

ЕКОЛОГІЯ

DOI: 10.31319/2519-2884.38.2021.16

УДК 504.45

O. Troicka, Ph.D. in Biolog. Sc., Associate Professor

K. Belokon, Ph.D. in Tech. Sc., Associate Professor

Y. Manidina, Ph.D. in Tech. Sc., Associate Professor

V. Ryzkov, Ph.D. in Tech. Sc., Associate Professor

Zaporizhzhia National University, Zaporizhzhia city

ENVIRONMENTAL ASSESSMENT OF THE SURFACE WATER CONDITION OF THE DNIPRO RIVER FROM THE WATER SUPPLY AREAS OF ZAPORIZHZHIA CITY FOR SELECTED INDICATORS OF THE SALT COMPOSITION BLOCK

Environmental assessment of current state of the Dnieper surface water from Zaporozhye areas water abstractions based on land surface water quality qualification by salt composition is carried out. Quality degradation of the Dnieper surface water by ion composition is discovered with analysis. Ecological condition of the surface water is defines as "mediocre" and level of contamination is characterized as mildly polluted".

Keywords: *environmental assessment; quality class and category; sulphates; ionic sum; chlorides.*

Виконано екологічне оцінювання сучасного стану поверхневих вод р. Дніпро з районів водозаборів м. Запоріжжя на основі класифікації якості поверхневих вод суші, за блоком сольового складу. Дослідженнями встановлено погіршення якості поверхневих вод р. Дніпро за іонним складом. Екологічний стан дослідних поверхневих вод визначений як «посередній», а за рівнем забрудненості стабільно характеризується, як «помірно забруднений».

Ключові слова: *екологічна оцінка; клас і категорія якості; сульфати; сума іонів, хлориди.*

Problem statement, actual scientific researches and issues analysis

One of the important problems in the field of protection and rational use of water resources is development of effective methods for assessing the anthropogenic load on surface water bodies in order to ensure the sustainable functioning of aquatic ecosystems, since under conditions of maintaining a stable biotical cycle, the processes of self-restoration and self-purification of water can actively occur [1, 2].

The most dangerous type of anthropogenic load on surface waters is their pollution with environmentally hazardous chemicals that can disrupt self-purifying and bioproductive processes, lead to profound changes in the structural and functional organization of the biotic component of aquatic ecosystems. The main sources of water bodies pollution are wastewater discharge from enterprises of various economy sectors, as well as domestic and agricultural wastewater, the component composition of which is extremely diverse. Hundreds of thousands of chemicals get into water bodies, many of which have toxic properties [3].

A serious environmental problem in the region is pollution of the Dnipro river. This problem is particularly acute in Zaporizhzhia city. In Zaporizhzhia, Melitopol, Berdiansk cities, after many years of service, in the absence of proper capital investments, the sewerage and water supply systems are in an unsatisfactory technical condition. Water supply systems have low conveyance capacity and got old. The storm water and sanitary sewer system is in poor condition, and the additional load on it as a result of new construction can result with catastrophic consequences. Industrial accidents/effusions, as well as accidents at sewage pumping stations, lead to regular violations of water quality standards and endanger health of the population [4].

On the territory of Ukraine, river waters are predominantly of a carbonate class. The predominant ions of the salt composition of the Dnipro river and its water storage tanks are hydrocarbonate

and Ca^{2+} , it means that water belongs to the hydrocarbonate class, calcium group of the second type [5].

Among abiotic components that determine water quality, ionic composition is of great importance. The ionic composition of water is primarily influenced by natural factors. They create basic mineralization and ionic composition of natural waters. Anthropogenic factors make certain changes in the total mineralization and concentration ratios of individual ions, their influence can significantly worsen the water quality. The general characteristics of the land surface waters in terms of salt composition is performed on the basis of the following key indicators: total mineralization, ratio of ions and content of chlorides and sulfates [5, 6].

Chloride ions enter natural waters by dissolving chlorine-containing minerals and salt deposits. A significant amount is transported by atmospheric way from the seas and oceans to continental waters. According to experts, the influence of industrial and municipal wastewater on the flow of chloride ions into water bodies has recently increased. Chloride content in natural waters varies widely (from fractions of a milligram to several grams per liter), which is caused by washing out of salt-containing rocks or discharge of industrial and domestic wastewater into water bodies. Chlorides in water over 350 mg/l gives it salty taste and leads to disorders of human digestive system [6].

