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**ASSESSMENT OF THE  
CURRENT STATE OF USE,  
REPRODUCTION, AND  
PROTECTION OF WATER  
RESOURCES IN VINNYTSIA  
REGION**

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*The article examines the current state of use, reproduction, and protection of water resources in the Vinnytsia region, which is one of the key regions of Ukraine in terms of water balance and environmental safety. An analysis of the region's water management balance is conducted, identifying the main sources of water supply, including groundwater and surface water, as well as their ecological status. The level of water consumption in industry, agriculture, and the municipal sector is assessed, with particular attention to the dynamics of water resource use in the context of the region's economic development.*

*Special attention is given to the problems of water pollution, among which the most pressing issues are the impact of agricultural activities, industrial enterprises, and municipal discharges. The main sources of pollution and the factors contributing to the degradation of aquatic ecosystems are analyzed. The results of hydrochemical monitoring of the region's key water arteries, including the Southern Bug and Dniester rivers and their tributaries, are presented, with an assessment of the levels of contamination by organic and inorganic compounds.*

*The effectiveness of measures aimed at rational water use and water resource protection is evaluated, including the implementation of regional environmental programs, the application of water-saving technologies, and modern wastewater treatment methods. Emphasis is placed on the need to improve the monitoring system, strengthen state control, and introduce advanced water purification methods to ensure the long-term environmental stability of the region.*

*Promising directions for optimizing water management are proposed, which can be used to develop effective strategies for preserving Vinnytsia's water resources and improving the region's ecological state, an essential aspect of sustainable development.*

**Keywords:** water resources, water use, environmental safety, water monitoring, Vinnytsia region.

**Table 2. Fig. 3. Ref. 12.**

**Formulation of the problem.** Rational use and protection of water resources are critically important for ensuring ecological balance and sustainable regional development. Vinnytsia region possesses an extensive hydrographic network, including the Southern Bug, Dniester rivers, and numerous tributaries, as well as significant reserves of groundwater. However, increased anthropogenic pressure is causing the degradation of water bodies, threatening both the quality and availability of water.

Among the main challenges are the pollution of water resources by industrial wastewater, agrochemicals from agricultural lands, and untreated municipal waste. Water use in the region is characterized by low efficiency, which manifests in significant losses during transportation, outdated irrigation methods, and irrational exploitation of natural sources.

The shortage of high-quality drinking water is further exacerbated by the

depletion of underground aquifers due to intensive water extraction and insufficient natural replenishment. The inadequate monitoring and control system complicates timely responses to negative changes in the region's water balance.

Solving these problems requires a comprehensive approach that includes the modernization of water treatment facilities, the implementation of resource-saving technologies, the strengthening of state control, and the improvement of legal and regulatory frameworks in the field of water use.

**Analysis of recent research and publications.** The study of water resources in Vinnytsia region has been the subject of numerous scientific investigations, particularly by researchers from Vinnytsia National Agrarian University (VNAU) and other institutions. Below are key publications that address this topic.

The article *“Ecological State of Water Resources in Vinnytsia Region and Ways to Improve It”* analyzes the quality of surface and groundwater in the region. The authors improved the methodology for assessing water body pollution, which allows for more accurate identification of the main causes of water quality deterioration and the development of scientifically grounded recommendations for improving the state of the region's water resources [12].

In the study *“Analysis of Surface Water Quality in Vinnytsia Region”*, the authors examine water abstraction and use in the region. In particular, it is noted that in 2016, a total of 111.5 million m<sup>3</sup> of water was abstracted to meet the needs of the population and various economic sectors, of which 95.8 million m<sup>3</sup> came from surface sources and 15.7 million m<sup>3</sup> from underground sources [6].

The article *“Justification of the Surface Water Monitoring System by the Basin Department of Water Resources of the Southern Bug River”* by O.P. Tkachuk and O.V. Mazur provides a comprehensive scientific rationale for the surface water monitoring system in the Southern Bug River basin, implemented by the respective Basin Water Resources Department [8].

In the article *“Water Quality of the Southern Bug River Within the Vinnytsia Region”*, author H.S. Khayetskyi studies the impact of anthropogenic factors on the main water artery of the region and assesses its current water quality. The research is based on the analysis of the chemical composition of the water and statistical observation data. The conclusions indicate that the water quality of the Southern Bug River in Vinnytsia region complies with the requirements of DSTU 7525:2014 “Drinking Water. Requirements and Methods of Quality Control”, except for parameters such as odor, color, and turbidity [11].

