm^3, in October - 0.8 mg/dm^3. Frequent and high excess rates were observed in 2017 in May, August, and October. The maximum values of ammonium salt for all years were noted in August 2017 - 1.07 mg/dm^3.

The control point in the Korgalzhyn area also noted an increase in the level of ammonium salts. So, if in 2015 an excess was noted only in winter (January, February), then in 2016 an excess of MPC was found in March, June, and September, in 2017 - in February, June, July, and a sharp increase in MPC in November - 2.25 mg/dm^3. In 2018, ammonia levels were not exceeded.

Analysis of the data on the content of ammonium salts showed that the most polluted year is 2017, becauseof excess is noted at all observation points. In 2018, the state of the river stabilized. Thus, starting from 2015, pollution with ammonium salts intensifies reaching a maximum in 2017.

The most polluted waterwas near the settlements. This indirectly proves that the intensive activity of agricultural enterprises, flushing fertilizers from fields and animal waste by rain wastewater can be sources of pollution.

The content of nitrite nitrogen (NO_2^-) (figure 3).

The presence of nitrite nitrogen in water and an increase in its level characterizes the ongoing oxidative processes of decomposition of organic substances as a result of the vital activity of microorganisms and is an indicator of pollution. The presence of nitrite nitrogen in large quantities indicates recent organic pollution, as well as ongoing processes of mineralization of organic matter [18].

According to the content of nitrite nitrogen at the Romanovka control point in 2015 and 2017 in the winter period (January, February), the MPC level is exceeded. In 2016, nitrite nitrogen pollution was not observed. 2018 is characterized by a sharp excess from the MPC level in the summer period (July, August).

At the Sabyndy point, an increase of the nitrite nitrogen content was insignificant in 2015 and 2016; in 2017 and 2018, there was a sharp excess of the MPC level by several times (January 2017, the third quarter of 2018).

The nitrite nitrogen content in the Korgalzhynpoint is marked by an excess of the MPC level for all studied years. The highest nitrite nitrogen values are observed in January, February and July 2015 and in July and August 2018.

The phosphate and nitrate contents are shown in table 2.

Table 2 – The content of phosphates and nitrates

Investigated point		2015		2016		2017		2018	
		min	max	min	max	min	max	min	max
Romanovka Village	NO_3^-	0,090	0,580	0,040	0,850	0,020	2,91	0,030	0,950
	PO_4^{3-}	0,006	0,102	0,003	0,137	0,008	0,091	0,005	0,100
Sabyndy Village	NO_3^-	0,09	0,55	0,04	0,87	0,02	3,39	0,07	1,87
	PO_4^{3-}	0,005	0,091	0,001	0,12	0,007	0,078	0,006	0,080
Korgalzhyn Village	NO_3^-	0,09	0,72	0,07	0,81	0,05	2,36	0,06	1,81
	PO_4^{3-}	0,008	0,075	0,0009	0,043	0,009	0,072	0,007	0,070

According to the list of maximum permissible concentrations of harmful substances for water of fishery reservoirs, MPC for nitrates is 9.1 mg/l, maximum concentration limit for phosphates is not established.

Analyzing the above data, it can be stated that the content of phosphates and nitrates at all observation points show values that do not exceed the maximum permissible concentrations.

According to published data, nitrates up to 10 mg/l do not adversely affect aquatic organisms [19-21].

Many factors affect river pollution, including the rural areas through which the river flows. Domestic water is supposedly discharged from settlements to the Nura River, and pollution is caused by organic residues from animal husbandry.

Analyzing the data, it can be noted that the Nura River at the observation points is polluted with organic residues. This is evidenced by the presence of periodically elevated ammonia values of salt and nitrite nitrogen. It can be explained by the location of nearby settlements, agricultural land and livestock farming.

Comparative analysis of nutrients through observation points has allowed to identify the main periods of pollution, which is the summer seasons in all years.

