ІІІ. ПРИРОДНИЧА ГЕОГРАФІЯ: ТЕОРІЯ ТА ПРАКТИКА

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Лета Василь Васильович,
кандидат географічних наук, доцент

Чиняк Віталія Віталіївна,
доктор філософії з економічних наук

Лужанська Тетяна Юріївна,
кандидат географічних наук, доцент

Нич Тетяна Василівна,
кандидат географічних наук, доцент

Сировець Сергій Юрійович,
кандидат географічних наук, доцент

Мукачівський державний університет, м. Мукачево, Україна, e-mail: v.leta@mail.msu.edu.ua, https://www.researchgate.net/profile/Vasil-Leta, https://orcid.org/0000-0001-9111-7121
ДВНЗ «Ужгородський національний університет», м. Ужгород, Україна, https://www.researchgate.net/profile/Vitalia_Chyniak https://orcid.org/0000-0002-3471-5632
Мукачівський державний університет, м. Мукачево, Україна, https://orcid.org/0000-0003-0709-8293

Київський національний університет імені Тараса Шевченка, м. Київ, Україна, -mail: t.nych@ukr.net, https://orcid.org/0000-0003-3842-2009
Київський національний університет імені Тараса Шевченка, м. Київ, Україна, https://orcid.org/0000-0002-6775-3483

ВПЛИВ ОБ'ЄКТІВ РЕКРЕАЦІЇ ТА ТУРИЗМУ НА ЯКІСТЬ ПОВЕРХНЕВИХ ВОД У БАСЕЙНІ РІЧКИ ЧОРНА ТИСА

*Мета. О*бгрунтувати та проаналізувати вплив об'єктів туристично-рекреаційної сфери на формування гідроекологічного стану поверхневих вод річки Чорна Тиса в межах Рахівського району Закарпатської області.

Методика. Методологічною основою цього дослідження є системний підхід до вивчення та аналізу антропогенних факторів впливу на гідроекологічний стан річки Чорна Тиса з метою оптимізації природокористування та покращення водоохоронної діяльності. У дослідженні використано загальнонаукові методи (ретроспективний, системно-структурний) та спеціальні – математико-статистичний аналіз, напівстаціонарні спостереження, картографічні дослідження та ін.

Наукова новизна. Досліджено закономірності формування хімічного складу та гідрохімічного режиму поверхневих вод басейну річки Чорна Тиса під впливом об'єктів туризму та рекреації.

Результати. Сьогоднішні темпи антропізації навколишнього природного середовища, що в свою чергу призводить і до трансформації річково-басейнових систем, зумовлюють необхідність усебічного вивчення екологічного стану поверхневих вод. Від так, обираючи об'єкт дослідження ми враховували природні умови та різноманітні антропогенні чинники впливу, серед яких і об'єкти індустрії гостинності. При цьому ми намагались прослідковувати вплив на якість вод вздовж течії річки Чорна Тиса, обравши для цього два пункти моніторингу: вище села Чорна Тиса (референційні умови) та в селі Кваси. Це дозволило виявити та оцінити динаміку гідрохімічних показників якості вод, зокрема за вмістом розчиненого кисню (O_2), біохімічне споживання кисню п'ятидобове ($БСК_5$), хімічне споживання кисню (ХСК), а також мінеральних сполук азоту: ($N\text{-}NH_4^+$), ($N\text{-}NO_2^-$), ($N\text{-}NO_3^-$).

Природні умови території басейну річки Чорна Тиса вплинули на її гідрологічний режим та сформували гірський тип. Поряд з цим різноманіття природоресурсного потенціалу, а також історико-архітектурна спадщина формують розгалужену мережу об'єктів індустрії гостинності в межах досліджуваної території.

Вивчення об'єктів індустрії гостинності як потенційних джерел впливу на якість поверхневих вод за допомогою вибраної групи хімічних показників дозволило виявити незначні сезонні коливання зокрема за вмістом розчиненого кисню, ХСК та мінералізації вод.

