

UDC 504.453

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ECOLOGICAL EVALUATION OF THE MAN-CAUSED IMPACT ON THE HEADWATER AQUATIC ECOSYSTEMS OF ZHYTOMYR REGION (Case study the Gnylopiat River)

***Abstract.** The modern ecological state of aquatic ecosystems of headwaters of Zhytomyr region was researched and characterized for a long, chronological dynamics of water pollution was analyzed, and the main substance-pollutants have been identified. The given results indicate that the main volumes of substance-pollutants come into small aquatic ecosystems with insufficiently treated and untreated sewage.*

***Keywords:** man-caused impact; ecological safety; ecosystems, headwaters*

Target settings

The key element of the ecologically safe development of natural and socio-economic systems is the exploitation of natural waters, which foresees water management, provides sustained development, and for a long time retains sufficient water and resource potential. The nineteenth century is characterized by significant negative changes in the natural environment caused by uncontrolled management of natural resources, the development of industry and transport, which leads to increased water consumption and, at the same time, increased its pollution. It has become most noticeable for the last 50 years in grow, when the human impact on the planet water cycling reached a global scale [1–4].

Man-cause impact on aquatic ecosystems during the period of active industry development is the cause of unresolved relationship between humanity and the natural environment; as a result, the water quality state is constantly deteriorating. Therefore, in recent years, the quality of surface-waters has decreased significantly, and the level of water consumption remains extremely large. The researches have established a direct correlation between the quality of drinking water and the health of the population. According to the World Health Organization, about 75% of human diseases are cause precisely by consuming low-quality water and using water domestic demands that falls short of hygiene standards [5]. Despite the usage of advanced technologies and technological progress, the problems related to the quality of drinking water remain urgent today.

Particularly this problem concerns headwaters, and a considerable part of which they have become shallow, the process of eutrophication has been observed, the quantity and variety of living organisms of the aquatic ecosystem has decreased, water quality has deteriorated [6, 7].

In this regard, one of the main areas of environmental activity is the gradual reduction of man-caused environmental impact, including water bodies, rational use of water resources, providing society with quality drinking water, protecting of water-supply sources.

Actual scientific research and issue analysis

Headwaters form quantitative and qualitative factors of small and large-sized rivers, and they are integral parts of human anthropogenic activities. Due to the constant increasing industrial-domestic pollution, plowing and hydrotechnical reclamation of water intakes and floodplains, most of the headwaters and watercourses are at different stages of degradation.

85% of all river network of Zhytomyr region is headwaters. River basins form 60% of water resources. At present 10% sewer water flows into water basins of headwaters, overregulation has reached impossible level – almost 3 hectares per 1 kilometer of the river. In recent 10-15 years situation has deteriorated as land plots for country houses and industrial facilities. Significantly reduced the ability of aquatic ecosystems to self-purify due to chemical contamination, overregulation and siltation of waterways.

An important contribution to the development, improving the quality and defining the changing of water ecosystem condition was made by such scientists as S.I. Snizhko, V.K. Khilchevskiy, A.V. Yatsyk, V.I. Osadchyi, B.J. Nabyvanets, V.H. Horshkov, V.I. Danylov-Danylyan, A.Y. Vasiukov, V.M. Udod, A.B. Blank, V.D. Romanenko, O.O. Mysliuk, B. Nebel, R. Wright etc. In their scientific works there was paid attention to defining ecological changes in natural ecosystems including the qualitative and quantitative degrees of the water ecosystem changes provided with constant anthropogenic human action on it.

According to A.V. Yatsyk's investigations the biggest amount of substances-polluters gets in watercourses from industrial enterprises – 63,4%, communal sewage – 20,0%, agriculture – 16,6% of the total wastewater extent flowing into small rivers. However, the headwaters where the intensive agriculture takes place are polluting mainly by its effluence (for instance suspended particles, dissolved minerals and organic substances). The number of rivers in the district territory polluted with sewage comes to 90%.

The research aim, objective and methods

The research aim is to assess the man-caused impact on the aquatic ecosystem of headwaters of Zhytomyr region.

The object of research is the aquatic ecosystems of Zhytomyr region.

Accordingly [8] a methodology for scientific research was developed. First, it was necessary to develop a basic scheme on the topic of research, which takes into account the ecological approach to assessing the state of hydro ecosystems of headwaters, to show causal and consequential changes in the state of aquatic ecosystems of rivers. We concluded that interconnections and interaction in hydro

ecosystems depend on the intensity of the mechanism of self-regulation in hydro ecosystems under conditions of man-caused factors, and therefore the scheme has the following form (Fig. 1).

