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QUALITY LEVEL OF SURFACE WATER AT THE CONTROL POINTS OF THE WESTERN BUG RIVER (LVIV REGION)

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Abstract. The article analyzes the negative impact of enterprises and public utilities on the surface water quality of the Western Bug River basin (within the Lviv region). The dynamics of changes of indicators of the main pollutants at six control points (2016–2018) and the assessment of surface water quality for 2018 are presented. It is proposed to replace the control units on the Western Bug River and its tributaries in order to obtain more accurate information and improve the work on the basin water management.

Key words: control points, surface water monitoring, the Western Bug River basin, surface water quality level.

1. Introduction

Water is the national wealth of every country, one of the natural foundations of its economic development. Access to water sources determines the possibilities of industrial and agricultural development, location of settlements, organization of recreation and health improvement of people. Traditionally, water users of Ukraine (industry, agriculture, and public utilities) for decades have been collecting/discharging water as an economic resource from water bodies and using water energy (hydropower, water transport, fisheries, sports, and tourism). This causes the natural and ecological potential of the hydrosphere to be depleted.

Ukraine is one of the least water-supplied countries in Europe. According to the reserves of local water resources per capita, there is about 1 thousand m^3 of water per year, per capita of the European Union – an average of 5.2 thousand m3 per year. Ukraine’s water objects cover 24.2 thousand km^2, which is 4.0 % of its total territory (603.7 thousand km^2) with an average river network value of 0.34 km/km^2. In Ukraine, there are more than 4 thousand rivers longer than 10 km, of which 117 are over 100 km long. There are 0.25 km of rivers per 1 km of the country`s territory [1]. The main source of nutrition of rivers and the formation of water resources of Ukraine is the precipitation, which averages 366 km^3 (or 609 mm). However, only a small part of them (about 50 km^3, or 83 mm) forms an annual runoff. The remaining moisture is spent on evaporation. On average, 159 km^3 of water enters the territory of Ukraine from its borders. Thus, the total water resources are 209 km^3.

The main hydrographic characteristics of the rivers which indicate the development peculiarities of the river system formation processes and surface runoff are water intake area, number, and length of rivers, the density of the river network, the slope of the river, and characteristics of river valleys. Depending on the water intake area, length, water content, hydropower reserves, suitability for water transport, Ukrainian rivers are divided into large, medium, and small [2].

2. Theoretical part

In 2014, in accordance with the implementation of the provisions of the EU Water Framework Directive, 9 river basins were identified at the state level in 2014: the Dnipro river basin, the Dniester river basin, the Danube river basin, the Southern Bug river basin, the Don river basin, the Vistula river basin, the Crimea river basin, the Black Sea river basin, the Azov river basin [3] and 12 basin units have been established.

The flow of the Western Bug River basin is formed on the territory of three states – Poland (49.2 % of the area) of Ukraine (27.4 %) and Belarus (23.4 %). The Western Bug is a left tributary of the Narew River (the Vistula River basin). The length of the territory of Ukraine is 404 km, of which 363 km is the natural course of the watercourse serving as the state border between the Republic of Poland, Ukraine and the Republic of Belarus. The transboundary of the river is a particularly important factor as it flows into the Zeżyn reservoir, a source of drinking water for Warsaw.

The Vistula basin covers the rivers in northwestern Ukraine that are tributaries of the Sian River and the Western Bug. The Western Bug within Ukraine flows into Lviv and Volyn regions. There are no severe frosts, droughts, dry winds, and dust storms in this basin. On the contrary, there are frequent thaws in winter, heavy clouds, heavy rainfalls, and consequent summer-autumn floods. The Western Bug is a mixed-type river that receives nutrition from melted spring and summer rainfalls with a small part of groundwater nutrition. The highest water level is observed in March and April during the snow melting and in the first half of summer when the highest rainfall occurs. The lowest water level is in August-September and December-February. Hydrogeologically the territory of the Western Bug belongs to the Volyn-Podilskyi artesian basin, where mineralized and fresh groundwater is distributed. Conditions for groundwater formation in the basin are favourable. Waters of quaternary and pre-quaternary sediments move in the direction from the south to the north. [4]. The main tributaries within Ukraine are: right tributaries – the Solotvina River (L = 21 km, F = 151km^2); the White Stream River (L = 30 km, F = 268 km^2); the Spasivka River (L = 27 km, F = 240 km^2); the Luga River (L = 81 km, F = 1340 km^2); left tributaries – the Peltiv River (L = 60 km, F = 1440 km^2); the Kamianka River (L = 37 km, F = 142 km^2); the Rata River (L = 76 km, F = 1790 km^2); the Solokiia River (L = 71 km, F = 939 km^2); the Varezhanka River (L = 38 km, F = 239 km^2) [5]. Practically all the rivers of the Western Bug basin (except the Rata and the Solokia rivers) form river ecosystems within the Lviv region. A common feature of the tributaries is their small basins (from 240 to 1790 km^2) and wide wetland floodplains [6]. There is a well-developed hydrological network in the Western Bug basin. The average density of the river network is 0.35 km^2 [5].

Only underground water is used for drinking, sanitary and communal needs of the population of the Lviv region since the surface water from the Western Bug is not suitable for drinking. Surface water is most widely used in agriculture and over 80 % is related to fisheries.

