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ASSESSMENT OF WATER QUALITY IN THE LOWER REACHES OF THE INHULETS RIVER

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The level of water availability in Ukraine remains low, while the spatial distribution of water resources is uneven and does not correspond to the location of the most water-intensive economic sectors. The share of the agricultural sector in total water consumption reaches approximately 40 %, whereas the average daily water use per capita is about 270 liters. At the same time, nearly 50% of abstracted water is returned to water bodies in the form of wastewater or drainage water [1].

The regions that most deficient in water resources are those with a high concentration of industrial enterprises, particularly Donbas, the southern regions of the country, the Kryvyi Rih basin, and the territory of the Autonomous Republic of Crimea. The economic complex of the Kryvyi Rih region is represented by industries characterized by significant consumption of natural resources, energy, and water. The main water body in the region is the Inhulets River, which serves as a receiver of highly mineralized tailings wastewater and insufficiently treated industrial effluents. The volume of polluted wastewater discharges into the Inhulets and Saksahan rivers (a left tributary of the Inhulets) reaches approximately 12 million m^3 per year, resulting in significant deterioration of water quality within the area from Kirovohrad region (Iskrivka village) to Mykolaiv region (Snihurivka city) and Kherson region (Dariivka village). A substantial increase in concentrations of total dissolved solids (from 800 to 4200 mg/dm^3), chlorides (from 90 to 2084 mg/dm^3), sulfates (from 240 to 998 mg/dm^3), biochemical oxygen demand (BOD_5) (from 1.2 to 5.8 mg/dm^3), as well as elevated iron content from 0.1 to 0.3 mg/dm^3 has been recorded (data for 2019-2020).

Comparative results of water quality assessment based on hydrochemical indicators [7], obtained using different methodologies, indicate significant discrepancies in conclusions, highlighting the limitations of relying on a single approach for a comprehensive evaluation of the ecological status of the Inhulets River.

In this regard, conducting a comparative analysis of existing methodological approaches and identifying the most appropriate system for integrated water quality assessment in the lower reaches of the Inhulets as a habitat for aquatic organisms is of particular relevance.

Key words: water quality, fisheries use, hydrochemical indicators, ecological status assessment, environmental reliability.

Statement of the task. The aim of the study is to assess the quality of surface waters in the lower reaches of the Inhulets River based on hydrochemical indicators in accordance with fisheries standards, which are considered the most sensitive indicators of changes in the ecological status of aquatic ecosystems.

Analysis of recent research and publications. An important environmental issue in Ukraine's water supply sector remains the preservation of river ecosystems, which are the primary and most accessible sources of freshwater. The functioning of natural and anthropogenic systems is closely linked to the quantitative and qualitative characteristics of water resources, determining their role as one of the fundamental elements of societal life support. Disruptions of the water balance or deterioration of water quality lead to the degradation of natural complexes, reduced biological productivity, and destabilization of ecosystems, including those formed as a result of human economic activity.

The current state of Ukraine's water resources is largely shaped by anthropogenic factors. The main ones include regulation of river flow through reservoirs, intensive agricultural practices, land reclamation measures, industrial and municipal water use, discharge of insufficiently treated wastewater, as well as urbanization processes. At the same time, assessing the scale of such impacts is complicated by the interaction between anthropogenic changes and the natural variability of the hydrological regime. Medium and small rivers are the most sensitive to these impacts, as under conditions of irrational resource use they quickly lose their capacity for self-recovery [2].

One of the most illustrative examples of anthropogenically transformed water bodies is the Inhulets River, whose basin has been significantly affected by long-term economic activity. Within the Mykolaiv Region and Kherson region, the hydrochemical composition of water is largely determined by the inflow of highly mineralized industrial effluents from the Kryvyi Rih Iron Ore Basin. Particularly negative impacts are observed during periodic discharges of mine and domestic wastewater, which lead to increased mineralization, accumulation of pollutants, and deterioration of the ecological condition of aquatic ecosystems. As a result, biotic degradation occurs and water quality declines not only in the Inhulets itself but also in the estuarine zone of the Dnipro River.