The aim of the research is to assess the current state of use, reproduction, and protection of water resources in the Vinnytsia region.

**Research methods.** The research was conducted using modern methods of monitoring and assessing the quality of water resources, based on data obtained from environmental and regulatory authorities, as well as through practical training at the Department of State Environmental Supervision (Control) of Water Resources in the Vinnytsia Region.

The main data were sourced from the results of water quality monitoring of the Southern Bug River and other water bodies in the region, provided by the State Agency of Water Resources of Ukraine and regional environmental services.

Additional information was collected during the internship at the State Environmental Inspectorate in the Vinnytsia Region, particularly regarding the implementation of state control over the condition of water resources and results of inspection checks.

The application of a comprehensive approach, including laboratory studies, environmental supervision, and statistical analysis, enabled a thorough assessment of the condition of Vinnytsia Region's water resources and the development of recommendations for their improvement.

**Presentation of the main research material.** Water resources are a critical component of sustainable development, providing essential support for agricultural, industrial, and domestic needs. The Vinnytsia region, located in central Ukraine, is endowed with a variety of water bodies, including rivers, lakes, and groundwater resources. However, the increasing demand for water coupled with environmental pressures necessitates effective management and conservation strategies to ensure the long-term sustainability of these resources.

Water Resources of the Vinnytsia Region include both surface and groundwater, which are critically important for providing drinking and technical water supply, irrigation, fish farming, and hydropower. Surface waters are collected in rivers, reservoirs, ponds, and channels, forming the main water management infrastructure of the region.

The region's rivers belong to the basins of three key rivers of Ukraine: the Southern Bug, Dniester, and Dnieper. The basins of these rivers cover 62%, 28%, and 10% of the region's territory, respectively. The hydrological network of the region includes the water systems of the Southern Bug, Dniester, and Dnieper, which determine the main sources of water resources in the region.

One of the important characteristics of the rivers is their feeding. The rivers of Vinnytsia receive water from various sources: rainwater constitutes 48%, snowmelt 25%, and groundwater 27%. This influences seasonal fluctuations in runoff and the availability of water resources throughout the year. The mineralization of water in the region has a bicarbonate-calcium composition, reflecting the natural features of the water resources.

Water resources, as a special natural capital of strategic importance, are a national treasure on which the development of many sectors of the economy depends. In the Vinnytsia City Territorial Community (VCTC), water bodies are crucial for ensuring sustainable development, as they are used for drinking and technical water supply, navigation, fish farming, land irrigation, and hydropower.

The management of the use, protection, and reproduction of water resources in Ukraine is carried out by the State Agency of Water Resources through the Basin Management of Water Resources of the Southern Bug River, according to the River

Basin Management Plan for the Southern Bug for 2025–2030 (Resolution of the Cabinet of Ministers of Ukraine from 01.11.2024 No.1078-p). State supervision over compliance with legislation in the field of water use is ensured by the State Environmental Inspectorate in the Vinnytsia region, while control over the maintenance requirements of settlement territories is carried out by the Vinnytsia City Department of the Main Directorate of the State Service of Ukraine for Food Safety and Consumer Protection.

The Vinnytsia City Council (within the powers defined by the Water Code of Ukraine) also participates in regulating water relations within the Vinnytsia City Territorial Community (VCTC). The main regulatory documents are the Laws of Ukraine “On Environmental Protection,” “On Wastewater Discharge and Treatment,” “On State Control over the Use and Protection of Lands,” “On Local Self-Government,” as well as the Water and Land Codes of Ukraine.

In the community's territory, the key water artery is the Southern Bug River (14 km long), which, along with numerous small rivers (according to the Development Concept for Small Rivers of Vinnytsia – 2035, approved on 07.07.2023 No.1748), forms a water network of about 109 km in total. However, according to the Basin Management Registry, only 9 small rivers are recorded in the system, while hydrological studies have been conducted for 25 of them to include the results in the state water cadastre.

To ensure ecological balance, coastal protective zones are established, regulated by the Land Code of Ukraine (Articles 60–62). However, water quality remains one of the greatest environmental problems affecting public health and the state of the environment. In recent decades, water quality has deteriorated due to unauthorized discharges of domestic wastewater, industrial effluents, the use of pesticides, and the impact of climate change.