Numerous studies connect the chemical (mineral) composition of water with the possibility of developing mass diseases among the population. Assessment of the drinking water salt composition is of particular importance. Influence of the total mineralization of water, or its total salt composition on the human body is the most studied issue related to the problem of water supply. The limit of the drinking water mineralization (solid residue) 1000 mg/l was established by organoleptic indicators. Waters with a high salt content have a salty or bitter taste. The main part of the dry residue of fresh water is composed of chlorides and sulfates. As it is known, these salts have a salty or bitter taste, that is the basis for limiting their content in water at the level of sensation threshold: 350 mg/l for chlorides and 500 mg/l for sulfates. Experimental studies on laboratory animals and volunteers have shown that water with increased mineralization affects the secretory activity of the stomach, disrupts the water-salt balance, resulting in a derangement of many metabolic and biochemical processes in the body [5, 6].

Thus, it should be stated that ecological assessment of the Dnipro river surface waters condition according to individual indicators of the salt composition block makes it possible to identify the main water management and environmental problems and substantiate a system of recommendations aimed at improving the ecological state of our main waterway.

Purpose Statement

Analysis and assessment of the ecological state of the surface waters of the Dnipro river from the water supply areas of the Dnipro water supply stations No. 1 and No. 2 (DVS—1 and DVS—2) (Zaporizhzhia city) in terms of salt composition block (sum of ions, sulfates and chlorides) within the period of five years (2015-2019), by assessing the quality of waters under study according to the relevant classes and categories, as well as the degree of anthropogenic pollution.

Statement of Basic Materials

Zaporizhzhia Municipal Enterprise “Vodokanal” prepares water of a drinking quality at the Dnipro water supply stations No. 1 and No. 2 and transports it to consumers in Zaporizhzhia city, urban-type settlement Volniansk, urban-type settlement N. Mykolaivka and for a part of Zaporizhzhia district (Bohatyrovo, Lezheno, Balabyne, Kushuhum villages). Water-intake and waste treatment facilities of the Dnipro water supply station No. 1 are located on the left bank, the Dnipro water supply station No. 2 is located on the right bank of the Dnipro river. The source of water supply is the Dnipro river above the dam. Water intake is performed from different depths. Waterworks facilities consist of blocks No. 1 and No. 2, each of them includes: a pumping station of the 1st rise (water intake from the Dnipro river), water purification facilities and a pumping station of the 2nd rise, which provides water supply to the city.

Let's analyze the constant monitoring studies of water quality in the places of water intakes. This information is provided by the structural divisions of the State Institution “Zaporizhzhia Regional Laboratory Center of the Ministry of Health of Ukraine” [7, 8].

Fig. 1 illustrates the dynamics of the content of the sum of ions, chlorides and sulfates by average annual and maximum (worst) values in the surface waters of the Dnipro river from the water intake area Dnipro water supply station No. 1 for a five-year period.

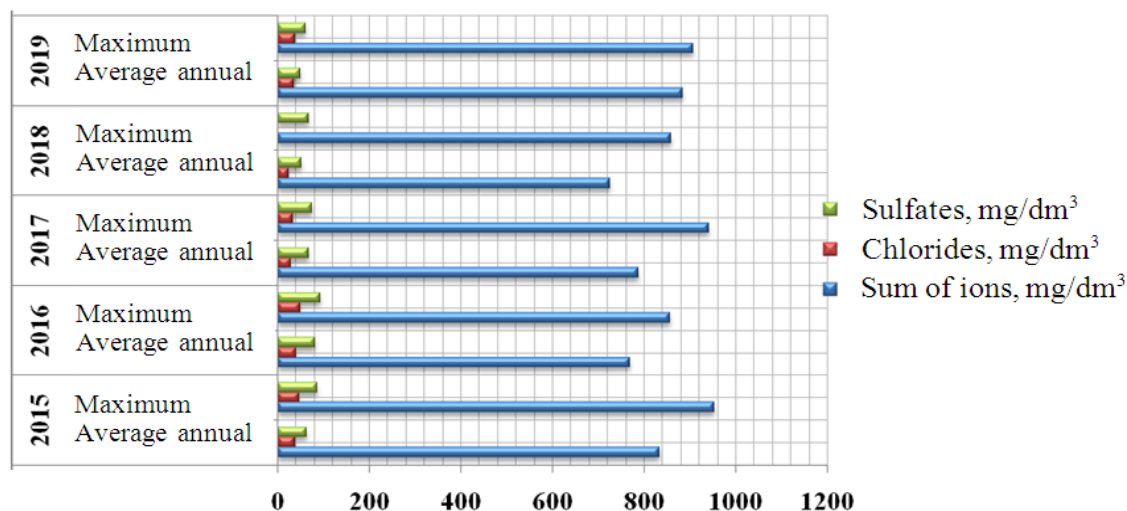


Fig. 1. Dynamics of content of the sum of ions, chlorides and sulfates in the surface waters of the Dnipro river from the area of water intake Dnipro water supply station No. 1