Control over the state of water resources is carried out within the framework of the national water monitoring system of Ukraine, which ensures regular collection, processing, and generalization of data on hydrochemical and hydrological parameters. This system makes it possible to assess pollution levels, determine the ecological status of river basins, and develop scientifically grounded conclusions regarding their safety. Monitoring of the hydrochemical regime of the Inhulets River has been conducted since the mid-20th century, associated with the commissioning of the Inhulets Irrigation System, which has significantly influenced the hydrological regime of the region [4].

The Inhulets Irrigation System covers extensive areas of southern Ukraine and plays an important role in supporting agricultural production. At the same time, its operation is associated with changes in the natural water regime, which, combined with technogenic pressure, intensifies the transformation of aquatic ecosystems. The spatial extent of the system includes the interfluve of the Inhulets and the Southern Bug River, resulting in the complex nature of water management processes in the region.

Water quality monitoring in the Inhulets basin is carried out through an extensive network of observation points. Within the Mykolaiv region, a monitoring system operates that includes several dozen water quality indicators measured at control sections upstream and downstream. Similar observations are conducted in the Kherson region, enabling a comprehensive assessment of changes in the hydrochemical condition of the river [3].

The main source of anthropogenic pressure on the Inhulets basin remains industrial enterprises of the mining and metallurgical complex of Kryvyi Rih. This region concentrates a significant number of enterprises involved in the extraction and processing of iron ore raw materials, as well as large metallurgical facilities, including ArcelorMittal Kryvyi Rih. The activities of such enterprises are accompanied by the formation of large volumes of industrial wastewater, which, if insufficiently treated, enter water bodies and significantly deteriorate their ecological condition.

Thus, the current state of the Inhulets River basin is the result of a long-term combination of natural processes and intensive anthropogenic impact. Under present conditions, taking into account climate change, wartime risks, and increasing pressure on water resources, the implementation of integrated water resources management becomes especially relevant, aimed at restoring ecological balance, improving water quality, and ensuring the sustainable use of water resources in the region [8].

Materials and methods. A significant contribution to the study of the chemical composition of the Inhulets River waters has been made by researchers from Taras Shevchenko National University of Kyiv – Horyev L. M., Peleshenko V. I., Khilchevskyi V. K., Rudenko R. V., Medvid V. M., Kravchynskyi R. L., and others. Some of the existing studies on surface water quality of the Inhulets River are limited in scope, as they are based only on specific assessment methodologies [6] or on data obtained in earlier years (prior to 2015) [5]. At the same time, modern approaches to comprehensive analysis of surface water conditions have been significantly advanced by the works of Ukrainian scientists Klymenko M. O. [6], Vozniuk N. M., Skyba V. P. [11] and others.

Integrated water quality assessment is used to determine trends in spatiotemporal changes in the ecological status of water bodies under the influence of natural and anthropogenic processes. It also enables comparison of pollution levels across different water systems based on unified criteria. An effective approach to water quality assessment is comparative analysis based on various methodologies of integrated evaluation proposed by specialists of Odesa State Environmental University – Yurasov S. M., Safranov T. A., Chuhai A. V., Kurianova S. O., and Yurasov M. S. [13, 14].

The integral indices used in assessment are calculated either for all hydrochemical parameters or for their individual groups. These indices reflect the overall condition of the aquatic environment, although detailed information on specific parameters is generalized. The procedure of comprehensive assessment includes two main stages: first, the numerical value of the index is calculated, after which a qualitative (verbal) classification of water quality is assigned according to an established scale. The resulting assessment is expressed in several score categories, allowing determination of the level of cleanliness or pollution of the water body.

The Water Pollution Index (WPI) is calculated using the following formula:

$$\text{WPI} = \frac{1}{6}\sum_{i=1}^{6}\frac{C_i}{MPC_i}, \qquad (1)$$

where: MPC_i – maximum permissible concentration of the chemical component;

C_i – actual concentration of the chemical component;

6 – number of components.