In Ukraine, the control and conservation of surface water is governed by the following legal acts: the Law of Ukraine “On Environmental Protection", the Water Code of Ukraine (Article 16), the Law of Ukraine “On Drinking Water and Drinking Water Supply", “Rules for the Protection of Surface Water from Pollution from Reclaimed Waters” (approved by the Resolution of the Cabinet of Ministers of Ukraine No. 465 dated 25.03.1999) and other valid normative and by-laws. The fundaments of the state water monitoring system are based in addition to the aforementioned documents on resolutions of the Cabinet of Ministers of Ukraine and orders of the Ministry of Ecology and Natural Resources of Ukraine: “On Approval of the Regulation on the State Environmental Monitoring System” (RCMU No. 391 of 1998, as amended by PCMU No. 528 dated May 16, 2001), “Regulations on the State Agency for Water Resources of Ukraine” (Decree of the President of Ukraine of April 13, 2011 No. 453/2011), “On Approval of the Procedure for State Water Monitoring” (RCMU No. 758 of September 19, 2018), “Methodological Recommendations for Preparation of Regional and General Environmental Monitoring Programs” (Ministry of Minecology Order No. 487 of December 24, 2001), “Recommendations for Comparison of Water Monitoring Data ”(RD 211.1.8.103-2002), “Methodological Guidelines for Analytical Control Laboratories Inventory” (RD 211.0.7.104-02), “Guidelines and Requirements for the Equipment of Standard Operational Water Control Points” (RD 211.1.7.105-02), “Organization and Implementation of Surface Water Pollution Monitoring” (in the Ministry of Ecology and Natural Resources of Ukraine) (CPI 211.1.1.106-2003), DSTU 3831-98 “Environmental Protection. Automated Natural Water Quality Control Systems. Types and Basic Requirements” and others.

The organization of a system of research on the qualitative and quantitative status of surface and groundwater (aquatic and hydro-ecological monitoring) in order to predict the risks of river ecosystem functioning in the future is relevant. Thanks to the National Security Strategy of Ukraine (2015), it is planned to bring national legislation in accordance with the EU environmental policy, in particular Directive 2000/60/EC “On Establishing a Community Framework for Water Policy” (Water Framework Directive). The basic requirements for the organization of water monitoring are set out in Annex V [7]. The European Commission has developed a series of Guidelines on a Common Strategy for the Implementation of the WFD, one of which is dedicated to the issue of monitoring organization (Guidance Document No. 7 [7]). For state monitoring of surface waters, national, regional, departmental and local water monitoring programs are being developed, according to which networks of points, indicators, and modes of observation for water bodies, and sources of water pollution, regulations for the transfer, processing and use of information are defined.

The main subject of state monitoring is the Ministry of Ecology and Natural Resources of Ukraine (the structure of which includes the State Environmental Inspectorate), the Ministry of Internal Affairs (the structure of which currently includes the State Hydrometeorological Service), the Ministry of Health, the Ministry of Agrarian Policy, Ministry of Regional Development, Construction, the State Water Agency of Ukraine and basin water management authorities. Observations of hydrological indicators are carried out on the network of hydrological posts by the departments of the Ukrainian Hydrometeorological Center (UHMC). Hydrochemical indicators are monitored by the following entities: the State Water Agency of Ukraine (436 observation bodies); subdivisions of the UHMC (327 observation sites), state environmental inspections in the regions (in the areas defined by permits for special water use).

The general scheme of environmental quality assessment is carried out according to the following steps:

– evaluation through continuous monitoring;

– location of observation posts in well-established locations with a predetermined sampling rate;

– carrying out laboratory analysis by an accredited laboratory according to certain methods and recording the data obtained (report);

– use of the accumulated database to substantiate water conservation measures or other management decisions at local, regional or global levels.

The studies on the assessment of the status of the Western Bug River basin have been conducted by such scientists as Klimenko, Likho [8], Zabokrytska [9], Koinova et al [10], Kozytska, Muzychenko [11], Burzyńska [12], Voznyuk and others. [13], Jacyk [14], Hopczak and others [15].

The introduction of a new monitoring system for surface, groundwater, and marine waters according to the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Procedure for State Water Monitoring" (No. 758 of 19.09.2018) is a step towards the implementation of the EU standards in the field of water quality and water management. According to the "Methodology for Determination of Surface and Natural Waters" (Order of the Ministry of Ecology of Ukraine No. 4 of 19.01.2019), the main criteria by which the surface water array is determined are ecoregion, surface water category, typology, geographical and hydromorphological differences, change of ecological status, the zones (territories) to be protected.

WFD foresees that mandatory control should be carried out at the points that meet the following criteria:

– the magnitude of the water runoff is significant within the river basin area, including points on large rivers with an area of water intake of more than 2500 km^2;

– the volume of water runoff of the river or the water mass of the lake is significant within the area of the river basin;

– points of intersection of the state border;

– estuary sections of rivers and at cross-border section for determination of chemical runoff of pollutants and other chemicals.

The parameters determined by the control monitoring should include parameters of biological and general physico-chemical state, hydromorphological indicators. Among biological and hydromorphological indicators are selected the indicators that are most sensitive to certain effects. For example, if a significant effect of organic pollutants is found, then the most sensitive to it are benthic organisms, which will serve as an indicator of this pollution. In this case, with no other contamination, phytoplankton and fish cannot be studied. However, it should be taken into account that the control program is conceptually based on the notion of ecological status, so it should be able to compare the ecological status with the reference conditions, not just reflect the influence of individual substances.

As the content of pollutants undergoes significant seasonal changes, the sampling frequency is an important parameter in the organization of monitoring. This parameter should provide reliable data to determine the ecological status of the water body over time. The density of location of points on the territory and the frequency of their selection determine the level of reliability and accuracy of the obtained results. The acceptable selection frequency must be balanced by the cost of the research.

Unlike the current water monitoring system in Ukraine, WFD applies the principle of multilevel monitoring which differs significantly by purpose and includes surveillance, operational and investigative types of monitoring. The main purpose of surveillance monitoring is to identify long-term changes in the quality of water bodies, operational monitoring is applied to objects with an ecological status other than the category of "good" status, and investigative monitoring – when it is necessary to find out the causes of pollution or in case of an emergency. Concerning the objectives set, the monitoring system should answer three basic questions: where to sample, when to select and what indicators to determine. Previously, only operational monitoring was conducted in Ukraine, and since 2019, diagnostic, operational and investigative should be conducted.

