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COMPARATIVE ASSESSMENT OF THE QUALITY OF TRANSBOUNDARY SURFACE WATER BODIES (ON THE EXAMPLE OF THE DNIEPER BASIN)

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ABSTRACT

The article analyzes the changes in the ecological status of the water of the Dnieper basin and identifies the possible causes of this phenomenon, as well as possible ways to improve its ecological status. The change in the ecological status of surface water was determine d by carrying out a retrospective analysis of the monitoring data and environmental assessment of the water resources of Ukraine by the State Water Resources Agency of Ukraine for the period 2010-2019. The retrospective analysis was conducted according to the data of the water abstraction control within the framework of the Dnieper Basin Water Resources Management, according to 14 fence posts, taking into account the requirements of the State Standard of Ukraine 4808: 2007.

Keywords: Dnieper basin, ecological status, anthropogenic load, quality assessment, ecological improvement.

INTRODUCTION

In Ukraine, almost 80% of the population is supplied with drinking water from surface sources, in particular, almost 75% – from the Dnieper. The Dnieper is the third largest river in Europe (after the Volga and the Danube). The Dnieper is a transboundary watercourse: 20% of the river basin is located in the territory of the Russian Federation, 23% – in the Republic of Belarus and 57% – in Ukraine. The Dnieper River is the main waterway of Ukraine, its water resources make up more than 60% of all water resources of the country. The total area of the Dnieper basin is 504 thousand km2, of which 286 thousand km2 is located within Ukraine in its most economically developed part. 80% of the land area of Ukraine is fed by the waters of the Dnieper through irrigation and watering systems.

The main problems of surface waters of the Dnieper basin at this time are: high pollution of the shores; construction of coastal protection strips; deterioration of hydraulic structures, which threatens accidents and pollution of water bodies; excessive overgrowing of water area with aquatic vegetation; drainage of rainwater drainage almost without cleaning; discharge of untreated municipal wastewater from apartments that are not connected to the centralized sewerage system; weakening of state control over environmental offenses; inefficient water monitoring system; imperfection of the existing system of public administration in the field of use, protection and restoration of water resources, lack of clear delineation of functions; non–full use of domestic scientific innovations in the field of biochemistry.

METHODS AND EXPERIMENTAL PROCEDURES

Assessment of water quality was carried out taking into account the indicators: BOC_5 and O_2 as mandatory, and others – by the highest ratios to the MPC from the list: SO_4^{2-}, Cl^-, COD, NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}, Fe total, Mn^{2+}, Cu^{2+}, Zn^{2+}, Cr^{6+}, Ni^{2+}, Al^{3+}, Pb^{2+}, Hg^{2+}, As^{3+} , synthetic surfactants. Determination of the change in the quality of the Dnieper water was carried out taking into account the change in the content of normalized parameters: the sum of anions (NO_2, NO_3^-, SO_4^{2-}, PO_4^{3-}, Cl^-), converted to molar mass, in order to level the difference between the masses of different atomic anions; dissolved oxygen in water; biochemical oxygen consumption (BOC_5); phosphates PO_4^{3-} nitrites, nitrates, as well as ammonium NH_4^+.

Assessment of changes in the composition of surface water was performed by retrospective analysis of monitoring data and environmental assessment of water resources of Ukraine of the State Agency of Water Resources of Ukraine for the period from January 2010 to January 2019.

A retrospective analysis of water quality was conducted according to the samples of control water intake of the Dnieper River within the Basin Water Resources Management at 14 posts (Fig. 1): post 1: Sozh River, 32 km, p. St. Yarilovichi, Ripkin district (border with Belarus); post 2: Dnipro, 1116 km, village Kamyanka, below the village, Ripky district (border with Belarus)); post 3: Uzh river, 15 km, village Cherevach, drinking in / from Chernobyl; post 4: Dnipro, 897 km, Vyshhorod, n / b Kyiv HPP, drinking water in Kyiv; post 5: Dnipro river, 833 km, Ukrainka town, below the town, above the Bila Tserkva-Uman water supply system; post 6: Dnipro, 678 km, c. Sokirne, drinking in / from Cherkasy; post 7: Dnipro, 580 km, village Vlasivka, left bank, drinking water in Kremenchuk; post 8: Dnipro, 462 km, village Aula, drinking in / from Dnipro and Kamyanske); post 9: Dnipro, 404 km, Dnipro, SE «PdTES» PJSC «DTEK Dniproenergo», drinking water; post 10: Dnipro, 312 km, Zaporizhia, GNS of the Zaporizhia Armed Forces; post 11: Dnipro, 253 km, Energodar, influence of Zaporizhzhya NPP; post 12: Dnipro, 160 km, township Velyka Lepetykha, Rubanivska ZS; post 13: Dnipro, 65 km, village Ivanivka, Belozersky district, in the district of drinking water supply from the Nikolaev water supply system; post 14: Dnipro, 0 km, village Kizomis (Rvach sleeve).