Thus, when calculating the Water Pollution Index (WPI), it is necessary to consider six indicators, among which the mandatory ones are: dissolved oxygen, biochemical oxygen demand (BOD_5), ammonium ions (NH_4^+), nitrites (NO_2^-), petroleum products (PP), and phenols (C_6H_5OH).

Unlike other parameters, for dissolved oxygen the WPI calculation uses an inverse ratio i.e., the standard value (MPC_i) divided by the actual concentration (C_i). This approach allows proper consideration of oxygen deficiency in water. The criteria for water quality assessment based on WPI are presented in Table 1.

Table 1. **Criteria for water quality assessment based on the water pollution index (WPI)**

Water quality class	Class description	Water Pollution Index value
I	Very clean	≤0.3
II	Clean	0.31-1.0
III	Moderately polluted	1.01-2.5
IV	Polluted	2.51-4.0
V	Dirty	4.01-6.0
VI	Very dirty	6.01-10.0
VII	Extremely dirty	>10.0

Waters of Class I are characterized by minimal anthropogenic impact; their hydrochemical and hydrobiological parameters are as close as possible to the natural conditions of the region. Class II is characterized by slight deviations from natural parameters that do not disturb ecological balance. Class III includes waters subjected to noticeable anthropogenic impact, approaching the threshold of ecological stability of aquatic ecosystems. Classes IV-VII represent waters with significantly disturbed ecological properties, where the state of the aquatic environment is regarded as ecological degradation [10].

The modified Water Pollution Index (WPI_{mod}) [9] is also determined based on six indicators, of which biochemical oxygen demand (BOD_5) and dissolved oxygen (O_2) are mandatory. The remaining four indicators are selected from substances with the highest ratios of actual concentration to maximum permissible concentration (C_i/MPC_i). These may include: sulfates (SO_4^{2-}), chlorides (Cl^-), chemical oxygen demand (COD), ammonium (NH_4^-), nitrates (NO_3^-), phosphates (PO_4^{3-}), total iron (Fe_{total}), manganese (Mn^{2+}), copper (Cu^{2+}), zinc (Zn^{2+}), chromium (Cr^{6+}), nickel (Ni^{3+}), aluminum (Al^{3+}), lead (Pb^{2+}), mercury (Hg^{2+}), arsenic (As^{3+}), petroleum products (PP), and synthetic surfactants (SS).

According to the improved methodologies [9], water quality assessment based on the Combinatorial Pollution Index (CPI) is carried out in several stages:

Determination of the nature of pollution based on the conditional complexity coefficient;

Identification of the level and class of water quality according to CPI values;

Determination of priority pollutants through analysis of the number and composition of limiting indicators;

Conducting a differentiated assessment of limiting substances that have the most significant impact on the ecological status of the water body [9].

Thus, the application of the combinatorial approach provides a more comprehensive understanding of the degree of pollution, the nature of anthropogenic impact, and the environmental safety of the aquatic environment.

The conditional complexity coefficient is determined by the following formula:

$$K_{\%} = \frac{m'}{m} \cdot 100\ \% , \quad (2)$$

where m′ – the number of substances whose concentrations exceed the maximum permissible levels (MPC);

m – the total number of regulated components defined by the monitoring program.

If $K < 10\%$, the assessment is carried out based on individual pollutants. In this case, the maximum concentrations of contaminants in water and the degree of exceedance of maximum permissible concentrations (MPC) are determined, with indication of levels such as 1 × MPC, 10 × MPC, or 100 × MPC, depending on the scale of pollution.

When $K \geq 10\%$, a three-level classification of the state of the aquatic environment is applied.

At the first stage of this classification, the stability of pollution is determined, which is assessed using the frequency indicator (P) of cases where established standards (MPC) are exceeded. This indicator allows a quantitative characterization of the persistence of pollution over time and enables tracking of its trends within a water body [12].

$$P_i = \frac{N_{MPC_i}}{N_i}, \quad (3)$$

where N_{MPC_i} – the number of analytical results in which the concentration of the i-th component exceeds its maximum permissible concentration (MPC);

N_i – the total number of analytical results obtained for the i-th component.