The purpose of the article is to analyze the impact of organic, biogenic, and certain toxic substances on the surface water quality of the Western Bug river basin (within the Lviv region), and to determine the quality of water in pollutants by classes of pollution. The materials of the Water and Soil Monitoring Laboratory of the Western Bug and the Sian Basin Water Resources Management during 2016–2018 were used to write the article.

3. Experimental part

The Western Bug is one of the 5 most polluted rivers in Ukraine. During the 1980s, a monitoring system for surface water was introduced to control discharges of industrial enterprises in the coal, energy and alcohol industries. Currently, most of aforementioned enterprises have ceased to exist, which is why utilities are the main pollutants of the Western Bug river basin. The water resources of this river are first and foremost a source of technical water supply for industrial enterprises of heat power, fisheries and agricultural enterprises.

The largest water users are now [16]:

– *industrial enterprises* – SE "Dobrotvirska TPP" (PJSC DTEK "Zahidenergo"), LLC "Radekhivskyi Sugar", PJSC "Company"Enzym", PJSC "Lviv Coal Company", SE "Lvivvugillia", "Stepova", "Chervonograd"), SE "Ukrspirt" ("Vuzlivske", "Stronibabske", "Strutynske", "Rava-Ruske"), SE "Danish Textiles";

– *agricultural enterprises* – LLC "Kunin", LLC "Yakimov Fish", Private agricultural firm "White Stik", tenant Fedorchak RV, PJSC "Lviv Regional Fish Production Plant" (WG "Krasne", WG "Yaniv");

– *housing and communal enterprises* – MCC "Zolochivvodokanal", KP "Kamiankavodokanal", KP "Zhovkivske VUVKG", KP "Chervonogradvodokanal", Sokalsk MCC VKG, LMKP "Lvivvodokanal";

– *transport industry* – enterprises of PJSC "Ukrainian Railways".

The authors of [15] point out that during 2016-2017 there was a tendency to reduce water consumption and the discharge of pollutants by industrial water users. This is due to the reduction of production needs.

In 2018 (see Fig. 1), water abstraction in the basin from natural sources amounted to 70.22 million m^3, but only 8.65 million m^3 (only 12.3 %) was collected from surface water bodies.

The total wastewater discharge in the Lviv region is 135.31 million m^3 of volume (192.7 % of the intake). This is explained by the presence of water intakes at the Lvivvodokanal LCM in the Dniester River basin, and all wastewater is discharged into the Poltva River. 93.33 million m^3 of the total discharge (see Fig. 2) is wastewater, normatively purified at treatment plants; 35.48 million m^3 – contaminated effluents (when the discharges have exceeded at least one indicator of the approved MPD standards individually for each enterprise); 3.3 million m^3 – normatively clean without treatment at treatment facilities; 3.2 million m^3 is uncategorized, mine water. In 2018, contaminated water was discharged by Lvivvodokanal LMCP – 33.0 million m^3 into the Poltva River (accounting for 93.1 % of the volume of all polluted wastewater); Chervonogradvodokanal – 0.7 million m^3 into the Western Bug and the Rata River; Rava-Rusky State Enterprise "State Enterprise Ukrspirt" – 0.25 million m^3 into the Rata River; KP Kamyankavodokanal – 0.18 million m^3 into the Kamianka River, NAU Lviv – 0.16 million m^3 into the Yarichevska River tributary, "Rava-Ruske BU No. 2" – 0.1 million m^3 into the Rata River [16].

