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Assessment of the Impact of Natural and Anthropogenic Factors on the State of Water Objects in Urbanized and Non-Urbanized Areas in Lozova District (Ukraine)

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ABSTRACT

The paper analyzes the impact of urban areas on the state of water objects which are under the influence of these areas. Furthermore, the temporal regularities of the oscillations in electrical conductivity in a number of water objects in Lozova Town and Lozova District (Ukraine) were obtained using the method of conductometry. It was discovered that there was no significant anthropogenic impact on the studied water objects in Lozova Town and Lozova District of Kharkiv Region. The fluctuations in conductivity are mainly related to surface runoff. It was shown that the water in Lozova Town and Lozova District is characterized by electrical conductivity values in the range from 2000 μS to 3000 μS.

Keywords: water objects, electrical conductivity, anthropogenic impact, pollution.

INTRODUCTION

The anthropogenic activity has recently been affecting the environment to an increasing extent. During their life, people have a multifaceted impact on natural objects, mostly negative. It may be the impact of industry and transport [Pospelov et al., 2019; Sładkowski, 2020], agriculture [Parris, 2011; Zia et al., 2013], housing and communal activities [Koop et al., 2017], tourism etc. However, the impact itself can be both direct and indirect; it has both an instant effect and a delayed one. [Omarova et al., 2019; Loboichenko et al, 2020b]. Various emergencies are also an additional factor affecting the environment [Tiutiunyk et al., 2019; Abramov et al., 2018], including those related to water pollution [Loboichenko et al., 2018].

Water resources, as one of the essential elements of the life of living beings, are subject to special attention. The growing population on the planet and deteriorating water quality make this issue even more urgent [Khatri et al., 2015]. Cities, which are often industrial centers, concentrate a significant number of people who, in turn, have an additional negative impact on the environment [Ramachandra et al., 2015], and in particular on water objects [Glińska-Lewczuk et al., 2016].

The influence of chemical and biological pollutants on water quality, in particular, drinking water attracts close attention of researchers [Rui et al., 2018; Bezsonnyi et al., 2017], and to determine its state various parameters and data processing methods are used [Baluch et al, 2019; Attua et al, 2014]. The water quality indices are proposed to assess the water quality in cities [Shen S., 2019], the state of urban rivers, lakes and small reservoirs is considered separately. [EEA Report No 26/2016, 2016], [Jha et al., 2020] Moreover, the impact of various elements of urbanized territories on the water quality was studied [McGrane S., 2016]. However, if the effect of individual anthropogenic factors on the state of waters in large cities is quite obvious [Tu J. 2013; Zhao et al., 2017] and they can be differentiated for different water objects [Loboichenko et al, 2020a] with further suggestions about water management [Luo et al., 2019], this issue is not always straightforward for small towns.

There is an insufficient supply of drinking water in small towns [Marks et al., 2020], and the need to develop the models of water resources management for such towns [Tutusaus et al., 2018]. Obviously, the individual characteristics of small settlements will affect the state of water objects, located there, more significantly. For example, the work of an individual enterprise can be considered as a permanent factor of influence, any emergency can be regarded as a temporary one [Dubinin et al., 2018]. Identification of possible natural factors affecting the water quality in such settlements also significantly influences the management of water resources in these areas. Therefore, an important point is the timely identification of the contributions of natural and anthropogenic components that determine the state of water objects in towns. In the future, this will allow making effective decisions to ensure rational water use in this region. As was previously stated, the purpose of this work was to study the state of a number of water objects in the urbanized, for example, Lozova Town, and non-urbanized territories in Lozova District (Ukraine).

MATERIALS AND METHODS

The research of the water objects of Lozova Town and Lozova District of the Kharkiv Region (Ukraine) was carried out by using the method of direct conductometry. The water samples were taken out of a number of water objects, including the sources of influence on their state. The water was sampled out of the Britay River, the pond 1 Domakha, the pond 2 Domakha, the pond in Druzhba Park and from the well in Lozova Town. As reference additional samples were taken out of the Lozova River (pond) in Katerynivka village and the well in Lozova Town (Fig. 1) as well as the tap water in Lozova Town. The water samples were taken during December 2017 – May 2018 according to [ISO 5667-4:2016, ISO 5667-6:2014, DSanPiN 2.2.4-171-10].