The second stage of the classification is based on determining the level of pollution of the aquatic environment, the indicator of which is the exceedance factor (K) of the maximum permissible concentration (MPC). This coefficient reflects the intensity of pollution by a particular substance and is calculated as the ratio of the average or maximum actual concentration of the contaminant in water to the established MPC standard. The higher the value of coefficient K, the more hazardous the level of pollution is considered for the ecosystem [13].

$$K_i = \frac{C_i}{MPC_i}, \quad (4)$$

where C_i – the concentration of the component in soil;

MPC_i – its maximum permissible concentration.

The rating scores for water quality classification are determined according to Tables 2 and 3.

Table 2. **Classification of water bodies by frequency of pollution occurrence**

Frequency, %	**Water pollution characteristic**	**Partial assessment scores**	
		Symbolic designation	**Absolute values**
0-10	single	*a*	0-10
10-30	unstable	*b*	10-30
30-50	stable	*c*	30-50
50-100	characteristic	*d*	50-100

Table 3. **Classification of water bodies by the degree of exceedance of standards**

Degree of exceedance of standards	**Water pollution characteristic**	**Partial assessment scores**	
		Symbolic designation	**Absolute values**
0-2	low	a_1	0-10
2-10	medium	b_1	10-30
10-50	high	c_1	30-50
50-100	very high	d_1	50-100

When determining the first and second stages of classification, generalized water quality scores are calculated for each of the studied components, which are established according to Table 4 [14].

At the third and final stage of the classification, the Combinatorial Pollution Index (CPI) is calculated. It is determined by summing the generalized assessment scores (S_i) obtained for all n analyzed indicators:

$$\text{CPI} = \sum_{i=1}^{n} \cdot S_i \,, \qquad (5)$$

Table 4. **Assessment of the condition of water bodies based on individual indicators**

Comprehensive characterization of water pollution status of water bodies	General assessment scores		Water quality classification of water bodies
	Symbolic designation	Absolute values	
Single pollution			
low level	$a \cdot a_1$	1	slightly polluted
medium level	$a \cdot b_1$	2	polluted
high level	$a \cdot c_1$	3	dirty
very high level	$a \cdot d_1$	4	dirty
Unstable pollution			
low level	$b \cdot a_1$	2	polluted
medium level	$b \cdot b_1$	4	dirty
high level	$b \cdot c_1$	6	very dirty
very high level	$b \cdot d_1$	8	very dirty
Stable pollution			
low level	$c \cdot a_1$	3	dirty
medium level	$c \cdot b_1$	6	very dirty
high level	$c \cdot c_1$	9	very dirty
very high level	$c \cdot d_1$	12	extremely dirty
Characteristic pollution			
low level	$d \cdot a_1$	4	dirty
medium level	$d \cdot b_1$	8	very dirty
high level	$d \cdot c_1$	12	extremely dirty
very high level	$d \cdot d_1$	16	extremely dirty

Result and discussion. The initial data for assessing the ecological status of water resources in the lower part of the Inhulets River basin, covering the territories of Mykolaiv region and Kherson region, were based on the results of analytical monitoring conducted by the State Environmental Inspectorates during 2006-2020. In total, 127 water samples were analyzed, comprising 3,343 chemical determinations. The obtained data were systematized in the form of tables of average annual concentrations of pollutants for the main monitoring sections: Inhulets River – Arkhanhelske village, Inhulets River – Kalininske village, Inhulets River – Snihurivka, and Inhulets River – Dariivka village.

Water quality assessment was carried out based on hydrochemical indicators at the Inhulets River – Snihurivka section using the Water Pollution Index (WPI), calculated in accordance with fisheries standards, which establish the most stringent limits for maximum permissible concentrations (MPC) of both inorganic and organic substances.

Based on long-term monitoring data, a gradual decrease in petroleum product concentrations in the Inhulets water has been observed over the last five years of monitoring, indicating a trend toward improvement in the hydrochemical condition of the river and a potential for partial restoration of its fisheries function.