It is determined that the average annual and maximum values of the content of the sum of ions in the surface waters of the Dnipro river from the water intake area Dnipro water supply station No. 1, the quality of waters under study, within the ecological classification, throughout the five-year study period, corresponded to quality class III and category 5 (Fig. 2).

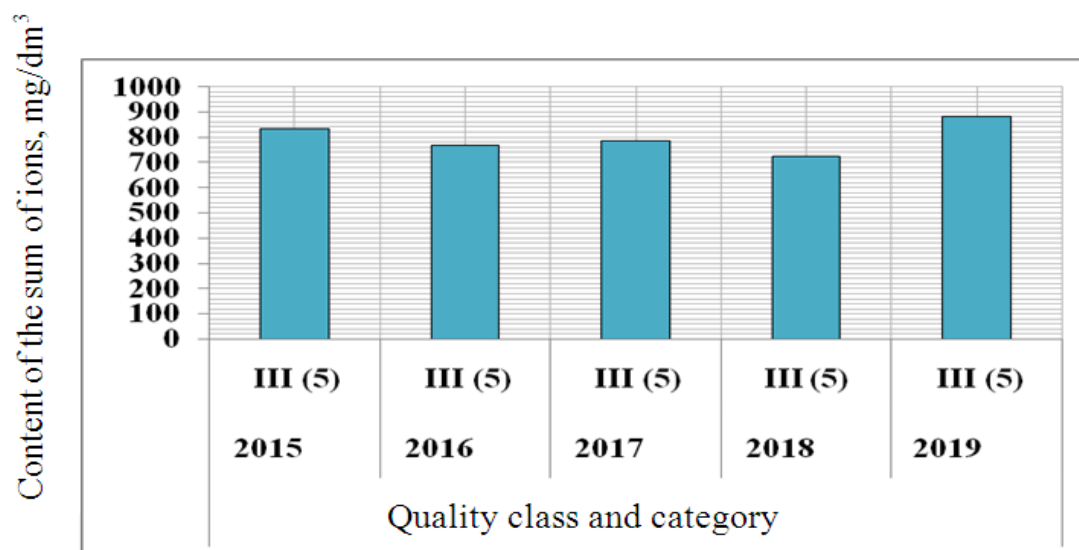


Fig. 2. Class and categories of surface water quality of the Dnipro river from the area of water intake Dnipro water supply stations No. 1 according to the average annual values of the sum of ions

According to the average annual values of sulfate content in the surface waters of the Dnipro river from the water intake area Dnipro water supply station No. 1, the quality of waters under study, within the ecological classification, in 2015, 2016 and 2017 corresponded to quality class III and category 4 (according to the condition “satisfactory”, according to purity level — “slightly contaminated”). In 2018—2019, the quality of waters under study in terms of the average annual content of

sulfates improved and corresponded to quality class II and category 3 (according to the condition “good”, in terms of purity — “fairly clean”). However, according to the maximum (worst) values, during the entire five-year study period, no improvement in the quality of the waters under study was detected. According to the maximum content of sulfates, the quality of surface waters of the Dnipro river from the Dnipro water supply station No. 1 water intake area is defined in terms of condition as “satisfactory”, “slightly contaminated” in terms of purity (III (4)). An illustration of the abovementioned analysis is provided in Fig. 3.