Surface water quality assessment was conducted by analyzing hydrochemical indicators in comparison with maximum permissible concentrations (MPC) and background values.

All analyzed indicators were grouped by their type and quantitative characteristics into three main groups:

**1. Salt Composition Components:**

Includes the sum of ions, hydrocarbons, chlorides, sulfates, magnesium, calcium, and sodium ions.

Determines the overall mineralization of water and its suitability for use.

**2. Trophic Saprobiological State Indicators:**

Includes concentrations of dissolved oxygen, acidity, organic compounds (BOD<sub>5</sub> and COD), and key biogenic compounds (ammonium, nitrate, nitrite nitrogen, phosphates).

These indicators characterize the level of water pollution with organic substances and its biological state.

**3. Specific Substances:**

Includes pollutants of anthropogenic origin: petroleum products, surfactants (SAS), phenols, and heavy metals (iron, zinc, chromium, lead, nickel, cadmium).

High levels of these indicators may indicate significant industrial and agricultural emissions.

In September 2024, diagnostic monitoring of surface waters of the Southern Bug River in the Vinnytsia region was conducted to assess the risks and trends in the changes of pollutant concentrations. The research included analyzing the content of organic pollutants, biogenic compounds, and specific substances impacting the ecological state of water bodies.

The studies were carried out at four water intake points:

- Khmilnyk (Southern Bug River, upstream of the city);
- Kalynivka (Southern Bug River, Hushchyntsi village);
- Vinnytsia (Sabariv Reservoir);
- Ladyzhyn (Ladyzhyn Reservoir, Mankivka village).

The analysis results indicate the presence of organic pollution (biochemical oxygen demand – BOD<sub>5</sub>, chemical oxygen demand – COD), as well as seasonal fluctuations in hydrochemical indicators. Specifically, a decrease in the concentration of dry residue was noted, which may be attributed to the hydrological regime of the river and weather conditions. The content of biogenic compounds is below the toxic level, and the oxygen regime is assessed as satisfactory (Table 1).

*Table 1*

### **Hydrochemical Indicators of Water Quality of the Southern Bug River in September 2024**

indicator	Khmilnyk	Kalynivka	Vinnytsia	Ladyzhyn
BOD <sub>5</sub> (mg O <sub>2</sub> /dm <sup>3</sup> )	9	8,9	8,2	9
COD (mg O <sub>2</sub> /dm <sup>3</sup> )	43	47	47	37
Dry Residue (mg/dm <sup>3</sup> )	388	369	378	358
Oxygen Regime (mg O <sub>2</sub> /dm <sup>3</sup> )	7,1	7,7	6,6	5,5
Biogenic Compound Level	Below toxic levels	Below toxic levels	Well below toxic levels	Well below toxic levels

*Source: Compiled by the authors based on data from the Basin Management of the Southern Bug River Water Resources*