The summarized results of the calculations are presented in Table 5. During this period, the degree of river water quality underwent significant changes: in 2006-2014, the water was classified as "very dirty"; in 2015-2016, as "moderately polluted"; and starting from 2017, it reached the level of "clean."

Table 5. **Integrated assessment of water quality of the Inhulets River – Snihurivka based on the water pollution index (WPI) according to fisheries standards for the period 2006-2020**

Observation year	Water Pollution Index (WPI)	Water quality class	Degree of purity
2006	6.73	VI	very dirty
2007	6.43	VI	very dirty
2008	6.11	VI	very dirty
2009	6.16	VI	very dirty
2010	6.26	VI	very dirty
2011	6.14	VI	very dirty
2012	6.42	VI	very dirty
2013	6.63	VI	very dirty
2014	6.23	VI	very dirty
2015	1.13	III	moderately polluted
2016	1.08	III	moderately polluted
2017	0.99	II	clean
2018	0.75	II	clean
2019	0.78	II	clean
2020	0.79	II	clean

To improve the reliability of the assessment, a modified Water Pollution Index (WPI_{mod}) was also applied, which accounts for a broader range of hydrochemical indicators. A summarized analysis of the modified indices for the Inhulets River – Snihurivka section for 2006-2020 is presented in Table 6.

The obtained values of the modified WPI ranged from 3.95 (2019) to 13.7 (2012), corresponding to water quality classes from "polluted" to "extremely dirty." This dynamic indicates significant interannual fluctuations in pollution levels, driven by the intensity of industrial discharges and the hydrological conditions of specific years. Comparison of the results obtained using the two methodologies shows agreement for the period 2006-2014, whereas after 2015 noticeable discrepancies are observed, particularly during 2017-2020. This highlights the need to apply additional comprehensive water quality assessment methods to improve the accuracy of ecological diagnostics.

Table 6. **Integrated assessment of water quality of the Inhulets River – Snihurivka based on the modified water pollution index according to fisheries standards for the period 2006-2020**

Observation year	Water Pollution Index (WPI_{mod})	Water quality class	Degree of purity
2006	9.80	VI	very dirty
2007	9.45	VI	very dirty
2008	9.73	VI	very dirty
2009	9.12	VI	very dirty
2010	9.47	VI	very dirty
2011	12.2	VII	extremely dirty
2012	13.7	VII	extremely dirty
2013	11.6	VII	extremely dirty
2014	9.83	VI	very dirty
2015	5.27	V	dirty
2016	4.70	V	dirty
2017	5.09	V	dirty
2018	4.60	V	dirty
2019	3.95	IV	polluted
2020	3.98	IV	polluted

Summarizing the results of the analysis, a clear trend toward improvement in water quality in the lower reaches of the Inhulets River can be observed from a persistently polluted state during 2006-2014 to gradual improvement after 2015, largely explained by a decrease in petroleum product concentrations in the water. A graphical representation of this trend is shown in Figure 1.

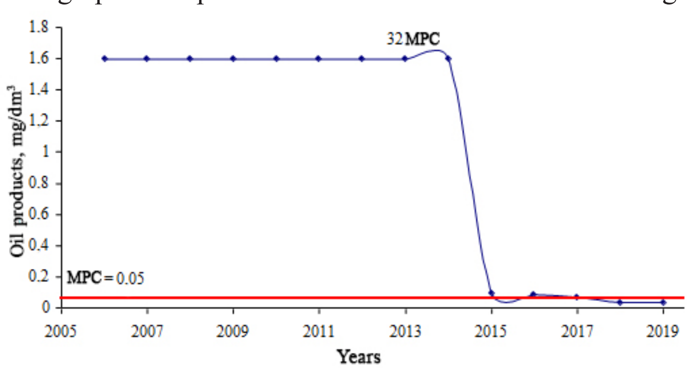

Fig. 1. **Dynamics of changes in petroleum product concentrations in the Inhulets River within Mykolaiv region for the period 2006-2019**

The next stage of the study involved assessing the water quality of the Inhulets River and determining its suitability for fisheries use using the methodology of the Hydrochemical Institute, which is based on the calculation of the Combinatorial Pollution Index (CPI). This method is one of the most informative, as it accounts for the combined influence of multiple groups of pollutants and allows for a differentiated assessment of pollution levels and priority sources of anthropogenic pressure.