The electrical conductivity of the water samples taken out of the studied water objects was measured. Standard approaches to processing the statistical data were used in order to obtain the result [Dvorkin, 2001]. The number of measurements for a single sample n = 5, the relative standard deviation S_r does not exceed 2%. Electrical conductivity was measured using a EZODO 2170 conductometer. It can be used any other model with manual or automatic temperature control [Andronov et al., 2016]. In February and March, samples were not taken due to the complete water freeze.

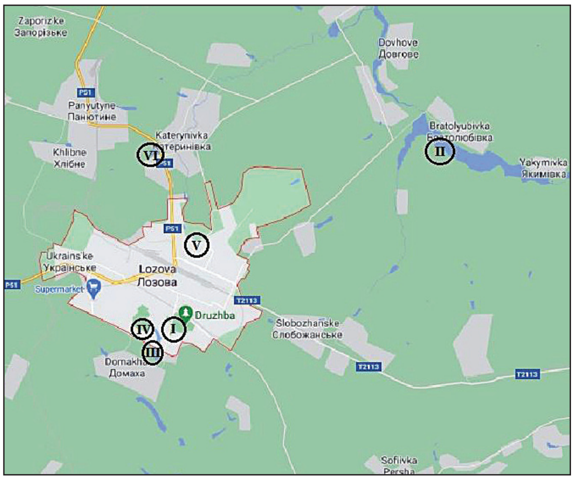

Fig. 1. The studied water objects Lozova Town and Lozova District of Kharkiv Region. I – pond of Druzhba Park, II – Britay River, III – pond 2 Domakha, IV – pond 1 Domakha, V – well in the Lozova Town, VI – Lozova River (Katerynivka)

RESULTS AND DISCUSSION

The sampling was performed at several locations to obtain more detailed data and take into account the possible anthropogenic and natural impacts on a number of researched sites. In order to analyze the ecological state of the water pond in Druzhba Park located in Lozova Town, the sample was taken at point 1 (Fig. 2).

According to the obtained data, the highest value of electrical conductivity was observed in January (Fig. 3) about 5000 μS which is associated with significant freeze of the pond, whereas in April there is a tenfold decrease in electrical conductivity due to the dilution of the water in the pond with pure melting water. In May, the electrical conductivity of water stabilizes and reaches the characteristic value of the pond (3000 μS). The Britay River is located in Lozova District of Kharkiv Region. The ecological condition of the water was analyzed; the samples were taken near the road (point 2) and after the beach (point 3) (Fig. 4).

Fig. 2. Place of water sampling in the pond of Druzhba Park, Lozova (point 1)

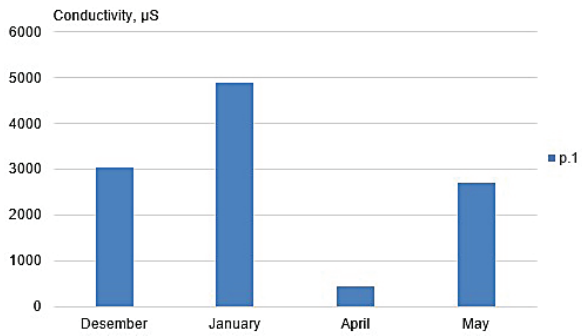

Fig. 3. Dynamics of fluctuations in the values of electrical conductivity of the pond in the "Druzhba" park, point 1 – the pond in the "Druzhba" park

The results of the research are shown in Figure 5. The obtained data show a seasonal fluctuation of water conductivity with the impact of the road as a source of pollution in January. The decrease in electrical conductivity in April is due to the melting snow and the dilution of water in the Britay River. In May, the electrical conductivity increases and stabilizes, and the impact of the road appears again.