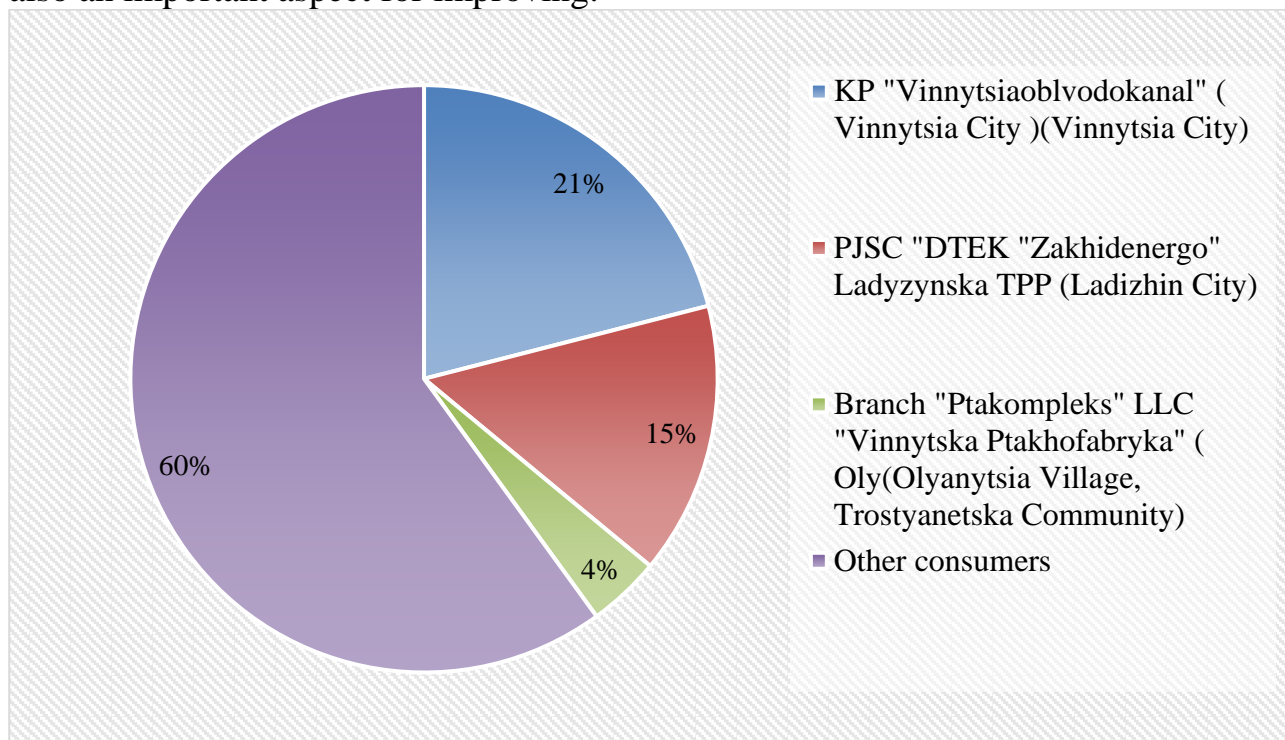
The results obtained indicate that the state of water resources of the Southern Bug River basin generally meets environmental standards, as water pollution levels do not exceed the approximate permissible levels (APL) and maximum permissible concentrations (MPC). However, there is significant anthropogenic impact that threatens the stable functioning of the water management system.

One of the main factors determining the state of water resources is the intensive water consumption carried out by industrial enterprises, municipal services and agricultural facilities. This requires comprehensive measures to reduce water consumption and improve the efficiency of water use. For example, significant water

losses during transportation (15.11 million m<sup>3</sup>) indicate an urgent need to modernize water supply systems and optimize water intake.

The main pollutants of water resources in Vinnytsia region include organic substances, in particular nitrogen compounds, which lead to eutrophication of water bodies, as well as surface runoff carrying mineral pollutants. This worsens water quality and reduces the level of its water exchange, which can lead to shallowing of rivers and silting of water bodies.

In addition, over 1,000 km of riverbeds in the region need to be cleared, which is also an important aspect for improving.