Zhytomyr region, in comparison with other regions of Ukraine, belongs to the region with low water supply. According to the data of the Head Department of the State Land Agency, the total land area of the water fund is 205,598 thousand hectares (6.9% of the territory of the region – 2990 thousand hectares). It includes under the water-storage basins and ponds – 20.847 thousand hectares, under rivers and streams – 7,223 thousand hectares, under lakes and other natural closed waters – 0,691 thousand hectares, under channels, hydrostructures and stripes of discharge – 19,882 thousand hectares, under protected shoreline strips (calculated in accordance with the requirements of the Water Code) – 55,865 thousand hectares and under bogs – 101,09 thousand hectares [9].

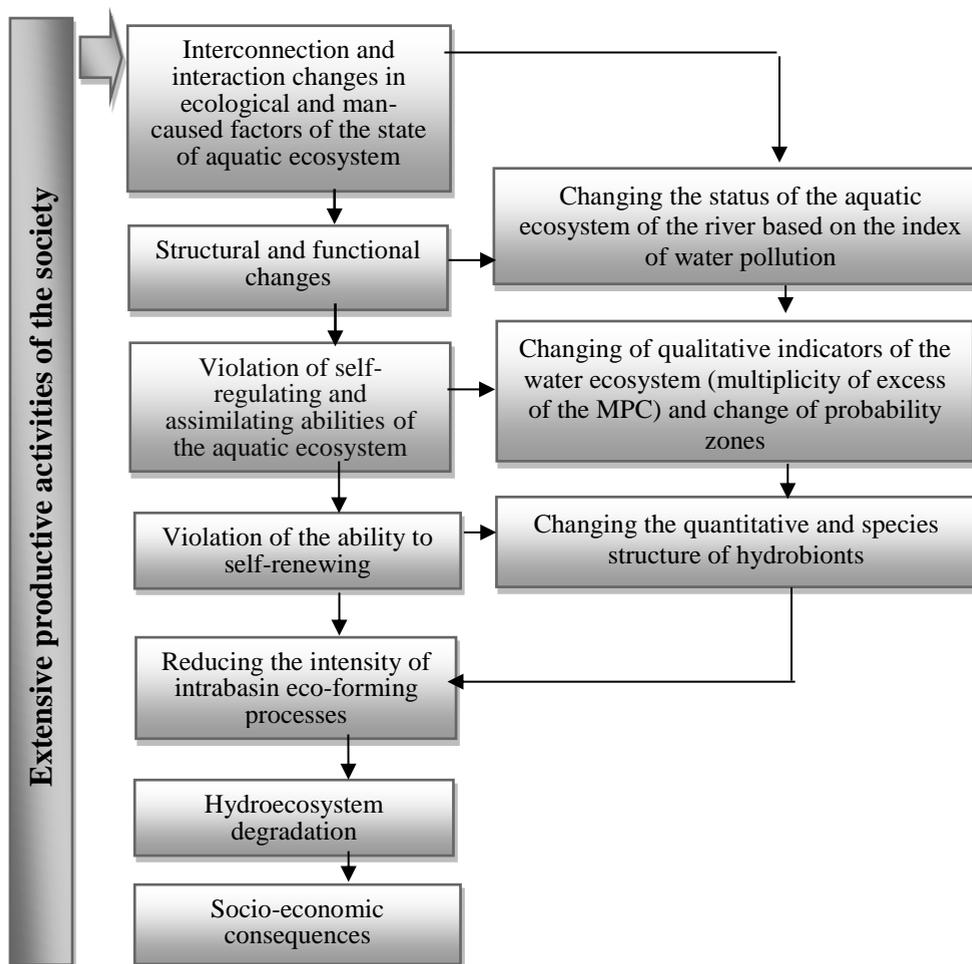


Fig. 1 – Ecological approach to ecological assessment of the status of water ecosystems of headwaters

On the territory of the region, there are 2822 rivers with a total length of 13.7 thousand km. There are no large rivers in the structure of the hydrographic network, but there are the eight average rivers: Sluch, Uber, Stryva, Slovechna, Uzh,

Teteriv, Irsha, Irpin, with a total length of 996.6 km. The total length of the rivers is more than 10 km – 321, their total length is 6692 km (Table 1). Shoots less than 10 km in length are 2491, their total length is 7062 km.

Water resources are mainly formed from the local effluence in the river network, mainly in its own territory due to atmospheric precipitation event, as well as the transit effluence coming from adjacent areas. In addition, part of the resources is replenished from groundwater and water reserves lumped in reservoirs, lakes and bogs.