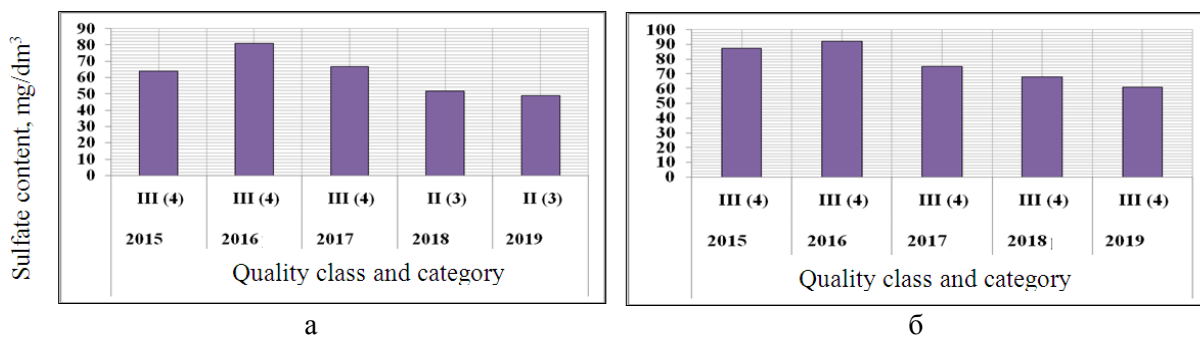


Fig. 3. Class and categories of quality according to the content of sulfates in the surface waters of the Dnipro river from the water intake area Dnipro water supply station No. 1: a — according to the average annual values; б — according to the maximum values

Further, we analyze the ecological status of surface waters from the water intake area of the station No. 2.

Fig. 4 illustrates the dynamics of the content of the sum of ions, chlorides and sulfates according to the average annual and maximum values in the surface waters of the Dnipro river from the area of water intake Dnipro water supply station No. 2 for a five-year period.

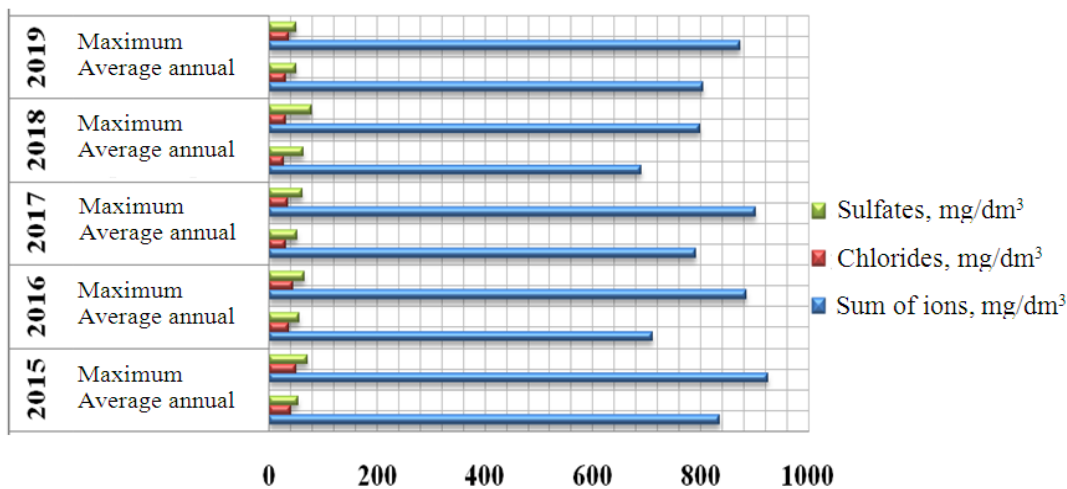


Fig.4. Dynamics of the content of the sum of ions, chlorides and sulfates according to the average annual and maximum values in the surface waters of the Dnipro River from the area of water intake Dnipro water supply station No. 2

It was determined that the average annual and maximum values of the content of the sum of ions in the surface waters of the Dnipro river from the area of water intake Dnipro water supply station No. 2, the quality of waters under study, within the ecological classification, almost throughout the five-year research period, corresponded to quality class III and category 5 (according to the state “me-

diocre”, according to the degree of purity — “moderately polluted”). Only in 2016 and 2018, according to the average annual values, the third class and the 4th category of quality were determined (according to the condition “satisfactory”, according to the degree of purity — “slightly polluted”). An illustration of the abovementioned analysis is provided in Fig. 5.