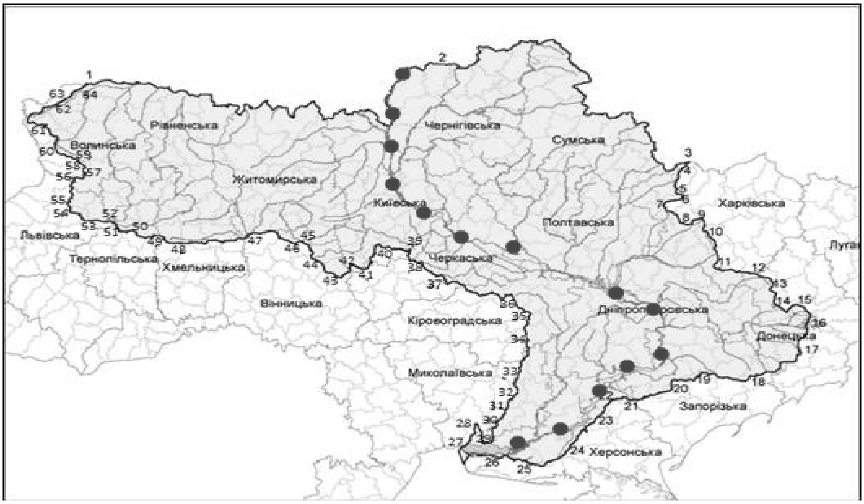

Fig. 1. Schematic layout of 14 posts of control water intake, according to which the study was conducted

THE RESEARCH RESULTS AND DISCUSSIONS

At fixed network points, the list of water quality components is determined mainly by the composition and volume of wastewater discharged into the water body, their toxicity and requirements from water consumers. These include: water temperature, suspended solids, mineralization, chromaticity, pH, dissolved oxygen, COD and BOC, odor, major ions, nutrients, and very common pollutants such as petroleum products, surfactants, volatile phenols, nutrients, heavy metals [1].

The approach to the organization of the system of observations of biological indicators in general is the same as for physical and chemical ones, ie it provides for observations and control at the established points in an agreed time and according to a single unified methodology.

To determine the program of hydrobiological observations it is necessary for some time to accumulate hydrobiological information on different species: macrophytes, phyto-, bacterio- and zooplankton, zoobenthos, neuston, periphyton [2].

Of the 17 main tributaries of the Dnieper, 15 flows into the river within Ukraine (Table 1). The largest of them are the rivers Pripyat and Desna, which carry the bulk of the water to the Dnieper.

Tributaries of the Dnieper flow through the territory of the most important industrial centres and settlements of Ukraine, creating a widely branched complex river system, which has important economic, social and environmental significance. The Dnieper, which has undergone significant changes due to the construction of a cascade of reservoirs, is no longer a river ecosystem capable of self-regulation [3, 4].

Table 1. The main characteristics of the surveyed rivers of the Dnieper basin

Name of water body (main tributaries)	Areas through which it flows	Surface water body characteristics		
		Catchment area, thousand km^2	Average annual runoff, m^3/s	Length of watercours e, km
river Sozh	Russia (Smolensk region) Republic of Belarus (Mogilev region, Gomel region) Ukraine (Chernihiv region)	41,4	207	648
Pripyat River	Republic of Belarus (Brest region, Gomel region) Ukraine (Volyn region, Rivne region, Kyiv region)	121	460	775
Teteriv river	Ukraine (Zhytomyr region, Kyiv region)	15,3	18,4	385
Irpin river	Ukraine (Zhytomyr region, Kyiv region)	3,3	173,6	162
Desna river	Russia (Smolensk region, Bryansk region) Ukraine (Chernihiv region, Sumy region, Kyiv region)	88,9	360	1130
the river Trubizh	Ukraine (Chernihiv region, Kyiv region)	4,7	3,6	113
the river Ros	Ukraine (Vinnytsia region, Kyiv region, Cherkasy region)	12,6	22,5	346