According to the obtained results, the conditional complexity coefficient (Equation 2) exceeded 10% for all years of observation, indicating a high diversity of pollutants and the necessity of applying the full (three-stage) water quality classification. The coefficient values ranged from 44.4% (2018) to 72.2% (2007), reflecting significant variability in the composition of pollutants during the analyzed period.

Within the framework of the three-stage classification, the following steps were carried out sequentially:

– first stage calculations – determination of pollution stability (frequency of MPC exceedance) according to Equation 3;

– second stage calculations – determination of pollution level based on the degree of exceedance of standards (Equation 4);

– final third stage – calculation of the Combinatorial Pollution Index (CPI) according to (Equation 5) and assignment of water to the corresponding quality class.

Conclusions. The information basis for assessing the ecological status of water resources in the lower part of the Inhulets River basin within Mykolaiv Oblast and Kherson Oblast was provided by the results of state surface water monitoring for 2006-2020 (127 samples, 3,343 chemical analyses; monitoring sections: Arkhanhelske, Kalininske, Snihurivka, Dariivka).

Assessment based on the Water Pollution Index (WPI) according to fisheries standards showed a transition from “very dirty” water (2006-2014) to “moderately polluted” (2015-2016) and “clean” (2017-2020). The modified water pollution index ranged from 3.95 to 13.7, corresponding to water quality classes from “polluted” to “extremely dirty.”

According to the methodology of the Hydrochemical Institute (calculation of the Combinatorial Pollution Index, CPI), it was found that in 78.6% of cases the water was classified as “very dirty,” and in 21.4% as “dirty.” The main pollutants during 2006-2014 were petroleum products and copper.

ОЦІНКА ЯКОСТІ ВОДНИХ РЕСУРСІВ ПОНИЗЗЯ РІЧКИ ІНГУЛЕЦЬ

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Рівень забезпеченості водними ресурсами в Україні залишається низьким, тоді як їх просторовий розподіл є нерівномірним і не відповідає розміщенню найбільш водоємних галузей економіки. Частка аграрного сектору у загальному водоспоживанні становить близько 40%, тоді як середньодобове водоспоживання на одну особу сягає приблизно 270 літрів. Водночас майже 50% забраної води повертається у водні об’єкти у вигляді стічних або дренажних вод [1].

Найбільш дефіцитними за водними ресурсами є регіони з високою концентрацією промислових підприємств, зокрема Донбас, південні області країни, Криворізький басейн, а також територія Автономної Республіки Крим. Господарський комплекс Криворізького регіону представлений галузями, що характеризуються значним споживанням природних ресурсів, енергії та води. Основною водною артерією регіону є річка Інгулець, яка слугує приймачем високомінералізованих хвостових вод і недостатньо очищених промислових стоків. Обсяг скидання забруднених стічних вод у річки Інгулець і Саксагань (ліва притока Інгульця) становить близько 12 млн м³ на рік, що спричиняє суттєве погіршення якості води на ділянці від Кіровоградської області (с. Іскрівка) до Миколаївської області (м. Снігурівка) та Херсонської області (с. Дар’ївка). Зафіксовано значне зростання концентрацій загальної мінералізації (від 800 до 4200 мг/дм^3), хлоридів (від 90 до 2084 мг/дм^3), сульфатів (від 240 до 998 мг/дм^3), біохімічного споживання кисню (БСК$_5$) (від 1,2 до 5,8 мг/дм^3), а також підвищення вмісту заліза з 0,1 до 0,3 мг/дм^3 (дані за 2019-2020 рр.).