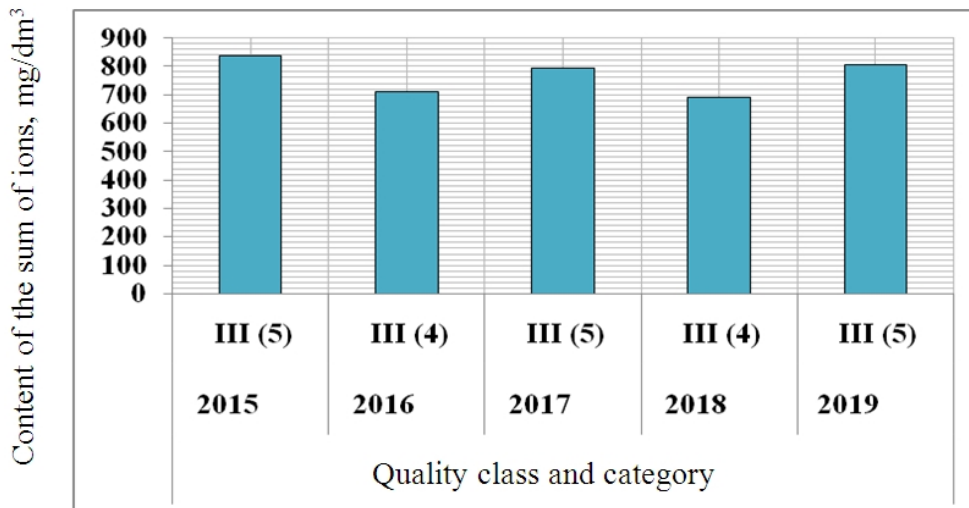


Fig. 5. Class and categories of surface water quality of the Dnipro River from the area of water intake Dnipro water supply stations No. 2 according to the average annual values of the sum of ions

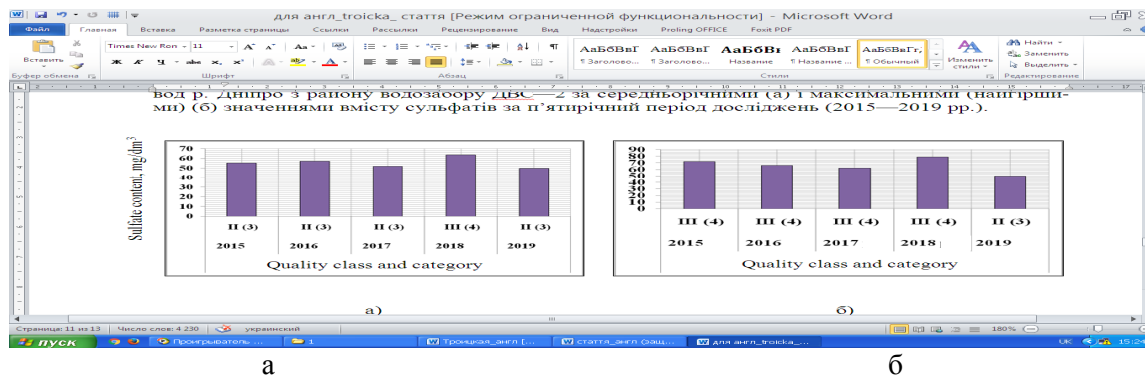


Fig. 6. Class and categories of quality according to the content of sulfates in the surface waters of the Dnipro river from the water intake area Dnipro water supply station No. 2: a — according to the average annual values; b — according to the maximum values

According to the average annual and maximum values of chloride content, during the whole five-year period of research, it corresponded to the quality class II and category 3 (according to the condition “good”, according to the degree of purity — “quite pure”).

It is established that the quality of surface waters of the Dnipro river from the Dnipro water supply station No. 2 water intake area, according to the average annual values of sulfate content, in 2015, 2016 and 2017 corresponded to quality class II and category 3 (according to the condition “good”, according to the degree of purity — “quite pure”). In 2018, deterioration of the quality of water under study to the III class and 4 quality categories was recorded (according to the condition “satisfactory”, according to the degree of purity — “slightly polluted”). In 2019, the quality of waters under study improved and again corresponded to quality class II and category 3. According to the maximum (worst) values, during the four research years (2015, 2016, 2017 and 2018), the water quality corresponded to quality class III and category 4 (according to the condition “satisfactory”, according to the degree of purity — “slightly polluted”). In 2019, improvements to the quality class II and

category 3 were revealed (according to the condition “good”, according to the degree of purity – “quite clean”). An illustration of the abovementioned analysis is provided in Fig. 6.

Conclusions

Environmental condition of the surface waters of the Dnipro river from the water intake areas of the Dnipro water supply stations No. 1 and No. 2 has been analyzed according to the indicators of the salt composition block within the five-year period. The study was performed by means of assessing the quality of surface water in relation to relevant classes and categories, as well as the degree of anthropogenic pollution.