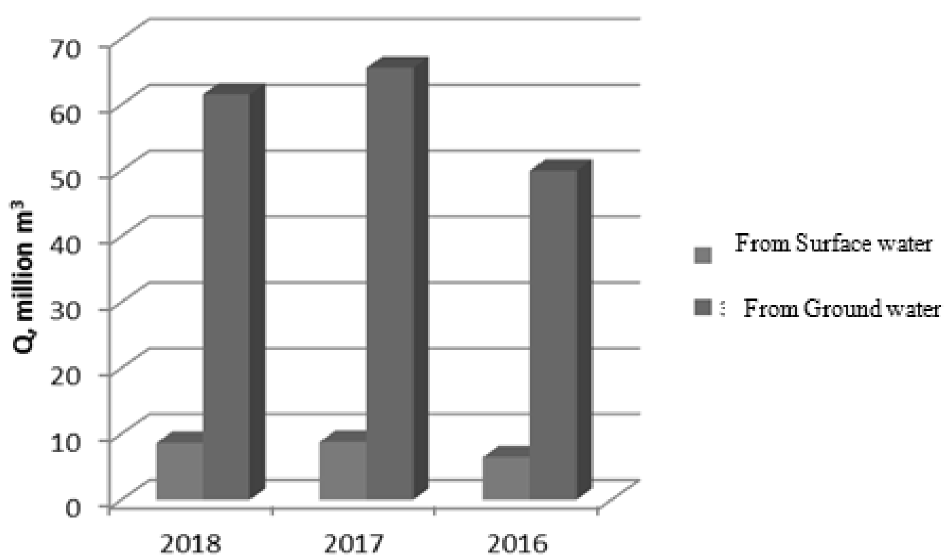

Fig. 1. Water intake from ground and surface waters in 2016–2018

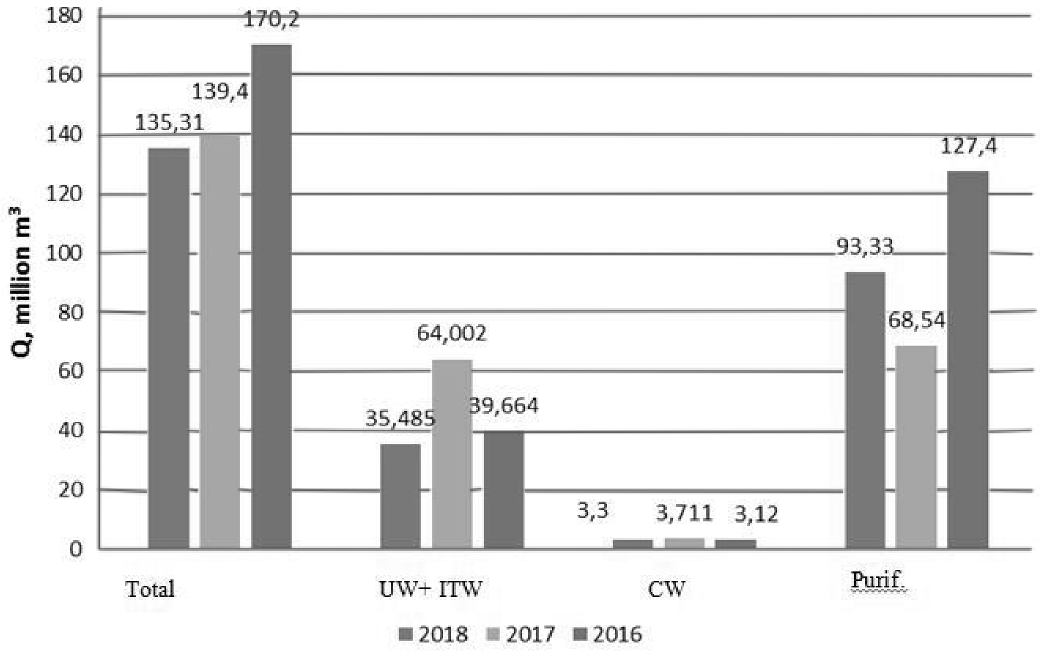

Fig. 2. Surface water discharge in 2016–2018 by categories:

Total – general discharge.

UW + ITW – polluted water discharges that: UW (untreated wastewater) – have not been treated and do not meet the quality requirements of wastewater, and ITW (incompletely treated wastewater) – have been purified at treatment plants, but have not achieved the qualitative parameters approved in the draft limit values.

CW – conditionally pure flush or heat exchange waters.

Purif. – waters that have been purified on treatment plants and meet the quality approved in the projects of maximum permissible discharges.

The total discharge to the Western Bug River basin in 2018 is 129.6 million m^3, of which 1.5 million m^3 is the discharge into the sump, storage, filtration trenches, and underground filtration fields. The main pollutants in the basin are utility companies, which discharge over 90 % of all wastewater, of which the discharge of LWCW "Lvivvodokanal" is over 90 %. Therefore, the biggest pollution in the Western Bug river basin on the territory of the Lviv region is undoubtedly coming from the Lvivvodokanal LLMP with the discharge of 116.9 million m^3 of sewage, of which 33.04 million m^3 is insufficiently treated. In 2018, as compared to 2017, the discharge of pollutants BOD5, COD, and suspended matter decreased by reducing the volume of discharges and improving the operation of the CBS-2 of LMWC "Lvivvodokanal". However, according to the results of the monitoring studies, compared to the previous years (2013–2017), the water quality in the control points of the basin is deteriorating. Therefore, it is necessary to take urgent measures to improve the ecological status of the Western Bug river basin.

3.1. Test Results

Surface water quality monitoring in the Lviv region was carried out in accordance with the "Regulation on the State Environmental Monitoring System", approved by the Cabinet of Ministers of Ukraine Decree No. 391 of 30.03.1998, as amended, under the CMU Resolution No. 528 dated May 16, 2001, and "Regulation on State Water Monitoring", approved by the Resolution of the Cabinet of Ministers of Ukraine No. 815 of 20.07.1996, as amended. The network of state monitoring of water and soil quality of the Lviv region in 2016–2018 included approved observation points (control points). Measurements of water quality indicators at the points of state monitoring were carried out quarterly by the laboratory of the Lviv Hydrogeological and Reclamation Expedition. Water samples in the Western Bug river basin in the Lviv region were collected in 6 control points. These are four control points on the Western Bug River, and on two tributaries – the Poltva River and the Rata River.

The dynamics of changes in concentrations of pollutants in control plants for 2016–2018 is presented in Fig. 3–10. The decisive impact on the pollution of the Western Bug River is caused by sewage of municipal enterprises and agribusinesses, as well as infiltrates of numerous landfills. The main contaminants of household discharges are: BOD, ammonium nitrogen, total iron, phosphates, suspended particles. In previous years, the same data were confirmed in the studies by Wozniuk et al [13], Hopchak et al. [15], Chmielowski et al [17]. After getting into the surface reservoirs, they cause rapid development of plants and increase the number of zooplankton. As a result, eutrophication occurs, the amount of oxygen and the water transparency reduce drastically. The fluctuation of the BOD values is caused by the inefficient operation of Lvivvodokanal treatment plants. Peaks of loads of ammonium nitrogen and phosphates occur in the winter-spring period and are caused by the use of mineral fertilizers in agricultural lands. The index of iron is increased in all control points due to the natural background.

At the control point of ***the Poltva River in the village of Kamyanopil*** in Pustomyty district (below treatment plants) low content of dissolved oxygen (0.78–2.78 mgO_2/dm^3 at MPC $\geq$ 4 mgO_2/dm^3) was detected, as well as the exceedance of the BOD5 limit values (5.17–19.68 times), COD (2.82–7.37 times), suspended solids (from 2,72 to 6,96 times), ammonium (6.1–50.9 times), nitrites up to 37.25 times, phosphates (1.49–7.76 times), iron (2.8–8.4 times) (see Fig. 3–6), and sulfates (up to 1.72 times).