Порівняльні результати оцінювання якості води за гідрохімічними показниками [7], отримані із застосуванням різних методик, свідчать про суттєві розбіжності у висновках, що підкреслює обмеженість використання лише одного підходу для комплексної оцінки екологічного стану річки Інгулець.

У зв’язку з цим особливої актуальності набуває проведення порівняльного аналізу існуючих методичних підходів та визначення найбільш доцільної системи інтегрованої оцінки якості води у нижній течії Інгульця як середовища існування водних організмів.

Ключові слова: якість води, рибогосподарське використання, гідрохімічні показники, оцінка екологічного стану, екологічна надійність.

BIBLIOGRAPHY

1. Алмашова В. Моніторинг екологічної оцінки якості води річки Дністер. *Водні біоресурси та аквакультура*. 1(17), 2025. 261-278.
2. Breus D. Assessment of the ecosystem state of the Bile Lake (Rivne region) based on a set of ecological indicators. *Водні біоресурси та аквакультура*. 2(18), 2025. 165-179.

3. Breus D. Experience in water resources management under the climate change conditions on the example of Norway. *Водні біоресурси та аквакультура*. 1(17), 2025. 152-161.
4. Державні санітарні норми та правила «Гігієнічні вимоги до води питної, призначеної для споживання людиною». ДСанПіН 2.2.4-171-10. Електронний ресурс. URL: http://zakon4.rada.gov.ua/laws/show/z0452-10
5. Іщук О.В., Бордюг Н.С. Моніторинг хлорорганічних сполук у водних біологічних ресурсах річки Сейм як основа екологічної безпеки рибної продукції. *Водні біоресурси та аквакультура*. 2(18), 2025. 238-248.
6. Клименко М.О., Вознюк Н.М., Вербецька К.Ю. Порівняльний аналіз нормативів якості поверхневих вод. *Наукові доповіді НУБіП*. 8, 2012. 30 с.
7. Пічура В.І., Потравка Л.О., Білошкуренко О.С. Дослідження наслідків руйнації Каховської дамби та осушення водосховища для населення України. *Водні біоресурси та аквакультура*. 1(17), 2025. 218-247.
8. Pichura V., Potravka L., Skok S., Vdovenko N. Causal regularities of effect of urban systems on condition of hydro ecosystem of Dnieper river. *Indian Journal of Ecology*. 2(47), 2020. 273-280.
9. Pichura V.I., Malchykova D.S., Ukrainskij P.A., Shakhman I.A., Bystriantseva A.N. Anthropogenic Transformation of Hydrological Regime of The Dnieper River. *Indian Journal of Ecology*, 45 (3), 2018. 445-453.
10. Potravka L., Pichura V., Melnyk V. Results of the sociological research Kakhovka reservoir: past, present, and future. *Водні біоресурси та аквакультура*. 2(18), 2025. 204-223.
11. Skyba V.P., Kopylova O.M., Vozniuk N.M., Likho O.A., Pryshchepa A.M. Ecological risks in river basins: a comparative analysis of steppe and forest Ukrainian areas. *Ukrainian Journal of Ecology*, 2021, 11(1), 306-314, doi: 10.15421/2021_46
12. Харитонов М.М., Анісімова Л.Б. Екологічна оцінка якості поверхневих вод басейну річки Дніпро у Дніпропетровській області. *Екологія і природокористування*. 2013. Випуск 17. С. 75-85.
13. Yurasov S.M., Karaulov V.D., Terzeman V.V. Improved assessment and forecasting of irrigation water quality. *Man and Environment. Issues of Neoecology*, 2025, (43). 33-46. doi: 10.26565/1992-4224-2025-43-03
14. Юрасов С.М., Сафранов Т.А., Чугай А.В. Оцінка якості природних вод: навчальний посібник. Одеса: Екологія, 2012. 168 с.

REFERENCES

1. Almashova V. (2025). Monitorynh ekolohichnoi otsinky yakosti vody richky Dnister. [Monitoring of the ecological assessment of water quality of the Dniester River]. *Vodni bioresursy ta akvakultura*. 1(17), 261-278 [in Ukrainian].