The results of ecological assessment of surface water quality make it possible to acknowledge a rather stable ecological state of the studied surface waters according to individual indicators of the salt composition block (sum of ions, chlorides and sulfates).

Considering the fact that almost 100% of drinking water supply in Zaporizhzhia city is provided by the waters of the Dnipro river, the problem of ensuring environmentally safe water quality indicators of the main waterway of Ukraine comes to the fore. In order to improve the environmental condition of the water resources of the Dnipro river basin, it is necessary to improve water protection measures and strengthen control over the environmental condition to ensure ecological safety and health of the population.

References

- [1] Sait Verkhovnoi Rady Ukraini [Site of Ukrainian Parliament]. Retrieved from <https://zakon.rada.gov.ua/laws/show/2697-19#top> [in Ukrainian].
- [2] Snizhko, S.I. (2001). *Otsinka ta prohnozuvannia yakosti pryrodnykh vod [Natural water quality assessment and forecasting]*. Kyiv: Nika-Tsentr [in Ukrainian].
- [3] Berezhnov, S.P. (2006). Pytna voda iak factor natsionalnoi bezpeki [Drinking water for national security]. *SES: profilaktychna medytsyna – SES: preventive medicine*, 4, 8-13 [in Ukrainian].
- [4] Troicka O.O. (2020). Ekolohichni stan poverkhnevyykh vod r. Dnipro v mezhakh Zaporizhzhia v kontekste staloho rozvytku Zaporizkoho raionu [Ecological status of the surface waters of the Dnieper river within Zaporizhya city in the context of sustainable development]. *Ecology. Human Security'20: XXI Mezhdunarodna naukovo-praktychna konferenciia – XXI International Science Conference*. (pp. 268-271). Kyiv: NTU “Ihor Sikorsky Kyiv olytechnic Institute” [in Ukrainian].
- [5] Feshenok, V.P.(Eds.) (2016). *Ratsionalne vykorystannia ta vidnovlennia vodnykh resursiv [Rational use and restoration of water resources]*. Zhytomir: Zhytomir State University named after I.Franko[in Ukrainian].
- [6] Osadchyi, V.I., Nabyvanets, B.Y., & Lynnyk, P.M. (2013). *Protsesy formuvannia khimichnoho skladu poverkhnevyykh vod [Processes of formation of chemical composition of surface waters]*. Kyiv: Nika-Tsentr [in Ukrainian].
- [7] Yatsyk, A.M., Zhukynskyi, V.M., Cherniavska, A.P., & Yezlovetska I.S. (2006). *Dosvid vylorystannia “Metodyky ekolohichnoi otsinky poverkhnevyykh vod za vidpovidnymi katehoriiami [poiasnennia, zasterezhennia, pryklady]” [Experiences with “Methodologies foe environmental assessment of surface waters by category (Exlanations, warnings, examples)”]*. Kyiv: Oriiany [in Ukrainian].
- [8] Troicka, O.O., Kozhemiakin, H.B., & Novokshchonova, O.V. *Ekolohichne otsiniuvannia iakosti vody 1 pidionu z Dniprovskoi vodoprovodnoi stantsii (DVS-2) m. Zaporizhzhia za okremymy pokaznykamy bloku solovoho skladu [Ecological assessment of water quality from the Dnieper Water Intake Station of Zaporozhye city by selected indicators from podium №1]. SCIENTIFIC ACHIEVEMENTS OF MODERN SOCIETY: VII Mezhdunarodna naukovo-praktychna konferenciiaa) – 7th International scientific and practical conference*. (pp. 902-910). United Kingdom: Cognum Publishing House [in Ukrainian].

ЕКОЛОГІЧНА ОЦІНКА СТАНУ ПОВЕРХНЕВИХ ВОД Р. ДНІПРО З РАЙОНІВ ВОДОЗАБОРІВ М. ЗАПОРІЖЖЯ ЗА ОКРЕМИМИ ПОКАЗНИКАМИ БЛОКУ СОЛЬОВОГО СКЛАДУ

Троїцька О.О., Белоконь К.В., Манідіна Є.А., Рижков В.Г.