Практична значущість. Матеріали дослідження можуть бути використані при формуванні заходів зменшення та попередження наслідків впливу різних видів антропогенної діяльності на стан водної геосистеми в басейні річки Чорна Тиса.

Ключові слова: антропогенний вплив, якість поверхневих вод, індустрія гостинності, басейн річки Чорна Тиса.

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Leta Vasyl,
Candidate of Geographical Sciences, Associate Professor

Chyniak Vitalia,
Doctor of Philosophy in Economic Sciences

Luzhanska Tetiana,
Candidate of Geographical Sciences, Associate Professor

Nych Tetiana,
Candidate of Geographical Sciences, Associate Professor

Syrovets Serhii,
Candidate of Geographical Sciences, Associate Professor

Mukachevo State University, Mukachevo, Ukraine, e-mail: v.leta@mail.msu.edu.ua, https://www.researchgate.net/profile/Vasil-Leta, https://orcid.org/0000-0001-9111-7121
Uzhhorod National University, Uzhhorod, Ukraine https://www.researchgate.net/profile/Vitalia_Chyniak https://orcid.org/0000-0002-3471-5632
Mukachevo State University, Mukachevo, Ukraine https://orcid.org/0000-0003-0709-8293

Taras Shevchenko National University of Kyiv Ukraine, Kyiv, Ukraine, e-mail: t.nych@ukr.net, https://orcid.org/0000-0003-3842-2009

Taras Shevchenko National University of Kyiv, Kyiv, Ukraine, https://orcid.org/0000-0002-6775-3483

THE INFLUENCE OF RECREATION AND TOURISM FACILITIES ON THE QUALITY OF SURFACE WATER WITHIN THE BASIN OF THE BLACK TISZA RIVER

Objective. To substantiate and analyze the impact of tourist and recreational facilities on the formation of the hydroecological state of the surface waters of the Black Tisza River within the Rakhiv district of the Transcarpathian region.

Methods. The methodological basis of this study is a systematic approach to the study and analysis of anthropogenic factors influencing the hydroecological state of the Black Tisza River in order to optimize nature management and improve water protection activities. The study used general scientific methods (retrospective, system-structural) and special methods - mathematical and statistical analysis, semi-stationary observations,

cartographic studies, etc.

Scientific novelty. The regularities of formation of the chemical composition and hydrochemical regime of surface waters of the Black Tisza River basin under the influence of tourism and recreation facilities were investigated.

Results. Today's pace of anthropization of the natural environment, which in turn leads to the transformation of river basin systems, determine the need a of comprehensive study of the ecological state of surface waters. Therefore, when choosing the object of research, we took into account natural conditions and various anthropogenic factors of influence, including objects of the hospitality industry. At the same time, we tried to monitor the impact on water quality along the Black Tisza river, choosing two monitoring points for this purpose: above the Black Tisza village (reference conditions) and in the village of Kvasy. This made it possible to identify and evaluate the dynamics of hydrochemical indicators of water quality, in particular by the content of dissolved oxygen (O_2), five days biochemical oxygen consumption (BOD_5), chemical oxygen consumption (COD), as well as mineral nitrogen compounds: ($N\text{-}NH_4^+$), ($N\text{-}NO_2^-$), ($N\text{-}NO_3$-).

The study of the facilities of the hospitality industry as potential sources of influence on the quality of surface water using a selected group of chemical indicators has revealed minor seasonal fluctuations, in particular, in the content of dissolved oxygen, COD and water mineralization.

Practical significance. The research materials can be used in the development of measures to reduce and prevent the effects of various types of anthropogenic activities on the state of the aquatic geosystem in the Black Tisza River basin.

Keywords: anthropogenic impact, surface water quality, hospitality industry, Black Tisza river basin.