Supiy river	Ukraine (Cherkasy region, Kyiv region, Chernihiv region)	2	6,0	130
Sula river	Ukraine (Sumy region, Poltava region)	19,6	29	363
the river Tyasmin	Ukraine (Kirovograd region, Cherkasy region)	4,5	0,2	161
river Psel	Russia (Kursk region, Belgorod region) Ukraine (Sumy region, Poltava region)	22,8	55	717
Vorskla river	Russia (Belgorod region), Ukraine (Sumy region, Poltava region)	14,7	36	464
Eagle river	Ukraine (Kharkiv region, Poltava region, Dnipropetrovsk region)	9,8	13,2	346
Samara river	Ukraine (Donetsk region, Kharkiv region, Dnipropetrovsk region)	22,7	17	320
Ingulets river	Ukraine (Kirovograd region, Dnepropetrovsk region, Nikolaev region, Kherson region)	14,9	8,5	549

The results of the analysis to determine the difference in the total anion content between the posts of water intakes of the Dnieper basin are shown in table 2.

When conducting a retrospective analysis of the total anion content in the water of the Middle Dnieper, it is necessary to take into account the possible impact on the source water of the Pripyat, Teteriv, Irpin, Desna, Trubizh, Ros, Supiy, Sula, Tyasmin, Vorskla and Psel river basins and their tributaries.

Based on the obtained data (Table 2), it can be argued that there is a constant increase in the total content of anions from the fence 3 and further downstream to the mouth of the Dnieper.

Table 2. Differences in the total anion content between the posts of water intakes of the Dnieper basin

Year	$\Delta \sum_{anions}$, mmol/dm^3										
	P2–1	P4–3	P5–4	P6–5	P7–6	P8–7	P10–9	P11–10	P12–11	P13–12	P14–13
2010	–0,04				0,11	0,04	–	–	–	–	–
2011	0,18			–0,08	–0,07	0,22	–	–	–	–	–
2012	–0,04			0,14	–0,08	0,23	–	–	–	–0,08	0,62
2013	–0,09			0	0	0,2	–	–	–	–0,16	0,80
2014	–0,06			0,09	–0,07	0,02	–	–	0,01	0,06	–0,10
2015	0,02			–0,1	0,04	0,13	–	–	–0,12	–0,35	12,99
2016	0,11	0,05	–0,11	0,16	–0,07	0,21	0,07	–0,27	–0,35	–0,02	8,75
2017	0,01	0,08	–0,15	0,07	0,19	0,12	–0,67	–0,03	–0,03	0,14	1,41
2018	0,03	–0,2	–0,12	0,07	0,08	0,22	0,35	–0,32	–0,19	0,11	2,08
2019	0,01	–0,05	0,29	–0,45	0,09	–0,04	–0,36	0,06	–0,19	0,06	3,96

The total content of anions at the posts of water intakes of the Dnieper basin for 2018 is shown in Fig. 2.

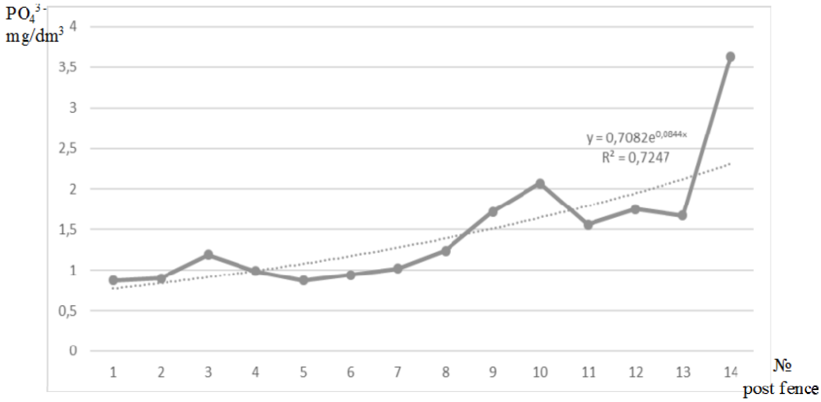

Fig. 2. T he total content of anions at the posts of water intakes of the Dnieper basin for 2018

From the data given in Table 2 and Figure 2, an increase in the total anion content along the entire course of the Dnieper River is clearly observed. And, despite the fact that in three areas (between posts 3-4-5, 10-11) a slight self-cleaning is provided, yet after them there is again a significant increase in pollution.