Реферат

Обов'язки України щодо вимог СОТ, вимагають налагодження системи контролю за якістю навколишнього середовища. Найнебезпечнішим різновидом антропогенного навантаження на поверхневі води є їх забруднення екологічно небезпечними хімічними речовинами, які здатні порушувати самоочисні та біопродукційні процеси, призводити до глибоких змін у структурно-функціональній організації біотичної складової водних екосистем. Основними джерелами забруднення водних об'єктів є скиди стічних вод підприємств різних галузей економіки, а також побутові та сільськогосподарські стоки, компонентний склад яких дуже різноманітний. Серйозною екологічною проблемою в регіоні є забруднення води р. Дніпро. Загальні показники якості води, до яких належать показники блоку сольового складу, характеризують звичайні властивості водних екосистем та інгредієнти, концентрації яких можуть змінюватися під впливом господарської діяльності людини.

Мета досліджень — аналіз і оцінка екологічного стану поверхневих вод р. Дніпро, з районів водозаборів Дніпровських водопровідних станцій № 1 та № 2 (м. Запоріжжя), за показниками блоку сольового складу (сумою іонів, сульфатів і хлоридів) на протязі п'ятирічного періоду (2015—2019 рр.), шляхом оцінки якості дослідних вод за відповідними класами і категоріями, а також ступенем антропогенного забруднення.

Результати екологічної оцінки якості поверхневих вод р. Дніпро з районів водозаборів ДВС-1 і ДВС-2 за 2015—2019 рр., дозволяють констатувати їх досить стабільний екологічний стан за окремими показниками блоку сольового складу. Однак, враховуючі отримані результати оцінки екологічного стану дослідних вод за сумою іонів, є підстави стверджувати, що ця стабільність вказує на постійний антропогенний пресинг на екосистему р. Дніпро в межах Запоріжжя. Можна констатувати, що значне антропогенне навантаження, вже, порушило природну рівновагу і знизило якість дослідних вод. Встановлена тенденція, вказує на те, що хоча у природному водному середовищі постійно проходять різноманітні процеси самоочищення, їх ефективності, у зв'язку із постійним ростом антропогенного навантаження на довкілля, недостатньо для того, щоб уникнути розвитку негативних процесів у водних об'єктах. Отже, значний вплив на сольовий склад має скидання виробничих і побутових стічних вод, що спричиняє глобальний характер антропогенного пресингу на динаміку водно-сольового режиму р. Дніпро в сучасний період.

З метою покращення екологічного стану водних ресурсів басейну р. Дніпро необхідне вдосконалення водоохоронних заходів і посилення контролю за показниками якості води для забезпечення екологічної безпеки і здоров'я населення.

Література

1. Про Основні засади (стратегію) державної екологічної політики України на період до 2030 року. № 2697-VIII § ст. 70, 2019.
2. Сніжко С.І. Оцінка та прогнозування якості природних вод : підручник. Київ : Ніка-Центр, 2001. 264 с.
3. Бережнов С.П. Питна вода як фактор національної безпеки. *СЕС профілактична медицина*. 2006. №4. С. 8–13.
4. Троїцька О.О. Екологічний стан поверхневих вод р. Дніпро в межах м. Запоріжжя в контексті сталого розвитку Запорізького регіону. *Екологія. Людина. Суспільство* : матеріали XXI Міжнар. наук.-практ. конф., 21-22 трав. 2020 р. Київ : НТУУ «КПІ ім. Ігоря Сікорського», 2020. С. 268–271.
5. Рациональне використання та відновлення водних ресурсів : монографія / За заг. ред. Феценка В.П. Житомир : Вид-во ЖДУ ім. І. Франка, 2016. 250 с.
6. Осадчий В.І., Набиванець Б.Й., Линник П.М. Процеси формування хімічного складу поверхневих вод : монографія. Київ : Ніка-Центр, 2013. 240 с.

7. Досвід використання «Методики екологічної оцінки якості поверхневих вод за відповідними категоріями (пояснення, застереження, приклади)» / Яцик А. В. та ін. Київ : Оріяни, 2006. 44 с.
8. Троїцька О.О., Кожемякін Г.Б., Новокщонава О.В. Екологічне оцінювання якості води I підйому з Дніпровської водопровідної станції (ДВС—2) м. Запоріжжя за окремими показниками блоку сольового складу. *SCIENTIFIC ACHIEVEMENTS OF MODERN SOCIETY* : матеріали VII Міжнар. наук.-практ. конф., 4-6 берез. 2020 р. Ліверпуль, 2020. С. 902–910.