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БИОГЕНДІ КӨРСЕТКІШТЕР БОЙЫНША НҰРА ӨЗЕНІНІҢ ЭКОЛОГИЯЛЫҚ ЖАҒДАЙЫН ТАЛДАУ

Аннотация. Нұра өзені Қорғалжын қорығының көлдер торабын қоректендіретін маңызды су көзі болып табылады. Қорықтағы көлдердің қалыпты тіршілігі осы өзен суларының құйылуына тәуелді, себебі өзен техногендік және антропогендік ластануға ұшырап екі облыстың аумағы арқылы ағып өтеді.

Көлдерге құятын өзендердің сапасын бағалау мониторингтік зерттеулердің маңызды бөлігі болып табылады.

Мақалада Нұра өзенінің сапасын биогенді элементтер бойынша бағалау үш бақылау бекеттері – Романовка, Сабынды ауылдары мен Қорғалжын тұрғын елінде 2015-2018 жылдар аралығында жүргізілді. Аммоний тұзы, нитритті азот, нитратты азот, фосфаттар секілді негізгі биогенді заттардың түсу динамикасына талдау жүргізілді. Талдау нәтижелері өзеннің барлық зерттелген нүктелерінде аммоний тұздары мен нитритті азотпен ластанғандығын көрсетті. Нитратты азот пен фосфат мөлшері шекті рұқсат етілген концентрациядан (ШРК) аспайды. Ластанудың негізгі көзі жақын орналасқан елді мекендер болуы мүмкін, олардың негізгі қызметі ауыл шаруашылығымен байланысты. Негізгі ластану мерзімдері – бұл барлық жылдар бойынша жаз мезгілі. Зерттелген нүктелер ластану дәрежесі бойынша орташа ластану деңгейіне жатады.

Түйін сөздер: Нұра өзені, экологиялықмониторинг, ластану, биогенді элементтер.

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АНАЛИЗ ЭКОЛОГИЧЕСКОГО СОСТОЯНИЯ РЕКИ НУРЫ ПО БИОГЕННЫМ ЭЛЕМЕНТАМ

Аннотация. Река Нура является важной водной артерией Центрального Казахстана, питающей сеть озер Коргалжынского заповедника, нормальное функционирование которого зависит от качества поступающих речных вод Нуры, так как река, протекая по территории двух областей подвергается техногенному и антропогенному загрязнению.

Оценка качества впадающих в озера вод является важным элементом мониторинговых исследований.

В статье дана оценка экологического состояния реки Нура по биогенным элементам втрех пунктах наблюдения – село Романовка, село Сабынды, поселок Коргалжын в период с 2015 по 2018 гг. Проведен анализ динамики поступления основных биогенных элементов, таких как, аммоний солевой, нитритный азот, нитратный азот, фосфаты. Результаты анализа указывают на загрязнение реки во всех исследованных пунктах солями аммония и нитритным азотом. Содержание азота нитратного и фосфатов не превышает предельно допустимых концентраций (ПДК). Основным источником загрязнения вероятно могут являться близлежащие населенные пункты, основная деятельность которых связана с сельским хозяйством. Основные периоды загрязнения – это летние сезоны во все года. Исследованные точки по степени загрязнения относятся к умеренному уровню загрязнения.

Ключевые слова: река Нура, экологический мониторинг, загрязнение, биогенные элементы.

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REFERENCES

[1] Grin G.B., Demin A.P., Fedorova B.G. Kanal Irtysh-Karaganda. M.: Nauka, 1987. 153 p.; 2) Karaganda. Karagandinskaja oblast': Jenciklopedija. – Alma-Ata: Gl. red. Kazahskoj sovetskoj jenciklopedii, 1986. 713 p.; 3) Ohmanovich V.F. Vodnye resursy Kazahstana i Karagandinsko-Temirtauskoj ag-lomeracii i ih ispol'zovanie // Voprosy geografii Kazahstana. 1968. Vyp. 14. P. 74-82; 4) Spravochnik po vodnym resursam SSSR. Vol. 13: Severnyj Kazakstan. L.: GGI, 1933. 950 p.