Table 1 – General information about headwater objects of Zhytomyr region [10]

Indexes	Quantity, pcs	Total length, km	Total area, Ha	Total volume, million m ³
Headwaters	321	5695	-	-
Streams less than 10 km	2493	7062	-	-
Ponds (to 1 million m ³)	1826	-	11974,9	151,2

Small watercourses are important for the population as a source of drinking, technical and agricultural water supply. The analysis of the current state of headwaters shows a significant manufactured impact because of extensive farming, which resulted in the depletion of aquatic ecosystems, reducing the ability to self-renewing. The condition of headwaters in the region is mostly unsatisfactory.

The main influence of water usage on the water resources of the region is determined by irreversible water intake and dumping of contaminated wastewater into water facilities. Although volumes of water usage have an annual tendency to decrease, the degree of anthropogenic pressure on resource water potential remains rather large.

According to the annual reporting form of 2TP-water management in 2016, it was collected 104.6 million m³ of water, which is 7.1 million m³ less than it was in 2015. It was taken 85.86 million m³ from surface water sources.

The actual discharges of sewage into surface water objects in 2016 amounted to 63.99 million m³, which is 3.57 million m³ less than in 2015, of which 2.384 million m³ – contaminated 23.26 million m³ – normative clean without purification, standard purified – 30.88 million m³. The volume of discharged contaminated water decreased by 0.181 million m³ (7.1%).

During 2016, 132 business entities discharged backwater into surface water facilities. 113 enterprises of the region exploited sewage treatment facilities with a total capacity of 102.6 million m³, of which 55 were discharged into water bodies (91.44 million m³). Among the 55 sewage treatment facilities, after which the return water was discharged into surface water bodies, 21 – did not provide normative treatment of wastewater (or 38%), 17 of them – the housing utilities enterprise.

The Gnilopyat River originates in the Vinnytsia region. On the territory of Zhytomyr region flows through the territory of Berdychiv and Zhytomyr districts, where it flows into the Teteriv River. The length of the river in the Zhytomyr region is 70 km.

The hydrological regime of the river is influenced by a significant overregulation of the watercourse. Many ponds were created along the entire length of the river and about 10 dams have been built with reservoirs, but the technical condition of most of them needs reconstruction. 7 of them are located in the Berdychiv district.

The main water users located along the river's water basin are: production management of housing and communal and water supply facilities – LLC “Complex of Ecological Buildings” of Berdichev town, machine building – the “Progress” plant and its subordinated sanatorium “Prolisok”, LLC “Berdychiv Bakery”, PJSC “Dniprovud”, motor transport enterprises, fish industry enterprises and agro-industrial complex. Table 2 summarizes the data on the use of water by water users in Berdychiv town, Zhytomyr region, in the form No. 2TP- (water supply economy).

Table 2-1 – Summarized data on the use of water by water users in Berdychiv town, Zhytomyr region, in the form No. 2TP (water supply economy) (annual 2015-2017 (million m³))

Year	General drainage without transit and discharge into channels	Thrown into surface water objects				Thrown transit water on surface water objects	Thrown into the channels for subsequent usage	Lost in transit	Reverse and re-water supply
		In all	Contaminated wastewater	Normally clean without purification	Norm of purification at treatment facilities				
2015	2,26	2,257	0,180	-	2,077	-	-	0,916	2,602
2016	2,190	2,188	0,489		1,699	-	-	0,92	2,534
2017	2,291	2,279	0,318	-	1,961	-	-	0,913	2,514

Table 2-2 – Summarized data on the use of water by water users in Berdychiv town, Zhytomyr region, in the form No. 2TP (water supply economy) (annual 2015-2017 (million m³))

Year	Number of reporting water users	Taken		Used					
		From natural objects in all	Including from an underground water facility	Fresh water in all	included				
					For drinking and sanitary needs	For production needs	For irrigation	For agricultural water supply	For other needs
2015	25	3,847	0,997	2,931	2,319	0,612	-	-	-
2016	26	3,871	1,152	2,951	2,329	0,623	-	-	-
2017	27	3,829	1,171	2,917	2,233	0,684	-	-	-

Despite the decline of the region's economy, there has been no reduction in production volumes, the amount of discharges of inadequately treated sewage from stationary sources has not changed. In 2016, water was taken from the river – only 5,766 million m³ and 4,201 million m³ were used. The total amount of drainage in the water facility is 3.229 million m³, of which contaminated return water is 0.489 million m³.

According to the results of chemical analyzes, the quality of surface water in controlled areas corresponds to the norms of ecological safety for drinking water and fish farm of water category II, with the exception of such indicators as BOC₅ (biochemical oxygen consumption) and CCO (chemical consumption of oxygen) and iron in general. Results of measurements for 2016-2017 years by main indicators are presented in Fig. 2.