Introduction. Human economic activity within the basin systems of small rivers is an important factor influencing the hydrochemical regime of waters, in particular, the mineralization and runoff of organic and biogenic substances. The increase in anthropogenic load on surface water bodies can lead to changes in the river system with its subsequent transformation from natural to natural-economic, which generally has a negative impact on the ecological state of the basin geosystem. Considering this, there is a need to identify structural and functional changes, seasonal fluctuations of hydrochemical indicators, determine the dynamics of hydro-ecological conditions and their forecast in order to develop ways to optimize the water management complex and solve the specific problems of water quality in rivers. One of the main anthropogenic factors influencing surface water quality is the hospitality industry (Leta et. al., 2019).

In this context, the Transcarpathian region, where enterprises are specializing in providing a wide range of recreational, medical, and entertainment services, becomes a very interesting object of research. The mountainous part of the Transcarpathian region, in particular the sources of the Tisza River, is an interesting territory for guests of the region, due to a convenient geographical location, the proximity of the border with Romania (a member state of the EU), aesthetic appeal and the availability of infrastructure, including hotel enterprises, certain aspects the functioning of which is analyzed in the study (Slava & Chyniak, 2021).

Materials and research methods. The data of the Transcarpathian Regional Center for Hydrometeorology hydrological monitoring and hydrochemical monitoring of the waters of the Black Tisza River, carried out by the Tisza Water Basin Administration for the period 2020-2022, serve as research materials. The basis is the results of monitoring at points above the village of Black Tisza and in the village of Kvasy, which allows us to separately analyze the quality of water in two bodies of surface water, for one of which reference conditions have been established. The preliminary analysis and assessment of water quality was made on the basis of field research during 2015-2018 and the results of laboratory analyzes of water samples of the Black Tisza River selected by us in the villages of Bilyn, Kvasy, Black Tisza and the village of Yasinya of Rakhiv district in the period from autumn 2016 to spring 2018 p.

Results. Hydrological characteristics of the Black Tisza River.

The basin of the Black Tisza River is located within the southwestern part of the Ukrainian Carpathians. The area of the basin is 567 km^2, about 30% of the area of Rakhiv district. The outflow of the Black Tisza is at an altitude of 1242 m above sea level (Mount Bratkivska), and this causes the steep drop of the river bed. The river valley is V-shaped, and its width varies from 50 to 300 m downstream, the floodplain is narrow, and there are no towns at all. The riverbed has a width of up to 10 m, the current speed is from 1-1.5 m/s during the summer-autumn border to 4-4.5 m/s - during the flood. The average depth of the river is up to 1 m, and the height of the banks is 10 m, the slope is 19 m/km. When entering the Yasinyan basin, the Black Tisza valley becomes trapezoidal and widens, the slope of the river decreases, and the speed of the current slows down a bit.

Characteristics of the hospitality industry. The development and functioning of the hospitality industry in the Rakhiv district is conditioned by the significant natural resource potential of the industry, which is unevenly distributed within individual subbasins of the Tisza River. Thus, within the Black Tisza

basin, the presence of mineral water outlets ("burkut") and tourist infrastructure in the villages of Bilyn, Kvasy and the village of Yasinya causes a decrease in the share of recreational land upstream towards the Chornohora mountain massif. An exception is the basin of Lazeshchyna - the left tributary of the Black Tisza, within which the anthropogenic load is increasing due to the Kozmeschyk tourist shelter and the presence of popular hiking routes to the peaks of Petros and Hoverla.

The sphere of recreation and tourism within the basin of the Black Tisza River is represented by a great variety of natural and historical and architectural resources. Among the main attractions we can highlight: Chornohirskyi and Svydovetsky massifs of the Carpathian Mountains, mountain lakes Dogyaska, Apshinetske, Vorozheske and others, Trufanets waterfall (height 36 m), rock ledges of Gendarma near Blyznytsia mountain, beech forests, Church of the Ascension of the Lord (Strukivska church) in the village of Yasinya and a number of other objects.