At the control point of ***the Western Bug in Kamianka-Buzka*** the maximum level of ammonium was exceeded (from 5.42 to 11.72 times), BOD_5 (up to 1.86 times), phosphates (up to 3.82 times), iron (from 1.6 to 5.9 times) (see Fig. 7–10), nitrites (from 6.75 to 27.5 times), suspended solids (up to 2.64 times) and sulfates (up to 1.34 times). The quality of water in the control point is influenced by the wastewater of the LCM “Lvivvodokanal” through the Poltava River, as well as the wastewater of the Busko VUGK.

At the observation point of the Western Bug in Dobrotvir the maximum allowable levels were exceeded: BOD5 – up to 2.62 times, ammonium – up to 13.16 times, nitrites – from 4.25 to 19.75 times, phosphates – up to 4.53 times, iron – up to 3.3 times, suspended solids – up to 2.04 times, as well as a slight excess in sulfates and COD was detected. The comparatively low water quality at the observation point is caused by the stagnation of water in the Dobrotvir reservoir and the impact of runoff from the LCM “Lvivvodokanal” across the River Poltva. The quality of water in the facility is affected by the wastewater of PJSC “Zakhidenergo”, LCM “Kamenkavodokanal” and unauthorized sewage.

In the left tributary of the Western Bug, the Rata River (Velyki Mosty), water quality was of the best quality compared to the water in other basins. Exceedance of nitrite limits (up to 4.25 times), iron (up to 7.4 times) was detected, nitrogen (up to 2.12 times) and an insignificant excess of phosphates. The quality of water at the control point is affected by the wastewater of Zhovkva through the Svynia River and Rava-Ruska.

At the observation point of ***the Western Bug in Sokal***, the maximum allowable BOD5 was exceeded up to 1.55 times, ammonium – up to 3.38 times, nitrite – from 1.75 to 9.75 times, iron – from 1.3 to 3.7 times, and a slight increase in the concentrations of the suspended solids, sulfates, phosphates, COD was detected. The quality of water at the control point is affected by the wastewater of LCM “Chervonogradvodokanal”.

At the observation point of the ***Western Bug in the village of Stargorod***, the maximum allowable level of BOD_5 was exceeded up to 1.51 times, ammonium – up to 3.88 times, nitrite – from 1.25 to 10.25 times, iron – from 1.2 to 5.0 times, and a slight increase in the concentration of sulfates, phosphates, and suspended solids was detected. The quality of water at the control point is influenced by the wastewater of Sokal.

The water quality assessment was made according to the pollution factor (CPI 211.1.1.106-2003, Table 7) compared with the MPC for fisheries water bodies (under CMU Decree No. 552 of May 27, 1996). The Kharkiv Institute has developed a methodology for assessing the surface water quality, according to which the indicators are compared with the MPC. The environmental assessment of water quality is calculated in three blocks:

1) block of contamination with organic substances (K1) which includes BOD, COD, and dissolved oxygen;

2) block of contamination with biogenic substances (K2), including nitrates, nitrites, ammonium nitrogen, and phosphates;

3) block of indicators of the content of specific toxic substances (K3), which comprises one (total iron) up to eight components (total iron, copper, zinc, manganese, total chromium, phenols, petroleum products, synthetic surfactants). The results are calculated as an integral environmental indicator (KE). The assessment of the surface water quality in the structures of the Lviv region for 2018 is presented in Table 1.

Water quality at the Poltva River – Kamianopil village surveillance point belongs to class V of water quality (very bad) of category 7 (very dirty).

Water quality in the Western Bug – Kamianka-Buzka and Dobrotvir reservoir surveillance point belongs to class III (contaminated) of category 4.5 (slightly and moderately polluted).

Water quality in the control points of the Western Bug-Sokal and Stargorod city, as well as at the control point on the River Rata – Velyki Mosty belongs to class II (good) of categories 2 and 3 (clean and fairly clean).

According to the “Methodology of ecological assessment of surface water quality by respective categories”, the waters of the Western Bug River and other rivers of the basin can be classified as class III (satisfactory) and class II (good) and according to category 4 (satisfactory) and category 5 (medium) and respectively category 2 (very good) and category 3 (good), and in terms of their purity (contamination) – to class III (contaminated) and class II (clean) and accordingly to category 4 (slightly polluted) and category 5 (moderately soiled) and category 2 (clean) and category 3 (quite clean).

The conditions of water quality formation under the influence of anthropogenic factors fixed indices and ecological indicators of water bodies` limits of fluctuations were determined, which are important for solving the issues of water resources management, implementation of environmental protection, and measures of restoration.

A proposal for improving the scheme of existing monitoring points is being developed (see Table 2). It is proposed

– to relocate the control point on the Western Bug River in Stargorod (as there is a duplication with the monitoring point in the village of Litovezh, Volyn region, 7 km) to the town of Busk after discharge into the Poltva River;

– to relocate the control point on the Western Bug River to Dobrotvir after Dobrotvir reservoir (near Kamianka-Buzka) to the Nestanychi village. The Kiev Stream River (tributary of the Western Bug) contains discharges of the Vuzlivskyi spirit factory (Ukrspirt SE).