2. Breus D. (2025). Assessment of the ecosystem state of the Bile Lake (Rivne region) based on a set of ecological indicators. *Vodni bioresursy ta akvakultura*. 2(18), 165-179.
3. Breus D. (2025). Experience in water resources management under the climate change conditions on the example of Norway. *Vodni bioresursy ta akvakultura*. 1(17), 152-161.
4. Derzhavni sanitarni normy ta pravyla "Hihiienichni vymohy do vody pytnoi, pryznachenoi dlia spozhyvannia liudynoiu". DSanPiN 2.2.4-171-10. [State Sanitary Norms and Regulations "Hygienic Requirements for Drinking Water Intended for Human Consumption" (DSanPiN) 2.2.4-171-10]. URL: http://zakon4.rada.gov.ua/laws/show/z0452-10 [in Ukrainian].
5. Ishchuk O.V., Bordiuh N.S. (2025). Monitorynh khlororhanichnykh spoluk u vodnykh biolohichnykh resursakh richky Seim yak osnova ekolohichnoi bezpeky rybnoi produktsii. [Monitoring of organochlorine compounds in aquatic biological resources of the Seim River as a basis for the environmental safety of fish products]. *Vodni bioresursy ta akvakultura*. 2(18), 238-248 [in Ukrainian].
6. Klymenko M.O., Vozniuk N.M., Verbetska K.Yu. (2012). Porivnialnyi analiz normatyviv yakosti poverkhnevykh vod. [Comparative analysis of surface water quality standards]. *Naukovi dopovidi NUBiP*. 8, 30 p [in Ukrainian].
7. Pichura V.I., Potravka L.O., Biloshkurenko O.S. (2025). Doslidzhennia naslidkiv ruinatsii Kakhovskoi damby ta osushennia vodoskhovyshcha dlia naselennia Ukrainy. [Study of the consequences of the Kakhovka Dam destruction and reservoir drainage for the population of Ukraine]. *Vodni bioresursy ta akvakultura*. 1(17), 218-247 [in Ukrainian].
8. Pichura V., Potravka L., Skok S., Vdovenko N. (2020). Causal regularities of effect of urban systems on condition of hydro ecosystem of Dnieper river. *Indian Journal of Ecology*. 2(47), 273-280.
9. Pichura V.I., Malchykova D.S., Ukrainskij P.A., Shakhman I.A., Bystriantseva A.N. (2018). Anthropogenic Transformation of Hydrological Regime of The Dnieper River. *Indian Journal of Ecology*, 45 (3), 445-453.
10. Potravka L., Pichura V., Melnyk V. (2025). Results of the sociological research Kakhovka reservoir: past, present, and future. *Vodni bioresursy ta akvakultura*. 2(18), 204-223.
11. Skyba V.P., Kopylova O.M., Vozniuk N.M., Likho O.A., Pryshchepa A.M. (2021). Ecological risks in river basins: a comparative analysis of steppe and forest Ukrainian areas. *Ukrainian Journal of Ecology*, 11(1), 306-314, doi: 10.15421/2021_46
12. Kharytonov M.M., Anisimova L.B. (2013). Ekolohichna otsinka yakosti poverkhnevykh vod baseinu richky Dnipro u Dnipropetrovskii oblasti. [Ecological assessment of surface water quality in the Dnipro River basin

within Dnipropetrovsk Oblast]. *Ekolohiia i pryrodokorystuvannia*. Vol. 17, 75-85 [in Ukrainian].

13. Yurasov S.M., Karaulov V.D., Terzeman V.V. (2025). Improved assessment and forecasting of irrigation water quality. *Man and Environment. Issues of Neoecology*, (43). 33-46. doi: 10.26565/1992-4224-2025-43-03
14. Yurasov S.M., Safranov T.A., Chuhai A.V. Otsinka yakosti pryrodnykh vod: navchalnyi posibnyk. [Assessment of Natural Water Quality: textbook]. Odesa: Ekolohiia, 2012. 168 p [in Ukrainian].

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