[2] Resursy poverhnostnyh vod SSSR. Vol. 13. Central'nyj Kazahstan. Vyp. 2. Nura. L.: Gidrometeoizdat, 1974. 358 p.

[3] Kratkij obzor Nura-Sarysuskogo vodnogo bassejna // Otchet po materialam Nura-Sarysuskogo BVU. 2004.

[4] Bajkenova G.G., Isaev D.I., Benc T.V. Analiz kachestva poverhnostnyh vod bassejna reki Nura po gidrohimicheskim pokazateljam // Tret'i vinogradovskie chtenija. Granigidrologii. 2018. P. 297-300.

[5] Slivinskij G.G., Krupa E.G., Akberdina G.Zh. Harakteristika bassejna reki Nury v zone vlijanija Temirtau-Karagandinskogo promyshlennogo kompleksa po gidrohimicheskim i toksikologicheskim pokazateljam // Eurasian Journal of Ecology. 2016. Vol. 26, N 3.

[6] Ullrich S.M. et al. Mercury distribution and transport in a contaminated river system in Kazakhstan and associated impacts on aquatic biota // Applied Geochemistry. 2007. Vol. 22, N 12. P. 2706-2734.

[7] Heaven S. et al. Mercury in the River Nura and its floodplain, Central Kazakhstan: I. River sediments and water // Science of the Total environment. 2000. Vol. 260, N 1-3. P. 35-44.

[8] Hsiao H.W., Ullrich S.M., Tanton T.W. Burdens of mercury in residents of Temirtau, Kazakhstan: I: Hair mercury concentrations and factors of elevated hair mercury levels // Science of the Total Environment. 2011. Vol. 409, N 11. C. 2272-2280.

[9] Yanin E.P. Mercury in epiphyte-retained suspension of the Nura River (Kazakhstan) as an indicator of technogenic pollution // Geologiya i geofizika. 2000. Vol. 41, N 7. P. 1074-1077.

[10] Akbayeva L., et al. Ecotoxicological studies of Akmola region lakes // Potravinarstvo Slovak Journal of Food Sciences. 2019. Vol. 13, N 1. P. 25-31.

[11] Slivinsky G.G., Krupa E.G. Sovremennoe jekologicheskoe sostojanie Teniz-Korgalzhynskih ozer po gidrohimicheskim i toksikologicheskim pokazateljam // Eurasian Journal of Ecology. 2016. Vol. 37, N 1.

[12] Slivinskij G.G., Krupa E.G. Sovremennoe jekologicheskoe sostojanie Teniz-Korgalzhynskih ozer po gidrohimicheskim i toksikologicheskim pokazateljam // Vestnik KazNU. Serija jekologicheskaja. 2013. Vol. 1. P. 37.

[13] http://korgaljin.gov.kz/content/normotvorcheskaya-deyatelynosty

[14] Informacionnyj bjulleten' o sostojanii okruzhajushhej sredy bassejna reki Nury v 2015 g. Astana, 2016. 52 p.

[15] Informacionnyj bjulleten' o sostojanii okruzhajushhej sredy bassejna reki Nury v 2016 g. Astana, 2017. 57 p.

[16] Informacionnyj bjulleten' o sostojanii okruzhajushhej sredy bassejna reki Nury v 2017 g. Astana, 2017. 39 p.

[17] Informacionnyj bjulleten' o sostojanii okruzhajushhej sredy bassejna reki Nury v 2018 g. Astana, 2018. 35 p.

[18] RD 52.24.381-2006

[19] RD 52.24.382-2006

[20] KZ. 07.00.01219-2015

[21] GOST 26449.2-85, п.12

[22] https://www.msulab.ru/knowledge/water/organic-pollutants-BOD-and COD/

[23] (https://www.monographies.ru/ru/book/section?id=2253)