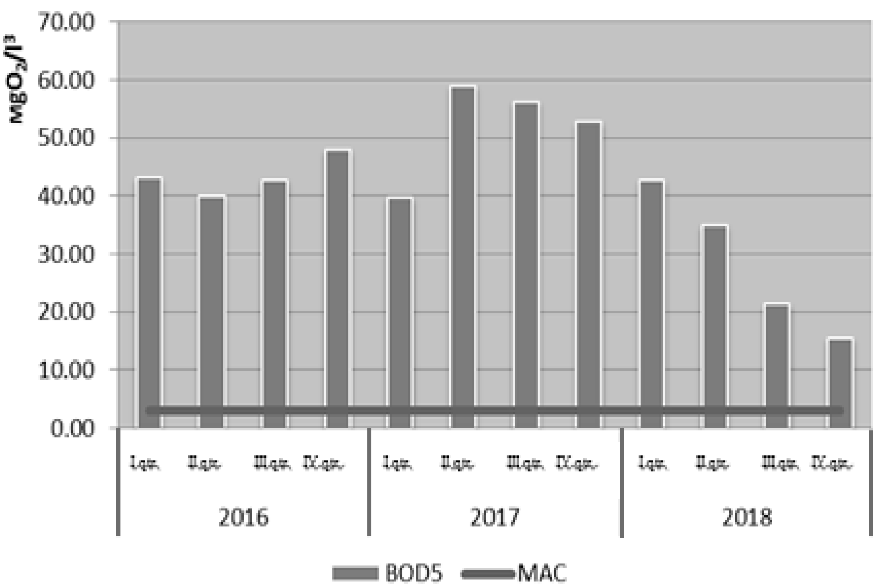

Fig. 3. Dynamics of changes in concentrations of BOD_5 at the observation point of the Poltva River – Kamianopil

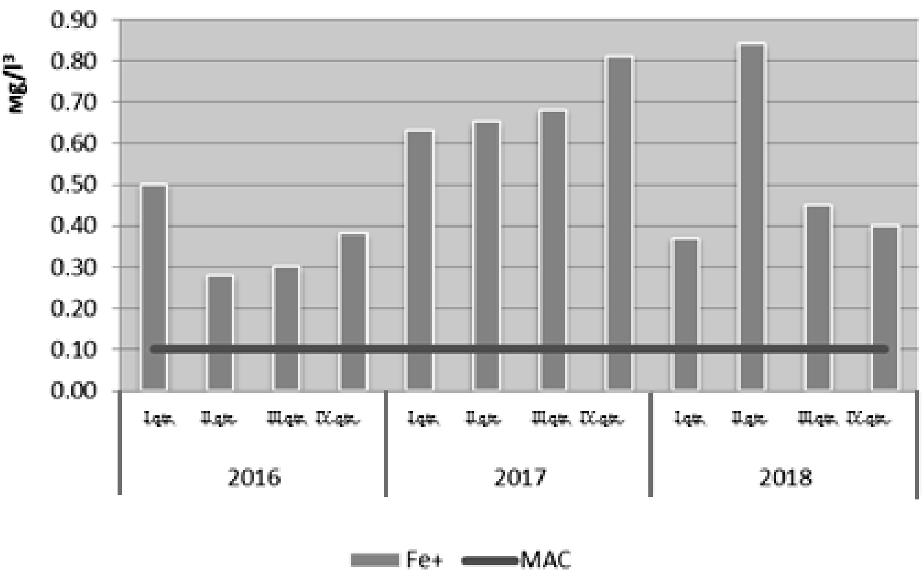

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Fig. 4. Dynamics of changes in concentrations of Fe^{+} at the observation point of the Poltva River – Kamianopil

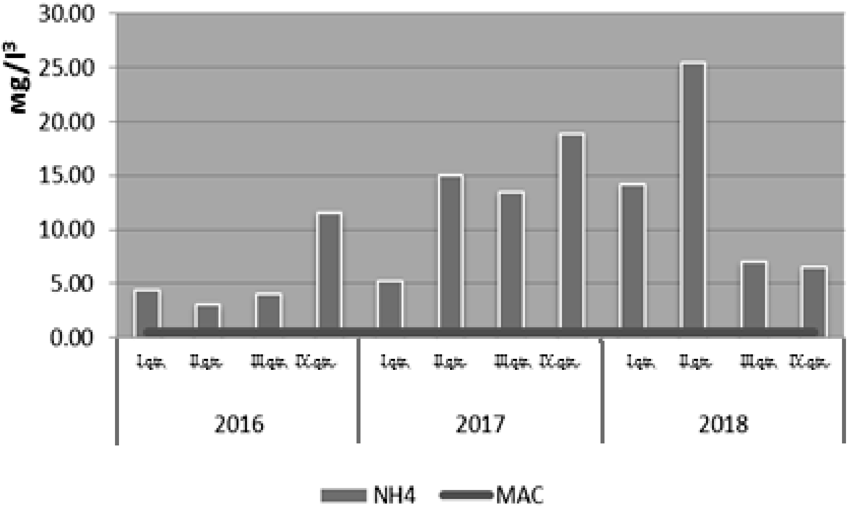

Fig. 5. Dynamics of changes in concentrations of NH_4
at the observation point of the Poltva River – Kamianopil

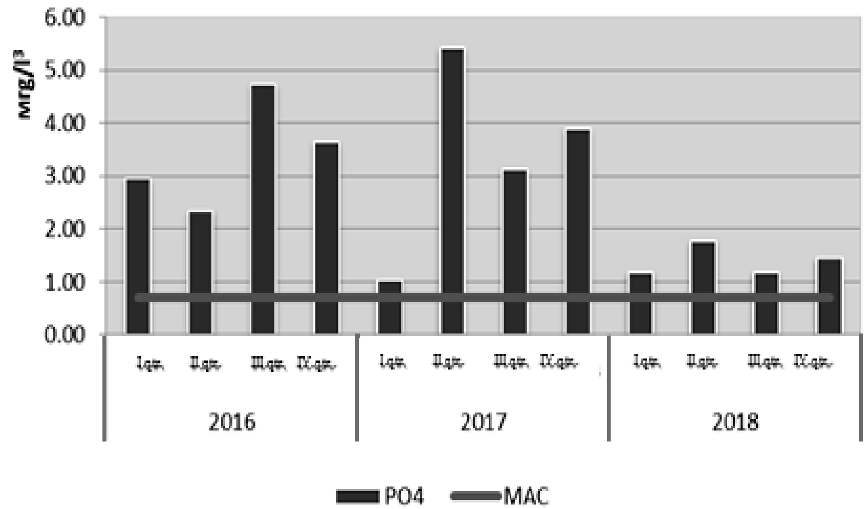

Fig. 6. Dynamics of changes in concentrations of PO_4
at the observation point of the Poltva River – Kamianopil