In order to study the ecological condition of the pond 2 Domakha, the water samples were taken at points 4–7 (Fig. 6), the influence of the private sector (point 6, Fig. 6) of the road was studied (point 7, Fig. 6). Within points 4–5 (Fig. 6) there are no sources of influence. The results are shown in Figure 7. According to the obtained data, the water condition of the pond is slightly affected by its location near the road and the presence of the

Fig. 4. Places of water sampling in the Britay River. Point 2 – near the road, point 3 – after the beach

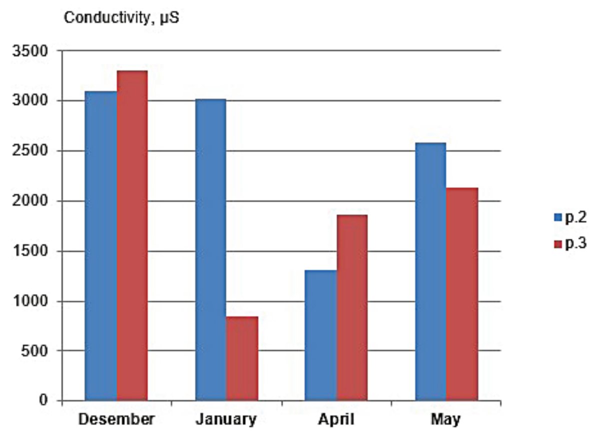

Fig. 5. Dynamics of oscillations of values of electrical conductivity of water of the Britay River. Point 2 – water sample near the road, point 3 – water sample after the beach

Fig. 6. Sampling points of pond 2 Domakha, point 4 – middle left (pond 2 in the Domakha village, middle pond), point 5 – left end (pond 2 in the village Domakha, left pond, end), point 6 – right end (pond 2 in the Domakha village, right pond, at the end), point 7 – near the road (pond 2 in the Domakha village, near the road).

Fig. 8. Places of water sampling in pond 1 Domakha, point 8 – middle on the left (pond 1 in the Domakha village, middle pond on the left), point 9 – near the road (pond 1 in the Domakha village, near the road), point 10 – middle on the right (pond 1 in the Domakha village, the middle of the pond on the right).

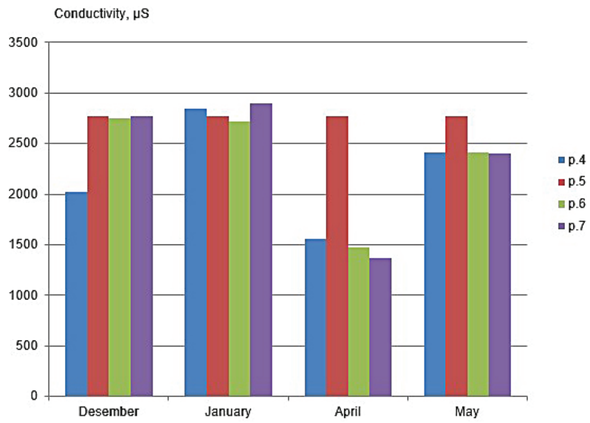

Fig. 7. Dynamics of oscillations of values of electrical conductivity of water of pond 2 Domakha. Point 4 – middle left (pond 2 in the Domakha village, middle pond), point 5 – left end (pond 2 in the village Domakha, left pond, end), point 6 – right end (pond 2 in the Domakha village, right pond, at the end), point 7 – near the road (pond 2 in the Domakha village, near the road).

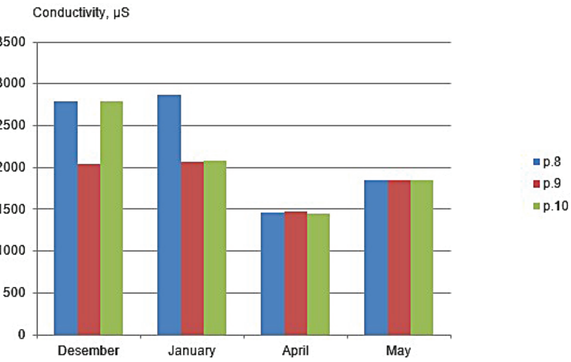

Fig. 9. Dynamics of oscillations of values of electrical conductivity of water of a pond 1 Domakha. Point 8 – pond 1 Domakha middle left (pond 1 in the Domakha village, middle pond left), point 9 (pond 1 in the Domakha village, near the road), point 10 – middle right (pond 1 in the Domakha village, middle pond right).

private sector. In April, there is the dilution of the pond with melting water, almost in half. In this month, the value of electrical conductivity (point 5) is probably falling down. In May, the values of electrical conductivity of the pond increase.