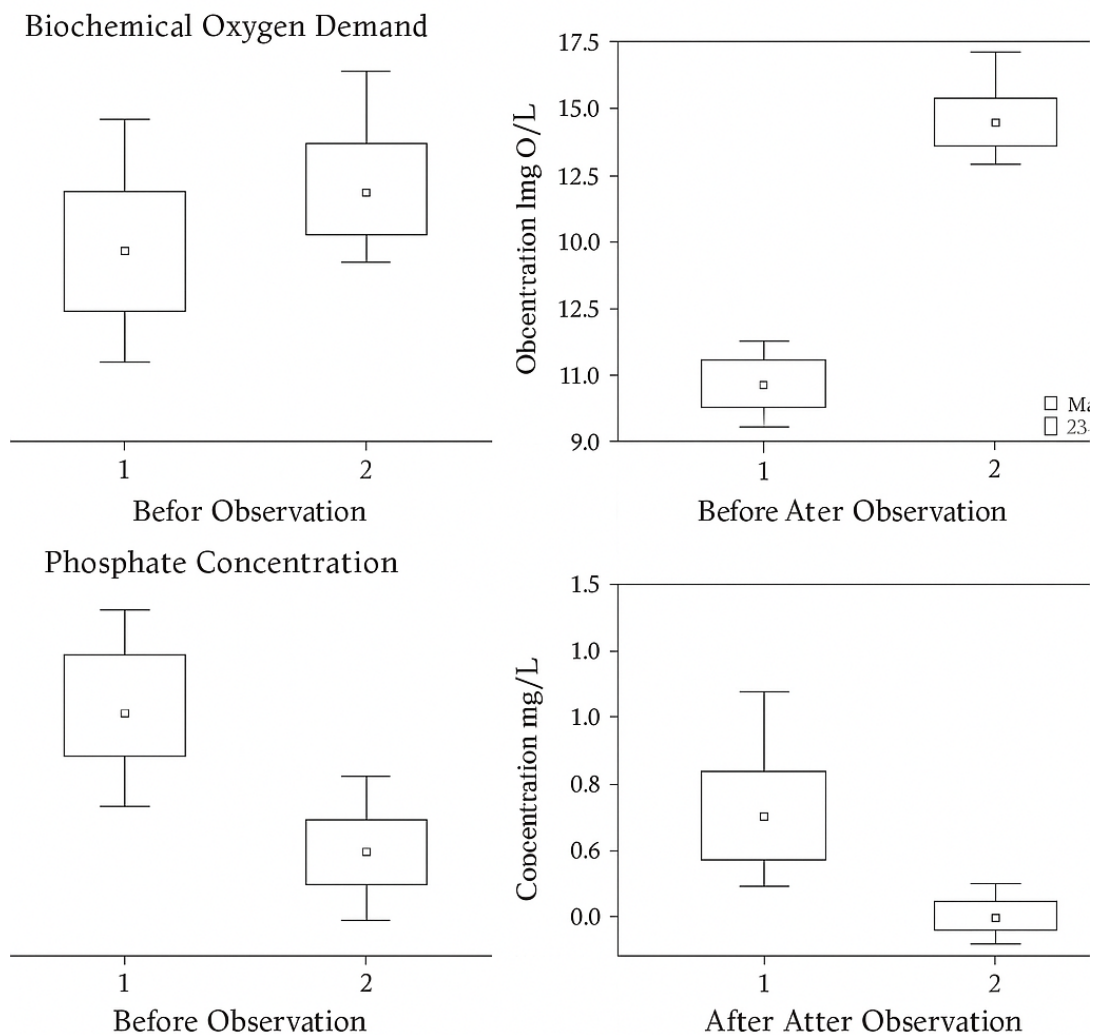
**Fig. 1. Major water consumers of Vinnytsia region**

*Source: constructed by the authors based on their own research*

As a result of regular monitoring conducted by the State Ecological Inspection of Vinnytsia Region in 2024, significant deviations from established norms were detected in the waters of the Southern Bug River (specifically, elevated levels of ammonium nitrogen and critically low concentrations of dissolved oxygen), as well as in the waters of the Tyazhivka River (elevated phosphate concentrations). Additional laboratory studies conducted by the Ministry of Health revealed discrepancies in sanitary-chemical indicators for water from well sources and monitoring points, as well as violations of microbiological standards at beaches and other water bodies [8].

During the study, a comparative analysis of hydrochemical indicators of water sampled above and below the city of Vinnytsia was carried out. The use of the Mann-Whitney nonparametric test in Statistica 10 allowed the identification of statistically significant differences ( $p < 0.05$ ) in the levels of the following indicators (Fig. 2):

biochemical oxygen demand (BOD<sub>5</sub>), suspended solids, phosphate concentration, and chemical oxygen demand (COD).



**Fig. 2. Comparison of hydrometric indicators obtained at observation posts**

Note: "1 - Southern Bug River, 582 km; 2 - Southern Bug River, 607 km; a - biological oxygen demand; b - suspended solids; c - phosphates; d - chemical oxygen demand" [5]

Source: [6]

The obtained results indicate a significant deterioration in water quality in the sections located downstream of Vinnytsia. The primary cause of pollution is the discharge of wastewater by the municipal enterprise "Vinnytsiaoblvodokanal," as well as the influence of the unsatisfactory state of riparian protection strips and surface runoff from the former "Khimprom" industrial complex and private sector areas. Considering that the waters of all rivers and streams directly or via their tributaries flow into the Southern Bug River, their ecological condition directly impacts the quality of water supply for household and utility needs. Therefore, special attention is paid to measures for the protection, improvement, and prevention of pollution of water bodies and riparian protection strips, as reflected in the decision of the Executive Committee of the Vinnytsia City Council dated February 8, 2024,

№ 284, regarding the inspection of water bodies within the Vinnytsia municipal territorial community (VMTG) [11].

In the following study, an analysis of water resources was conducted based on the provided data from the State Ecological Inspection of Vinnytsia Region, categorized into general water resources, surface water, marine water (which is absent in this case), and groundwater.