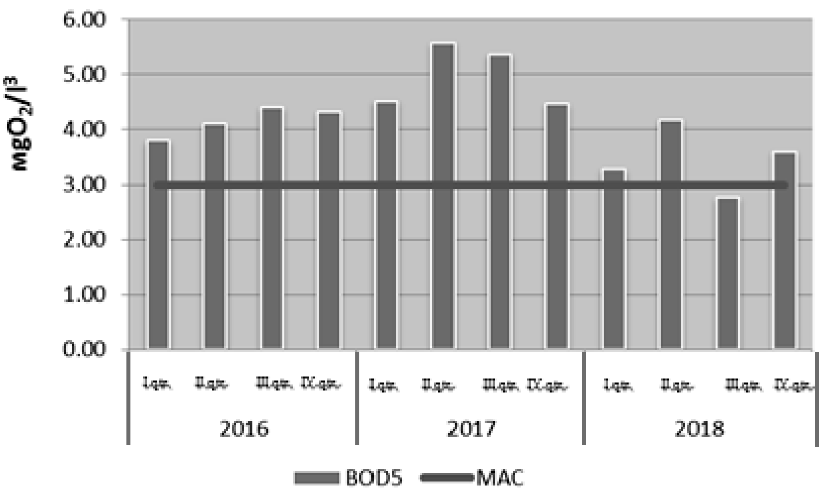

Fig. 7. Dynamics of changes in concentrations of BOD_5
at the observation point of the Poltva River – Kamianka-Buzka

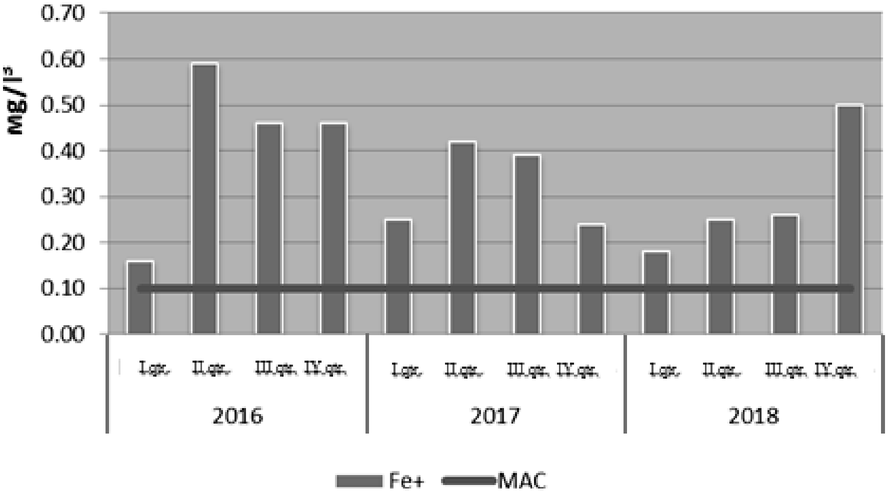

Fig. 8. Dynamics of changes in concentrations of Fe^{+}
at the observation point of the Poltva River – Kamianka-Buzka

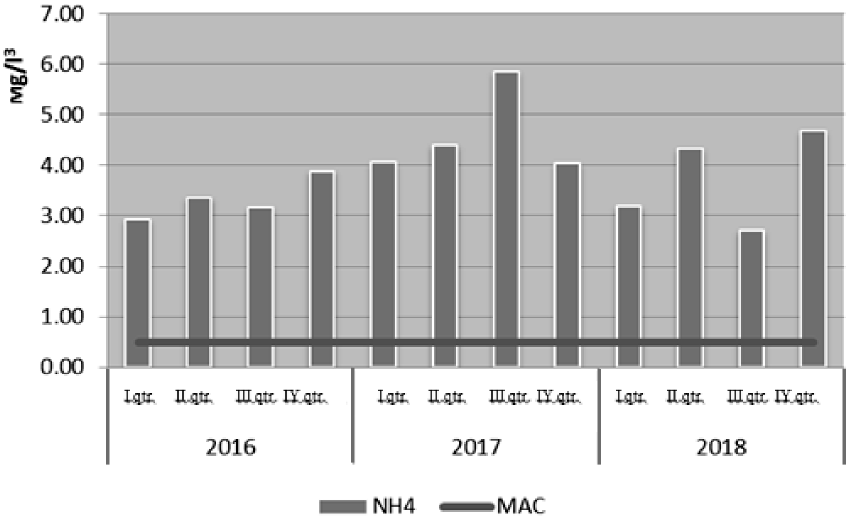

Fig. 9. Dynamics of changes in concentrations of NH_4
at the observation of the Poltva River – Kamianka-Buzka