In order to study the state of the water in the pond 1 Domakha (Fig. 8), the samples were taken from both sides of the pond – point 8, point 10 and near the road – point 9. Near point 8, at a distance of 5–7 m there is a country road, at a distance of 30 m from point 10, the housing and communal sector begins.

The obtained values of electrical conductivity are given in Figure 9. The obtained data show the water at point 9 is affected the least. This is probably due to the depth of the pond at point 9 (much deeper) (4 m) compared to point 8 and point 10 (0.5 m). The impact of the country road is manifested in December and January, whereas the influence of the communal sector is demonstrated only in December. The dilution of the pond 1 Domakha with melting water is observed. In May, the electrical conductivity begins to increase. The water in the pond 2 Domakha is characterized by higher electrical conductivity values (about 2500 μS) compared to the water in the pond 1 Domakha during the period being studied. The water sampled out of the well in Lozova Town was taken to analyze the underground water (Fig. 10). To the groundwater, there is a stability of electrical conductivity in the period being studied (Fig. 11).

In order to study the water in the Lozova River, Katerynivka village, the samples were taken near the highway at point 12 (Fig. 12), at point 13 at the end of the river, and at point 14 the middle of the river (Fig. 12). In December, it was not possible to take the samples at point 12, point 14. According to the obtained data (Fig. 13), the impact of the road on the state of water in the Lozova River in Katerynivka village is absent. In April, the Lozova River is diluted with melting water and the electrical conductivity decreases by 25% at all points. In May, the electrical conductivity of all water samples in the Lozova River increases slightly.

The average values of water conductivity of the studied objects in December, January, April, and May are given in Figure 14. It shows a

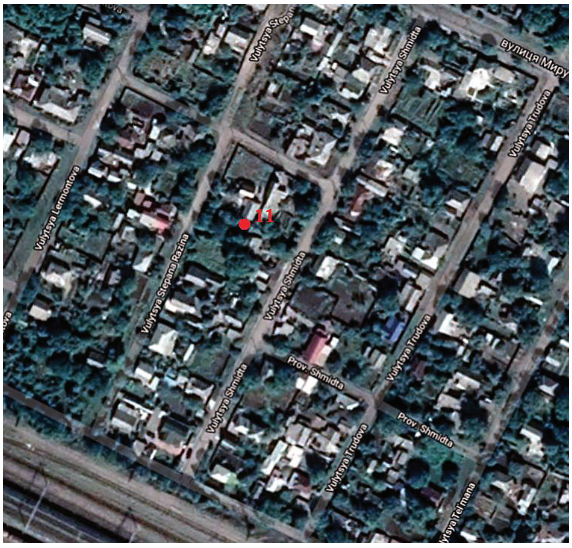

Fig. 10. Place of water sampling from a well in Lozova (point 11)

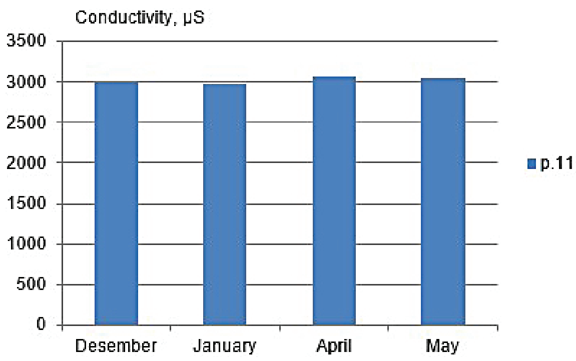

Fig. 11. Dynamics of fluctuations in the values of electrical conductivity of water in the well of Lozova. Point 11 – a well in Lozova Town

Fig. 12. Place of water sampling from the Lozova River, Katerynivka (pond in the Katerynivka village). Point 12 – near the road (Lozova River, near the road, in the Katerynivka village), point 13 – at the end (Lozova River, at the end, in the Katerynivka village), point 14 – the middle (Lozova River, in the Katerynivka village).