NH_4^+ ion is unstable, it is rapidly oxidized to nitrites and nitrates. The high content of ammonium indicates anaerobic conditions for the formation of the chemical composition of water and its unsatisfactory quality.

The analysis revealed a tendency to reduce the phosphate content of (Fig. 3) from post 1 to post 14 in the water of the Dnieper basin.

However, there is a local increase, especially between the 5th-6th posts, as well as the 7th-8th, which may be due to the influence of tributaries on them, as well as between the 12th-13th posts. A significant decrease in phosphate content is observed between 6-7th posts, as well as 11-12th (Table 3).

Table 3. Differences in the content of phosphates of ions PO_4^{3-} between the posts of water intakes of the Dnieper basin

Year	Δ PO_4^{3-} mg/dm^3										
	P2–1	P4–3	P5–4	P6–5	P7–6	P8–7	P10–9	P11–10	P12–11	P13–12	P14–13
2010	–0,18	–	–	–	–0,07	–0,12	–	–	–	–	–
2011	–0,06	–	–	0,22	–0,23	0,17	–	–	–	–	–
2012	0,01	–	–	0,19	–0,15	0	–	–	–	–	–
2013	–0,03	–	–	0,11	–0,24	0,32	–	–	–	0,03	0
2014	0,01	–	–	0,09	–0,09	0,23	–	–	–0,12	0,05	0
2015	0,02	–	–	0,04	–0,19	0,03	–0,07	0,02	–0,05	0,08	–0,01
2016	–0,03	–0,04	0,15	0	–0,18	0,13	–0,07	0,06	–0,04	–0,04	0,02
2017	–0,01	0,1	0,04	0,32	–0,33	0,1	–0,12	0,07	0	0,04	–0,01
2018	0,03	0,07	0,04	0,21	–0,28	0,14	0,01	0,01	–0,14	0,15	–0,05
2019	–0,04	0,18	0,07	0,1	–0,23	0,07	0,15	–0,06	–0,14	0,1	–0,02

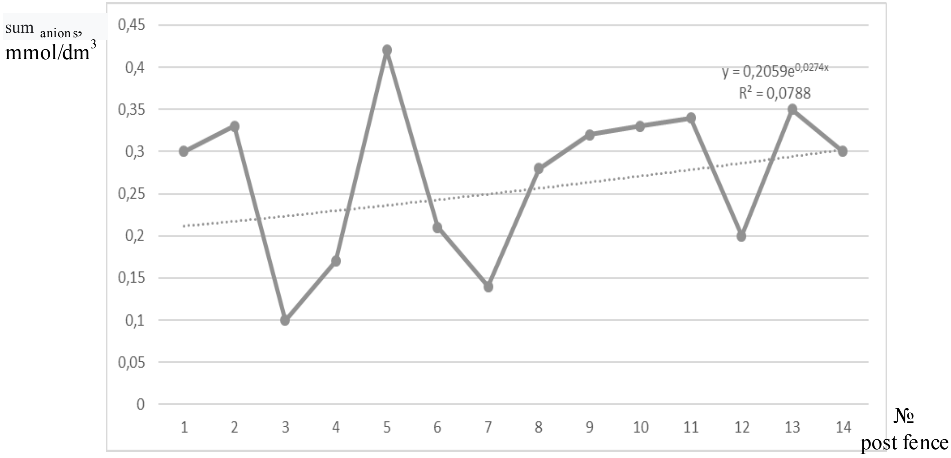

Fig. 3. The total content of phosphates of PO_4^{3-} ions – at the posts of water intake of the Dnieper basin for 2018

And, despite the fact that in five areas (between posts 2–3, 5–7, 11–12, 13–14) partial self–cleaning is provided, still between other posts there is a significant increase in pollution.