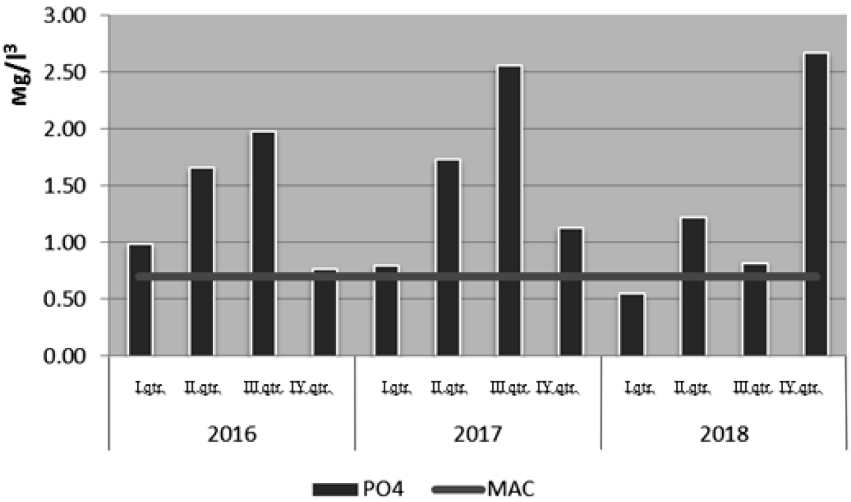

Fig. 10. Dynamics of changes in concentrations of PO_4
at the observation point of the Poltva River – Kamianka-Buzka

Table 1

Classes and categories for comparing surface water quality

No.	Name of the observation point	Quarter	block K1	Water quality class	block K2	Water quality class	block K3	Water quality class	block KE	Water quality class
1.	the Poltva – Kamianopil	I	6.2	IV	14.8	V	3.7	III	9.33	V
		II	5.6	IV	30.2	V	8.4	У	16.05	V
		III	3.7	III	10.8	V	4.5	III	6.7	V
		IV	3.2	III	8.49	V	4.0	III	5.51	IV
2.	the Western Bug – Kamianka-Buzka	I	1.61	II	7.2	V	1.8	II	3.51	III
		II	1.39	I	7.1	V	2.5	II	3.66	III
		III	1.0	I	5.0	III	2.6	II	2.86	II
		IV	1.9	II	6.6	У	5.0	III	4.5	III
3.	the Western Bug – Dobrotvir resorvoir	I	1.36	I	4.03	III	1.7	II	2.36	II
		II	1.58	II	4.87	III	2.5	II	2.98	II
		III	1.59	II	4.57	III	3.3	II	3.15	III
		IV	2.12	II	6.73	V	3.0	II	3.95	III
4.	the Western Bug – Sokal	I	1.0	I	1.75	II	1.5	I	1.41	I
		II	1.09	I	3.16	II	1.3	I	1.85	II
		III	1.47	I	3.6	III	3.2	II	2.76	II
		IV	1.52	II	5.67	IV	2.0	II	3.04	II
5.	the Western Bug – Starhorod	I	1.0	I	1.5	II	2.8	II	1.76	II
		II	1.09	I	3.26	II	1.4	I	1.92	II
		III	1.39	I	4.81	III	2.1	II	2.77	II
		IV	1.51	II	6.33	IV	2.1	II	3.31	II
6.	the Rata – Velyki Mosty uts.	I	1.0	I	1.0	I	3.1	II	1.7	II
		II	1.0	I	2.44	II	4.2	III	2.54	II
		III	1.0	I	3.1	II	2.2	II	2.1	II
		IV	1.0	I	3.0	II	2.8	II	2.26	II

Table 2

Current and perspective surveillance points at the surface waters in the Western Bug River basin in Lviv region

No.	Current monitoring points			Perspective monitoring points		
	Name of the river	Item observation	Distance from the mouth, км	Name of the river	Item observation	Distance from the mouth, км
1.	theWestern Bug	Kamianka-Buzka	704	the Western Bug	Busk	745
2.	the Western Bug	Dobrotvirsky reservoir, lower beef	689	the Western Bug	Kamianka-Buzka	704
3.	the Western Bug	Stargorod	669	the Western Bug	Sokal	669
4.	the Western Bug	Sokal	637	the Poltva, left tributary theWestern Bug	Kamianopil village of Pustomyty region	30
5.	the Poltva, left tributary the Western Bug	Kamianopil	30	the Rata, left tributary the Western Bug	Mezhyrichchia uts. of Sokal region	5
6.	the Pata, left tributary the Western Bug	Velyki Mosty uts.	22	the Kyiv Stream, right tributary the Western Bug	Nestanychi village of Radekhiv region	13

The author [18] considers the main shortcomings of the existing surface water monitoring system, in particular, the inability of prompt registration of emergency pollution of reservoirs or watercourses because of the lack of systems for continuous control of water quality. Creating a web-based integrated system of real-time surface water quality monitoring using mathematical simulation models, mapping, GIS technologies, satellite remote sensing based on a stationary monitoring network is the main goal of ensuring the ecological safety of the aquatic ecosystem [19, 20].

In our opinion, one of the most effective measures to improve performance is to equip control facilities with automated remote hydrological posts and complexes with autonomously operating equipment (water analysis continuously, or with a specified periodicity of 2–6 parameters) and the use of mobile laboratories (with sampling equipment and field water analysis of 5–15 indicators).

Conclusions

The analysis of technogenic pollution of the Western Bug River according to the results of observations in the control areas has been carried out. Significant levels of pollution have been found, which led to unsatisfactory ecological condition of the river. The main pollutants have been identified, among which the largest are Lvivvodokanal, water utilities of Chervonograd-Sokal industrial district, Dobrotvorska TPP. To achieve more accurate results, it is proposed to move the control points to the locations where the results of the evaluation of the selected samples would be complementary to the information on the general status of the river. It is also proposed to introduce continuous monitoring of water status in the Western Bug aimed at carrying out corrective measures in case of need.

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