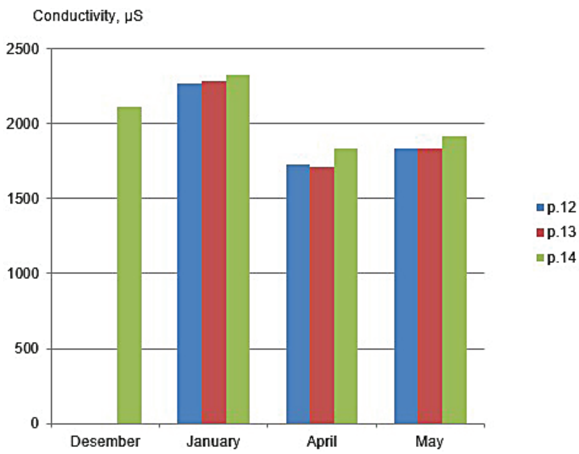

Fig. 13. Dynamics of fluctuations in the values of electrical conductivity of the Lozova River, Katerynivka village. Point 12 – the Lozova River, near the road, in the Katerynivka village, point 13 – the Lozova River, in the end, in the Katerynivka village, point 14 – the middle the Lozova River, in the Katerynivka village.

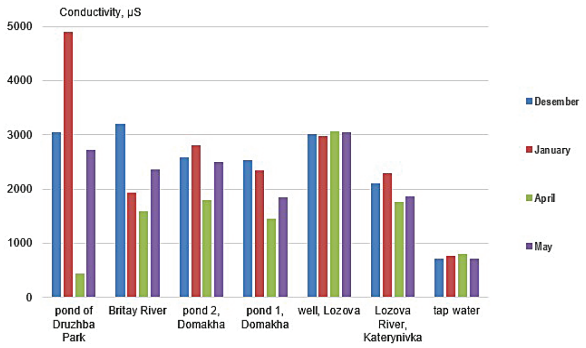

Fig. 14. Dynamics of fluctuations in the values of electrical conductivity of water bodies in Lozova Town and Lozova Distric

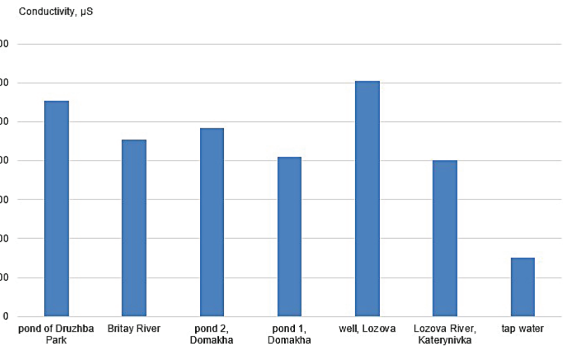

Fig. 15. The average values of electrical conductivity of water objects Lozova Town and Lozova District and tap water

decrease in electrical conductivity in April due to the dilution of their water with pure melting water except for the groundwater in Lozova Town. The general average values of electrical conductivity of water of the studied objects are given in Figure 15.

The significant anthropogenic impact on the studied water objects in Lozova Town and Lozova District of Kharkiv Region was not detected; the fluctuations of electrical conductivity are mainly related to the natural factor surface runoff. The obtained data (Fig. 15) show that the water objects of Lozova District are characterized by the electrical conductivity values in the range from 2000 µS to 3000 µS, the fluctuations in electrical conductivity are probably related to the soil structure of Lozova District. The water in the pond of the Lozova River in Katerynivka village has the lowest value of electrical conductivity, similarly to the water pond 1 located in Domakha village.

CONCLUSIONS

The ecological state of the water objects in Lozova Town and Lozova District of Kharkiv Region was studied according to the parameter of electrical conductivity. The influence of some natural and anthropogenic factors on the water quality of the studied objects was analyzed. The temporary regularities of fluctuations of electrical conductivity in a number of water objects of urbanized (Lozova Town) and non-urbanized territories in Lozova District in Ukraine were obtained.

It was shown that there is no significant anthropogenic impact on the studied water objects in Lozova Town and Lozova District of Kharkiv Region. The fluctuations of conductivity are mainly related to surface runoff.

The water in Lozova Town and Lozova District is characterized by the values of electrical conductivity in the range from 2000 µS to 3000 µS which is probably due to the peculiarities of the soil structure in Lozova District. The highest values of electrical conductivity are characteristic in the pond in Druzhba Park and in the groundwater taken out of the well in Lozova Town.

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