The primary objective of the research was to identify changes in the volume of water resources, examine their usage levels, and determine the potential impact of these changes on the water supply of the region.

The data were provided regarding the volume of water used over a certain period, as well as changes in the total volumes of water resources. The analysis will help to understand the significance of each category of water resources and their role in meeting the needs of the population. Table 2, presented below, contains information about the initial and final volumes of water resources, as well as their usage in the respective categories as of 2024.

*Table 2*

**Volume and use of water resources by category in 2024**

Water resources category	Initial volume (million m <sup>3</sup> )	Final volume (million m <sup>3</sup> )	Usage (units)	Amount of use (million m <sup>3</sup> )
General water resources	141	123	55	6477,668
Surface waters	115	102	52	6466,845
More	0	0	0	0
Groundwater	26	21	3	10,823

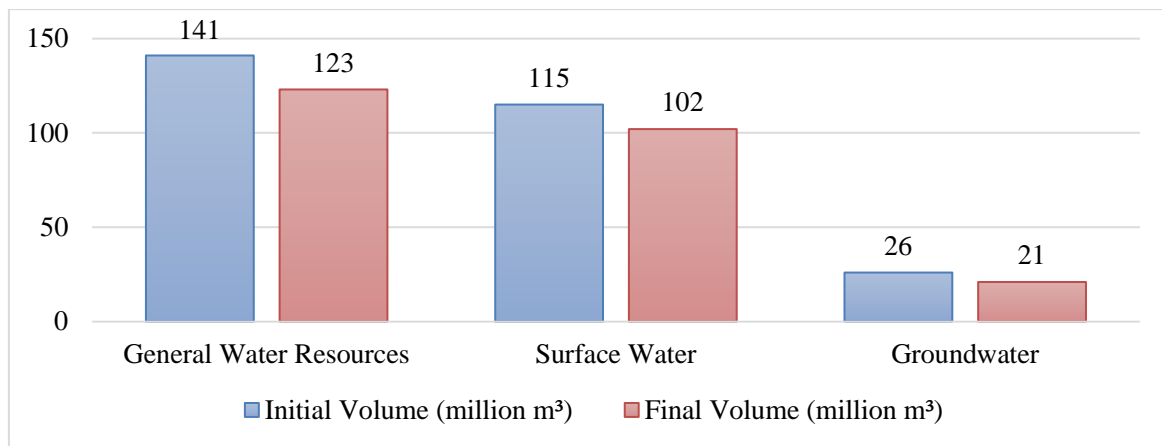
*Source: compiled by the authors based on data from the State Environmental Inspectorate in Vinnytsia region*

Based on the analysis of water resources presented in Table 2, the following conclusions can be drawn:

The initial water volume was 141 million m<sup>3</sup>, while the final volume decreased to 123 million m<sup>3</sup>. This indicates a slight reduction in water resources in the region. However, despite the decrease in total volumes, water resource usage remained significant, amounting to 6477.668 million m<sup>3</sup>, which may indicate a high level of water consumption in the economy. There was also a reduction in the volume of surface water, but it was not significant (from 115 million m<sup>3</sup> to 102 million m<sup>3</sup>). The usage of surface water amounted to 6466.845 million m<sup>3</sup>, pointing to the region's high dependence on surface water to meet the needs of the population and economic activities. Given that marine waters are absent in the region, their volume and usage were not recorded. Groundwater also showed a decrease in volume, from an initial 26 million m<sup>3</sup> to 21 million m<sup>3</sup> at the end of the period. The usage of groundwater was minimal-10.823 million m<sup>3</sup> -suggesting limited use compared to surface water [12].

The dynamics of the volumes and usage of water resources by category in 2024 are shown in Figure 3.





**Fig. 3. Dynamics of volumes and usage of water resources by categories in 2024**

*Source: Created by the author based on data from the State Ecological Inspectorate of Vinnytsia Region*

Based on the analysis of water resources presented in Table 2, the following conclusions can be drawn: The initial water volume was 141 million m<sup>3</sup>, while the final volume decreased to 123 million m<sup>3</sup>, indicating a decrease in water resources in the region. However, despite the reduction in total volume, the usage of water resources remained significant, amounting to 6477.668 million m<sup>3</sup>, which may indicate a high level of water usage in the economy. The reduction in surface water volumes also occurred but was not substantial (from 115 million m<sup>3</sup> to 102 million m<sup>3</sup>). The usage of these waters was 6466.845 million m<sup>3</sup>, pointing to the region's high dependence on surface waters to meet the population's needs and support economic activity. Given that the region lacks marine waters, their volume and usage were not recorded. Groundwater volumes also showed a decrease, from an initial 26 million m<sup>3</sup> to 21 million m<sup>3</sup> by the end of the period. The use of these waters was minimal – 10.823 million m<sup>3</sup>, suggesting their limited use compared to surface waters [12].