About 150 recreational and tourist facilities operate within the Rakhiv district, which include hotels, hostels, recreation centers, sanatoriums, estates and private residences, of which almost 130 are located in the Black Tisza basin. Leaders in this field are the Carpathian Biosphere Reserve, Dragobrat LLC, Hirska Tisza sanatorium, etc.

Considering the load of the recreation industry on the Tisa river basin system within the Rakhiv district, we will also consider the area of land allocated for recreational activities in the context of administrative units (village, town and city councils). In terms of land use, recreational land in Rakhiv district occupies a small area, but we can observe a differentiation in the share of such land due to the significant natural resource potential of the industry, unevenly distributed within the basin systems of the Black Tisza, White Tisza, Shopurka and Kosivska. The largest share of land allocated for recreation is within the Kobyletsko-Polyansky settlement council (1.2%) and Chornotysynsky village council (0.9%), which correspond to the upper reaches of the Shopurka and Chorna Tysa river basins, which in turn are confined to the Svydovets mountain range. The recreational load on the Chornohora ridge will be considered within the basins of the White Tisza, Black Tisza, and separately Lazeshchyna. The share of recreational land by village councils increases upstream of the White Tisza from 0.4% to 0.8%. The state of recreational land use in the Black Tisza basin is somewhat different, where the presence of mineral waters (locally known as burkut) and the development of tourist infrastructure in the villages of Bilyn, Kvasy and Yasinya causes a decrease in the share of recreational land upstream towards the Chornohora mountain range from 0.8% in the village of Bilyn to 0.4% in Yasinya. In the Lazeshchyna basin, the recreational land use rate is slightly higher and reaches 0.8%, due to the presence of the Kozmeschyk base and proximity to hiking routes to the peaks of Petros and Hoverla.

During the pre-crisis and crisis periods, the dynamics of the number of visitors/tourists has significant differences. The beginning of the crisis period took place from the end of 2019, and arose as a result of the spread of the COVID-19 disease and the introduction of a number of measures to contain the spread of this viral disease, which acquired the status of a global pandemic. In 2019, the number of visitors increased and reached its peak in 87.5% of enterprises, only 12.5% of hotels reported a decrease in the number of tourists (Chyniak & Salyuk, 2022).

Instead, in 2020, all hotel properties without exception reported a significant decrease in the number of customers due to the quarantine restrictions around the world with adjustments for regional and local features of the spread and mutations of the SARS-CoV-2 virus. Businesses has lost from 53 to 76% of the tourist flow, on average, the percentage of the decrease in visits compared to the previous year, 2019, was 69.2%.

According to the number of tourists, the trends regarding the load of the room stock also showed typical dynamics: in almost all hotels, the highest occupancy of rooms was in 2019, in 2020 this indicator fell (Chyniak & Salyuk, 2022). The most significant decline was observed in the spring of 2020, when strict quarantine restrictions and unforeseen means of personal and collective protection were introduced. The best situation in the field of hospitality developed in the summer - thanks to the seasonal decrease in infection rates and the implementation of various protective measures.

Characteristics of the chemical composition of water. In order to study the potential impact of the facilities of the hospitality industry on the quality of the surface water of the Black Tisza River, we analyzed a group of chemical indicators, the most important from an ecological approach: hydrogen index (pH) and the content of dissolved oxygen (O_2), five days biochemical oxygen consumption (BOD_5), chemical oxygen consumption (COD), as well as mineral nitrogen compounds: ammonium ($N\text{-}NH_4^+$), nitrites ($N\text{-}NO_2^-$), nitrates ($N\text{-}NO_3^-$).