Table 4. The difference in ammonium content of NH_4^+ between the posts of water intakes of the Dnieper basin

Year	ΔNH^{4+} mg/dm^3										
	P2–1	P4–3	P5–4	P6–5	P7–6	P8–7	P10–9	P11–10	P12–11	P13–12	P14–13
2010	–0,16	–	–	–	–0,07	–0,15	–	–	–	–	–
2011	–0,06	–	–	0,18	–0,11	0	–	–	–	–	–
2012	–0,14	–	–	0,27	–0,42	–0,11	–	–	–	–	–
2013	–0,15	–	–	0,19	–0,17	–0,1	–	–	–	–0,05	–0,06
2014	–0,02	–	–	0,18	–0,25	–0,12	–	–	–0,13	–0,01	0,04
2015	–0,09	–	–	0	–0,09	–0,06	–0,03	–0,08	–0,01	–0,05	0
2016	0,04	–0,1	0	0,08	0,05	–0,1	0,13	–0,17	–0,09	–0,05	–0,01
2017	0,03	0,03	–0,09	0,14	–0,06	0,04	0,09	–0,1	–0,14	0	0,01
2018	0,06	0,07	–0,14	0,18	–0,05	–0,01	0,15	–0,12	–0,14	–0,03	0,01
2019	–0,04	–0,08	–0,05	0,19	–0,23	0,05	0,29	–0,19	–0,15	–0,17	0,02

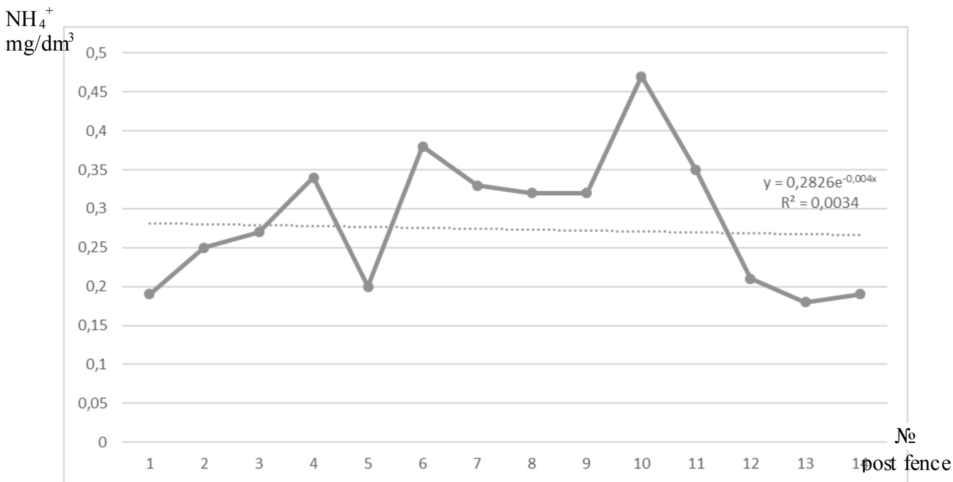

Fig. 4. Total ammonium content of NH_4^+ at water intake posts of the Dnieper basin for 2018

The ammonium content (2018) changes slightly differently from the phosphate ion content. From the data shown in Table 4 in Figure 4, a change in the ammonium content of NH_4^+ is observed along the entire course of the Dnieper River. Thus, in the areas between posts 2–3, 5–7, 10–13, partial self–cleaning is provided, yet between the other five posts there is a significant increase in pollution.

Analysis of changes in the values of the ratio of BOC5 to the concentration of dissolved oxygen in water (Table 5, Fig. 5) showed that only 4 posts of water sampling tend to improve the oxygen regime of water, the remaining 10 posts its constant deterioration, indicating loss the ability of the waters of the Dnieper basin to self–purify.

Table 5. The difference in the ratio of BOC_5 to the concentration of dissolved oxygen between the posts of water intakes of the Dnieper basin

Year	Δ BOC_5/CO_2 mg/dm^3										
	P2–1	P4–3	P5–4	P6–5	P7–6	P8–7	P10–9	P11–10	P12–11	P13–12	P14–13
2010	0	–	–	–	–	–	–	–	–	–	–
2011	–0,01	0,37	–0,39	0,2	0,09	–0,18	–	–	–	–	–
2012	–0,04	0,3	–0,41	0,07	0,09	–0,12	–	–	–	–	–
2013	–0,03	0,08	–0,11	0,11	0,02	–0,08	–	–	–	–0,03	0,03
2014	0,02	0,07	0,12	–0,16	0,02	–0,07	0,05	0,02	–0,18	0,01	–0,01
2015	0	0	–0,06	–0,09	0,15	–0,17	0,03	0,03	–0,19	–0,04	0,04
2016	0	0,04	–0,05	–0,17	0,28	–0,33	0,15	0,00	–0,15	–0,08	0,08
2017	0,01	0,11	–0,21	–0,07	0,17	–0,18	0,05	0,05	–0,19	–0,05	0,05
2018	0,02	0,53	–0,52	–0,03	0,19	–0,25	0,08	0,01	–0,23	–0,03	0,03
2019	–0,01	0,41	–0,43	–0,02	0,16	–0,13	0,08	0,11	–0,24	–0,08	0,08