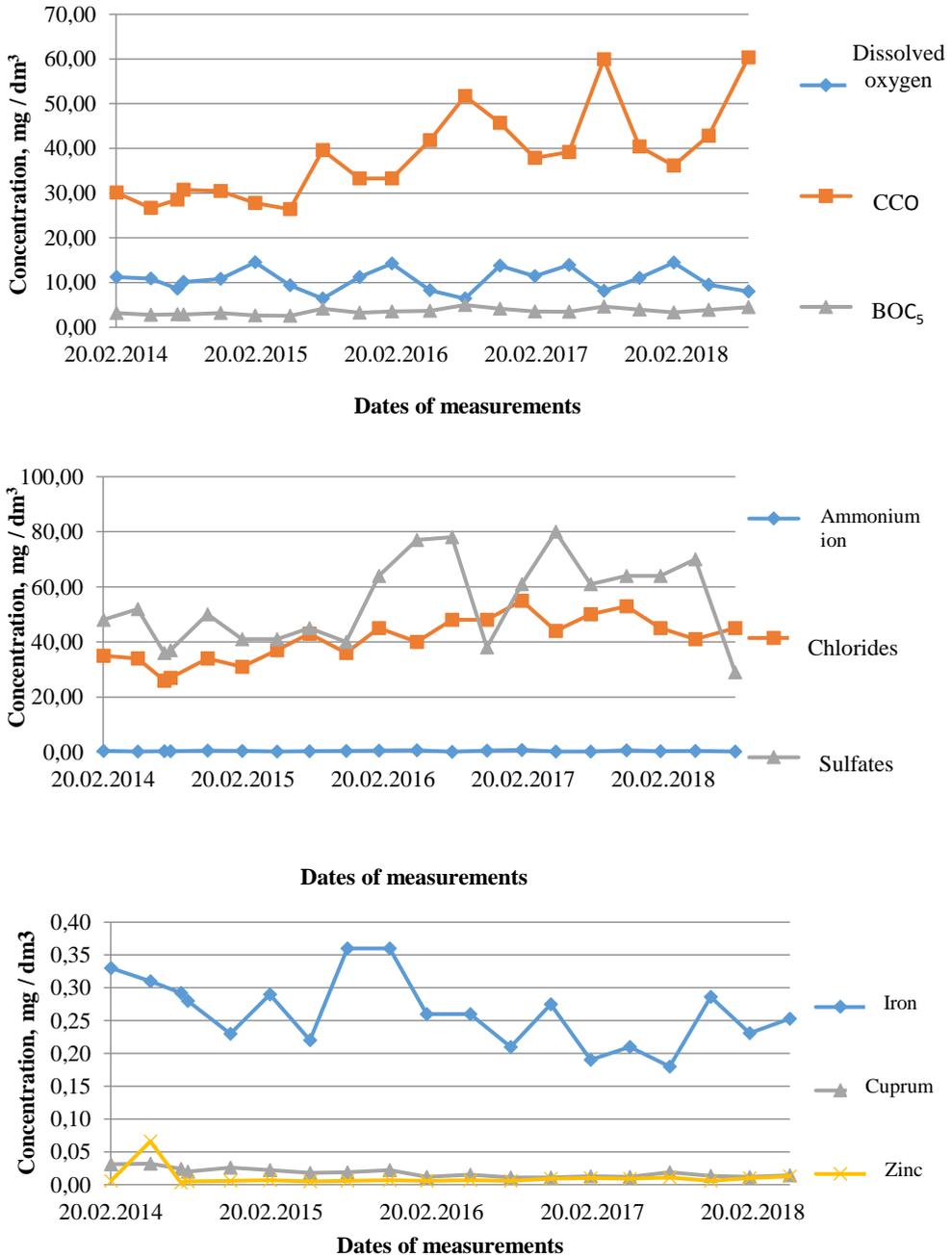


Fig. 2 – Results of measurements for 2016-2017 year by main hydrochemical indicators

The content of organic substances in the river was formed, mainly under the influence of natural factors and according to the results of observations in recent years remains constant.

During the period of research, the variation in sanitary-chemical indicators in the Berdychiv district exceeds the average in the oblast.