The dynamics of water volumes and usage by categories in 2024 is shown in Figure 3.

In general, the reduction in water volumes combined with a high level of usage points to the need for measures to manage water resources more effectively and preserve their quantity for the sustainable development of the region. In conditions of intensive anthropogenic impact, ensuring the ecological well-being of water resources largely depends on the volume of river runoff, which is determined by the efficient functioning of river valley ecosystems during various hydrological periods. However, the regulation of runoff from small rivers in Vinnytsia region is carried out without sufficient ecological justification and proper control, which contributes to the development of negative ecological processes [8].

In this context, public environmental organizations can play a special role in ensuring the ecological sustainability of small rivers and streams. With a proper approach, their involvement will contribute to restoring the natural balance and preventing the degradation of water bodies.

An urgent problem is the intensive siltation of small rivers in the Southern Bug River basin. Among the main factors contributing to this process are:

- Active erosion processes in the catchment area;
- Abrasion of the shorelines;
- Reduced water flow speed;
- Artificial lowering of the erosion base;
- Formation of significant stagnant zones in the riverbeds.

The problem is also exacerbated by the absence of spring floods and river surges, which rarely occur in the region's small rivers due to their regulation by ponds and reservoirs. The annual increase in the average turbidity of water serves as an indicator of the beginning of the siltation process of both small rivers and artificial water bodies created on their basis.

To ensure rational water use in Vinnytsia region, several measures have been implemented, including those under state and regional programs. The main goal of these measures is to optimize water consumption, reduce water wastage, and improve water conservation. One of the important steps has been the introduction of water-saving technologies in industry and agriculture, which include:

- The use of closed-loop water supply systems at enterprises;
- The application of advanced wastewater treatment methods such as biological treatment, membrane technologies, and reverse osmosis;
- The implementation of modern monitoring systems to control water consumption and water quality.

However, existing measures do not yet fully solve the water supply problem, as a significant amount of water was used without proper control and was not sufficiently treated after use.

One of the key directions of water resource protection is the implementation of regional environmental programs aimed at improving the condition of water bodies, reducing water pollution, and restoring ecosystems. These programs include:

- Reclamation of coastal areas and water intake sites;
- Wastewater treatment at municipal and industrial enterprises;
- Restoration of natural water ecosystems, particularly small rivers and streams, through silt removal and riverbed clearing.

Another important component of water resource protection is the maintenance of protective coastal zones, which help prevent water pollution and reduce shoreline erosion.

However, despite the implementation of these programs, many enterprises lack proper treatment facilities or discharge insufficiently treated wastewater, which remains an important issue for control.

Wastewater treatment programs are central to the region's environmental policy. These programs aim to modernize treatment facilities and reduce pollution, particularly through the application of biological treatment technologies. The largest projects include:

- Modernizing water treatment systems in major cities such as Vinnytsia and Ladyzhyn;
- Creating cleaning systems at industrial enterprises, particularly in the agro-industrial sector.

At the same time, there are significant problems with inadequate funding for such projects and maintaining the efficiency of their operation due to the aging of technological equipment.

Monitoring research plays a key role in studying the ecological condition of water bodies. Monitoring allows [9]:

- To assess the ecological status of water, determine its pollution level, and assess compliance with normative indicators;
- To identify key water management and ecological issues, such as wastewater pollution, eutrophication, riverbed siltation, and changes in hydrochemical regimes;
- To form a strategy for natural resource management within river basins, develop measures to improve water quality and ensure sustainable water use.

Through systematic water quality control, timely actions can be taken to reduce the negative impact of human activities on water ecosystems and ensure the rational use of water resources.

In general, the water quality in the Southern Bug River in Vinnytsia region meets the requirements of DSTU 7525:2014 [4], except for odor, color, and turbidity. The main problems with water resources in the region are related to anthropogenic impacts, including the discharge of polluted wastewater, eutrophication, riverbed siltation, and organic compound pollution.