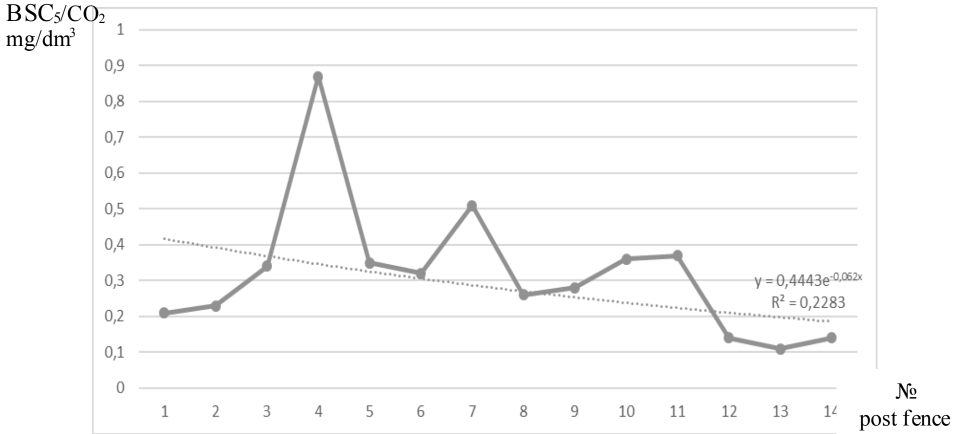

Fig. 5. Total content in relation to BOC_5 to the concentration of dissolved oxygen at the posts of water intakes of the Dnieper basin for 2018

The content of nitrates, nitrites is an important indicator of the chemical composition of natural water, which is used in environmental assessment and standardization of natural water quality. The relationship between their content, in addition to assessing water quality, can be used as an indicator in addressing the balance of nutrients, the relationship between the life processes of aquatic organisms and the chemical composition of water. Therefore, it was advisable to establish a correlation between the content of nitrates and nitrites at the studied fence posts (Fig. 6).

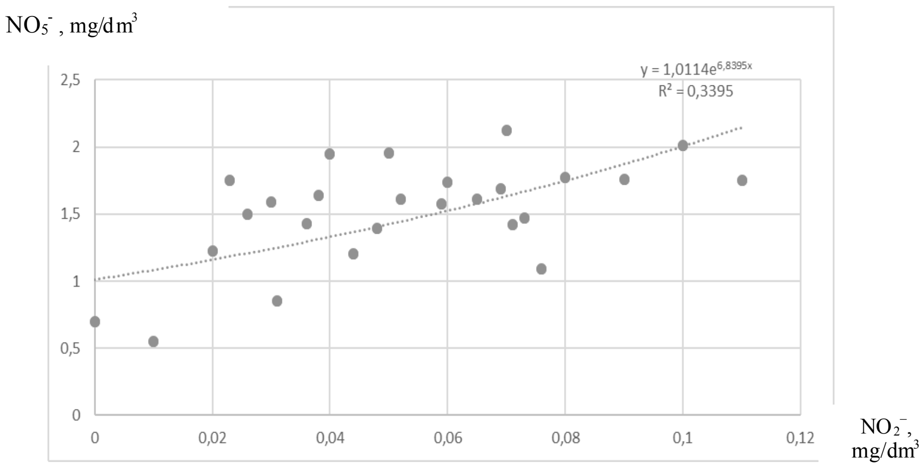

Fig. 6. Correlation between the average annual concentrations of nitrite and nitrate ions in the water of the Dnieper for the period 2010–2019.

In addition, it should be taken into account the fact that the rapid development of bioplankton of blue–green algae provokes water blooms in the shallow waters of the Dnieper reservoirs, which make up more than 30% of their territory.