Table 3 – Meteorological indicators of man-caused impact on the aquatic ecosystem of the Gnilopyat River

Index of water pollution	Water quality class	Averaged indices water quality				Saprobity zone	Saprobity Index value	Self-purification factor, %			Resistance to man-caused impact
		Pollution Index components salt content (I1)	Trophy-saprobiological (ecological and sanitary) index (I2)	Index of specific toxicity indicators (I3)	Ic			Low	Medium	High	
3,9 (polluted)	IV (polluted)	2,1	3,29	4,01	3,13	β -mesosaprobic	2,3	30,1	61	8,9	$0 < I_{cr} \leq 1,0$

Conclusions and perspectives of further researches

The water of headwaters, which makes up about 99% of the river network of large river basins and suffers an extremely large man-caused impact, provides over 20% of all national economic needs of Ukraine. Modern agricultural land usage does not meet the requirements of rational nature management; the environmental permissible ratio of arable land, natural forage lands, and forest plantations is violated [11, 12]. The researches have showed that the greatest influence on the formation of the hydrochemical composition of small water objects in Zhytomyr region is due to factors that depend on the state of the water intake surface and the structure of the water usage intake.

Therefore, the problem of rational usage and protection of headwaters should be solved in a complex, systematic way, taking into account the interactions of all factors, processes and components of the geographic network, as well as the influence of economic and other activities on the part of man. Largely, the solution to this problem depends on effective legal regulation of the usage and protection of headwaters of our country.

REFERENCES (TRANSLATED AND TRANSLITERATED)

1. Danilov-Danilian, V. I. (2007). Water – a strategic factor for the development of Russia. *Bulletin of the Russian Academy of Sciences*, 77(2), 108-114 (in Russian).
2. Danilov-Danilian, V. I. (2009). *World Water Resources and Prospects for the System of Water Management of Russia*. Moscow: “Levko’s Typografie” (in Russian).
3. Batluk, V. A. (2007). *Basics of ecology*. Kyiv: Znannya (Knowledge) (in Ukrainian).
4. Sukharev, S. M., Chundak, S. Y., & Sukhariyeva, O. Y. (2006). *Fundamentals of ecology and environment protection*. Kyiv: Center for Educational Literature (in Ukrainian).

5. Mikhailichenko, K. Y., Korshunova, A. Y., & Kurbatova, A. I. (2014). Integral assessment of drinking water quality of central water supply systems. *Vestnik RUDN, Series Ecology and Safety of Life*, (4), 99-106 (in Russian).
6. Verkhovna Rada of Ukraine. (2012). *On Adopting the National Target Program for Developing Water Management and Environmental Improvement of the Dnipro River Basin for the Period up to 2021 approved by the Law of Ukraine dated May 24, 2012 No. 4836-VI*. Kyiv: Oficijnyj visnyk Ukraïny (in Ukrainian).
7. Igoshin, N. I. (2009). *Problems of restoration and protection of small rivers and reservoirs. Hydroecological aspects. Tutorial*. Kharkiv: Burun Book (in Ukrainian).
8. Verkhovna Rada of Ukraine. (1995). *Water Code of Ukraine*. Retrieved from <http://zakon4.rada.gov.ua/laws/show/213/95-вр> (in Ukrainian).
9. Vishnevsky, V. I., & Kosovets, O. O. (2003). *Hydrological characteristics of rivers of Ukraine*. Kyiv (in Ukrainian).
10. Regional report on the state of the environment in the Zhytomyr region. (n.d.). Retrieved from https://menr.gov.ua/files/docs/Reg.report/Доповідь_Житомирська_2016.pdf (in Ukrainian).
11. Telyma, S., & Voloshkina, O. (2018). About some features of forecasting mass transport processes in saturated - unsaturated media. *USEFUL Online Journal*, 2(4), 1-8. doi:10.32557/useful-2-4-2018-0001.
12. Vasilenko, L., Zhukova, O., Klimova, I., & Gontscharenko, A. (2018). Anthropogenic changes in water ecosystem on the example of the river Tisza. *USEFUL Online Journal*, 2(4), 26-32. doi:10.32557/useful-2-4-2018-0003.

Text of the article was accepted by Editorial Team 27.09.2018

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ЕКОЛОГІЧНА ОЦІНКА ТЕХНОГЕННОГО ВПЛИВУ НА ВОДНІ
ЕКОСИСТЕМИ МАЛИХ РІЧОК ЖИТОМИРСЬКОЇ ОБЛАСТІ (на прикладі
р. Гнилоп'ять)

Анотація. Досліджено та охарактеризовано сучасний екологічний стан водних екосистем малих річок Житомирської області за багаторічний період, проаналізовано хронологічну динаміку забрудненості води, виявлені основні речовини-забрудники. Наведені результати свідчать, що основні обсяги забруднюючих речовин надходять у малі водні екосистеми з недостатньо очищеними та неочищеними стічними водами.

Ключові слова: техногенне навантаження; екологічна безпека; екосистеми; малі річки

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