For Vinnytsia region, the preservation of small rivers and streams, which are most affected by pollution, is particularly important. The solution to the ecological problems of water resources is only possible under the following conditions:

- Compliance with environmental protection requirements for water bodies;
- Strengthening the responsibility of enterprises and individuals who pollute water bodies;
- Investing in water resource restoration and improving wastewater treatment systems;
- Forming an ecological culture among the population and enterprises.

For further optimization of water management in Vinnytsia region, the following steps should be implemented:

- Water quality and consumption monitoring should be organized at a higher level using modern technologies. The introduction of automated monitoring systems will allow for faster access to current data on the state of water resources, timely responses to potential threats, and proper control;
- One of the key problems is the insufficient control over the enforcement of water resource protection standards by state authorities. It is recommended to strengthen oversight of compliance with environmental standards in enterprises,

particularly those sectors that are major water polluters;

- To reduce water pollution levels, advanced water treatment methods such as membrane technologies, ultraviolet, and ozone treatment should be introduced. This will significantly reduce the level of toxic compounds in water and improve water quality for drinking purposes;

- Public organizations play an important role in protecting water resources. They can assist in monitoring the ecological situation and implementing projects to clean water and restore water ecosystems. Strengthening their role will help achieve greater effectiveness in water resource protection.

If these measures are implemented, significant improvements in the state of surface waters in Vinnytsia can be achieved in the near future, contributing to their cleaning and ecological restoration.

**Conclusions and prospects for further research.** Despite certain progress in implementing water resource protection measures in the Vinnytsia region, the problem of water body pollution remains relevant. Intense anthropogenic pressure, insufficient control over the discharge of pollutants, and the lack of effective water purification systems continue to negatively affect the quality of the region's water resources.

Further scientific research should focus on:

- Improving water purification technologies, particularly bioremediation and membrane methods;

- Creating integrated monitoring systems to predict water pollution;

- Evaluating the effectiveness of ecological programs and improving water resource management;

- Preserving biodiversity in aquatic ecosystems through the development of new methods;

- Modeling the impact of anthropogenic pressures on water quality and enhancing public initiatives in the process of water resource protection.

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## **АНОТАЦІЯ**

### **ОЦІНКА СУЧАСНОГО СТАНУ ВИКОРИСТАННЯ, ВІДТВОРЕННЯ ТА ОХОРОНИ ВОДНИХ РЕСУРСІВ ВІННИЦЬКОЇ ОБЛАСТІ**

*У статті досліджено сучасний стан використання, відтворення та охорони водних ресурсів Вінницької області, яка є одним із важливих регіонів України з точки зору водного балансу та екологічної безпеки. Проведено аналіз водогосподарського балансу регіону, визначено основні джерела водопостачання, включаючи підземні та поверхневі води, а також їх екологічний стан. Оцінено рівень споживання води у промисловості, сільському господарстві та комунальному секторі, зокрема динаміку використання водних ресурсів у контексті економічного розвитку регіону. Особливу увагу приділено проблемам забруднення водних об'єктів, серед яких найбільш актуальними є вплив сільськогосподарської діяльності, промислових підприємств та комунальних скидів.*

*Проведено аналіз основних джерел забруднення, а також факторів, що призводять до деградації водних екосистем. Представлено результати моніторингу гідрохімічного стану ключових водних артерій області, зокрема річок Південний Буг, Дністер та їхніх приток, із визначенням рівня забрудненості води органічними та неорганічними сполуками. Оцінено ефективність заходів, спрямованих на раціональне водокористування та охорону водних ресурсів, включаючи реалізацію регіональних екологічних програм, застосування водоощадних технологій і сучасних методів очищення стічних вод. Акцентовано увагу на необхідності вдосконалення системи моніторингу, посилення державного контролю та впровадження новітніх методів очищення води для забезпечення довгострокової екологічної стабільності регіону.*

*Запропоновано перспективні напрями оптимізації водного менеджменту, які можуть бути використані для розробки ефективних стратегій збереження водних ресурсів Вінниччини та поліпшення екологічного стану регіону, що є важливим аспектом сталого розвитку.*

***Ключові слова:** водні ресурси, водокористування, екологічна безпека, моніторинг води, Вінницька область.*

***Table 2. Fig.3. Lit.12.***

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