Under conditions of supersaturation of the Dnieper water with organic and biogenic substances, the processes of extinction, putrefaction, decomposition of algae and bioplankton intensify, which causes deterioration of the oxygen regime, lowering the pH of water in the bottom layer and, consequently, increasing manganese ion concentration. The concentration of manganese in the period July – August increases, compared to the winter period, in 3–10 times and is about 1.9 ÷ 7.0 mg/dm^3.

First of all, it should be noted that the manganese ion $Mn^{2+}$is part of a fairly strong reducing agent. The reaction $MnO_2 + 4H + 2e– = Mn^{2+} + 2H_2O$ is characterized by the value of Red–Ox potential E_0 = 1,23 V. But in the summer, when the concentration of oxygen in the water of surface sources decreases significantly, it as a natural oxidant in water is not enough to to convert the highly water–soluble manganese ion Mn^{2+} to the sparingly soluble compound MnO_2.

Based on the survey of the Dnieper river basin and the results of hydrochemical analyzes, using the developed integrated matrix assessment of the state, a ranked series was compiled according to the selected sections along its length (Table 6).

Table 6. Ranked number of areas for the inflow of pollutants between the posts of water intakes of the Dnieper

№ by order	Areas between posts	The contribution of the site
1–2	Sozh river, 32 km, village St. Yarilovichi, Ripkin district (border with Belarus) – Dnieper, 1116 km, s. Kamyanka, below the village, Ripkin district (border with Belarus)	0,09
3–4	Uzh River, 15 km, village Cherevach, drinking water in the city of Chornobyl – Dnipro, 897 km, Vyshhorod, n / a Kyiv HPP, drinking water in the city of Kyiv	0,32
5–6	Dnipro River, 833 km, Ukrainka, below the city, above the water supply line Bila Tserkva–Uman – Dnipro River, 678 km, p. Sokirne, drinking in / from Cherkasy	0,23
7–8	Dnipro, 580 km, village Vlasivka, left bank, drinking water supply station, Kremenchuk – Dnipro river, 462 km, township Aula, drinking in / from Dnipro and Kamyanske	0,09
9–10	Dnipro, 404 km, Dnipro, SE «PdTES» PJSC «DTEK Dniproenergo», drinking water – Dnipro, 312 km, Zaporizhia, GNS Zaporizhzhya Armed Forces	0,18
11–12	Dnipro, 253 km, Energodar, influence of Zaporizhzhya NPP – Dnipro, 160 km, town Velyka Lepetykha, Rubanivska ZS	0,06
13–14	Dnipro, 65 km, village Ivanivka, Belozersky district, in the district of drinking water supply station of Mykolayiv water supply system – Dnipro river, 0 km, village Kizomis (Rvach sleeve)	0,03
Amount		1

Thus, the results of the research allow us to claim a significant deterioration of the ecological condition of the Dnieper, which today, due to man–made impact, leads to a deterioration of water quality and its river runoff.

The use of the proposed interpreted methodological approach to determine the assessment of water pollution in the Dnieper basin makes it possible to assert the nature and degree of its pollution; at the same time in the future requires a more detailed study of the impact of 15 tributaries of the Dnieper, which, flowing into the river within Ukraine, to change its ecological status.

The reasons for the constant increase in the total anion content in the waters of the Dnieper may be municipal sewage, as well as sewage of enterprises, especially against the background of insolvency, due to over–regulation of the construction of the Dnieper reservoir cascade, to its self–treatment.

An exception was the part of the water area between the 5th and 4th posts, the possible reason for which may be the dilution of the Dnieper water with the waters of the Desna and Trubizh rivers, the total water flow of which is more than 400 m^3/s.

However, it should be noted that in the water area between the 10th and 12th posts of the fence there is a process of self–cleaning; this can be explained by the fact that there are no tributaries between these posts (Fig. 2). This fact can be a confirmation of the Dnieper's ability to self–clean, and its tributaries can be the main source of pollution.

The revealed tendency to change the content of phosphate ions and ammonium, in the direction of their increase, can be explained by the fact that along with the intensification of bioproductive processes in reservoirs and the introduction of nitrogen and phosphorus fertilizers in water may increase the concentration of ammonium and phosphate ions. The influence of phosphate ions and ammonium on the qualitative ecological state of the surface source is explained by their ability to act as chemical catalysts for the process of man–made eutrophication of surface waters, which is characterized by a sharp increase in algal biomass, higher aquatic vegetation, phytoplankton due to nutrient nutrients.

As a result of biochemical decomposition of this biomass in river water and reservoirs, oxygen deficiency can occur, especially in summer, which is accompanied by fatigue and poses a significant threat to the life of many aquatic organisms. In addition, the decomposition of plant organisms releases toxic substances into the water that are dangerous for both animals and humans (toxoids, aphantotoxins, microcystins, metabolites and biologically active substances – hydrogen sulfide, methane, ammonia, phytohormones and enzymes).

An additional reason for the increase in phosphate content may be the inflow of untreated and insufficiently treated wastewater from municipal, industrial and agricultural enterprises into the Dnieper waters against the background of constant population use of various detergents and other household chemicals. points, including country settlements, the area under construction along the river banks is increasing every year without compliance with water protection zones.

Of particular concern is the increase in phosphate (as well as ammonium) content between intake posts 5 and 6, given the fashion trend and prestige of private sector buildings on the banks of the Kaniv Reservoir and given the main sources of surface water; the reasons for this increase have a logical explanation and allow us to assert the projected increase in their content in the future.

Additional sources of ammonium ions in water bodies can be livestock farms, domestic wastewater, as well as wastewater from the food, coke, forest chemical and chemical industries.

The concentration of dissolved oxygen in water directly depends on the degree of contamination of surface waters. The content of dissolved oxygen in water determines the life of aquatic organisms that use oxygen for respiration, the intensity of oxidation and decomposition of organic residues, self–purification of water bodies.

Elevated levels of BOC_5 indicate an insufficient amount of dissolved oxygen, which is spent on aerobic biochemical oxidation of unstable organic compounds to CO_2, H_2O, NH_3. In addition, BOC_5 also characterizes the total content of organic matter in water and the state of pollution of water bodies, the main indicators of which are the content of organic matter and ammonium compounds, on which largely depend the conditions to ensure the required oxygen content in rivers.

The source of high nitrate content in surface water can be surface water due to intra–reservoir nitrification processes of ammonium ions under the action of nitrifying bacteria, with precipitation, discharges of industrial and domestic wastewater, runoff from agricultural lands containing nitrogen.

Decreased nitrate levels are associated with their consumption by phytoplankton and denitrifying bacteria (aquatic plants). It is a known fact that today, due to the widespread use of mineral fertilizers in many parts of the world there are cases of contamination of surface waters with nitrates.

The danger of drinking water with a high content of NO_3^- is that nitrates, getting with water into the human body, are restored by the microflora of the digestive tract and tissue enzymes to nitrites, the toxicity of which is 10–20 times higher than NO_3^-, and react with amino acids , forming carcinogenic compounds nitrosoamines.

Nitrites NO_2^- is an intermediate form in the chain of bacterial processes of oxidation of ammonium to nitrates (nitrification – in aerobic conditions) and, conversely, the reduction of nitrates to nitrogen and ammonia (denitrification – in the absence of oxygen). Nitrates enter surface waters when nitrites are used as corrosion inhibitors in process water treatment, with wastewater discharges from the food industry, and runoff from agricultural lands.

Increasing concentrations of nitrites indicate increased decomposition of organic matter under conditions of slower oxidation. The increased concentration of nitrites indicates the intensity of decomposition of organic matter and delayed oxidation of NO_2^- to NO_3^-, which clearly indicates the pollution of the reservoir.

Additional evidence of the deterioration of the ecological condition of the waters of the Dnieper basin was revealed as a result of studies of increasing trends in the concentration of manganese ions in the form of Mn^{2+} due to the rapid development of blue–green algae bioplankton and water blooms due to their presence.

CONCLUSION

The proposed interpreted methodological approach to assessing the quality of surface water allows us to state that the aquatic ecosystem of the Dnieper River, as the main waterway of Ukraine, and the transboundary water body, under constant man–made influence, tends to permanent and persistent deterioration of its ecology. In the future, it is possible to use the proposed approach to analyze changes in the ecological status of other surface water sources. Given the results of the analysis, further change in the ecological status of surface waters of the Dnieper basin in the direction of its improvement can not occur without the development and implementation of a reliable and effective model for forecasting its ecological status, and the only possible way to solve the deterioration of the Dnieper control levers of the basin directorate.

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