The content of dissolved oxygen in the waters of the Black Tisza has a clear seasonal character, and the average annual values are within the normal range. During 2020-2022, fluctuations in the absolute

values of the dissolved oxygen content were recorded in the range of 8,6-14,4 mgO_2/dm^{-3} for the body of surface water of the Black Tisza River above the village of Black Tisza and 7,6-15,4 mgO_2/dm^{-3} – for the Black Tisza River within the boundaries of the village of Kvasy.

Hydrogen indicator of pH is important for assessing the habitat of hydrobionts. Fluctuations of the indicators during the studied period, and even the average annual values did not exceed the norms and were at the level of 6,6-8,5 units pH (Ministry of Health of Ukraine, 2022).

Table 1

Chemical parameters of the water quality of the Black Tisza River (2020-2022), $mg \cdot dm^{-3}$

River - point	Year	Dissolved oxygen O_2	pH	BOD_5	COD	$N\text{-}NH_4^+$	$N\text{-}NO_3^-$	$N\text{-}NO_2^-$
Black Tisza River - above village of Black Tisza	2020	11,5	7,8	1,31	12,7	0,12	0,29	0,003
	2021	11	8	1,45	10,9	0,08	0,45	0,004
	2022	10,7	8,02	2,05	8,7	0,1	0,39	0,006
Black Tisza River - Kvasy	2020	11,6	7,7	1,26	15,7	0,19	0,33	0,01
	2021	10,9	7,9	1,44	16,9	0,13	0,43	0,007
	2022	10,6	8,4	1,33	12,9	0,15	0,35	0,009

Indicators of biochemical oxygen consumption during 5 days and chemical oxygen consumption (BOD_5, COD) reflect the dynamics of self-purification of watercourses due to the reactions of oxygen consumption to the oxidation of trace elements and organic substances. Therefore, the analysis of these indicators makes it possible to identify potential sources of chemical and organic water pollution, including due to the activities of recreation and tourism facilities located within the Black Tisza river basin. Fluctuations of BOD_5 indicators in the range of 0,5-4 $mg \cdot dm^{-3}$, and COD 5-28 mg·dm-3 for the headwaters of the Black Tisza River and 6-60 $mg \cdot dm^{-3}$ for the massif of surface waters from the village of Kvasy to Yasinya village upstream. A sharp increase in COD indicators, in particular in the summer-autumn period, from the village of Black Tisza to the village of Kvasy gives reason to talk about organic pollution of the waters of the Black Tisza River.

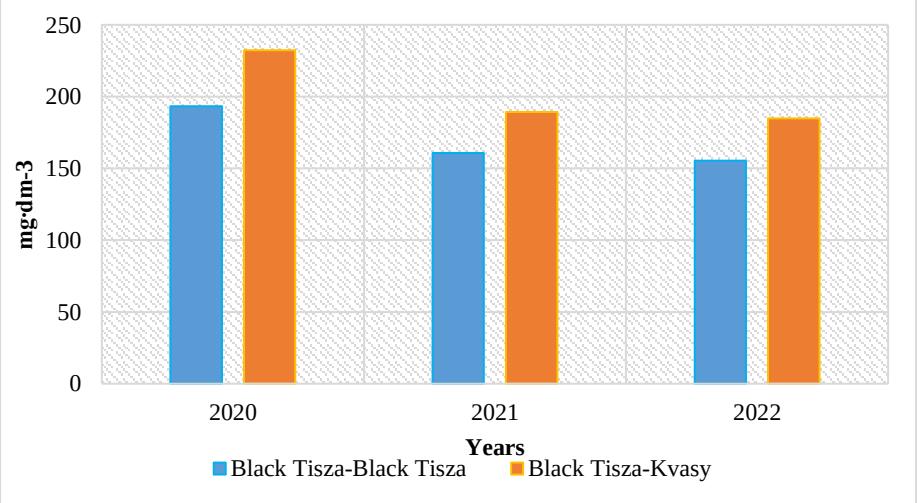

Figure 1 Average long-term values of water mineralization of the Black Tisza River

The presence of organic nitrogen-containing compounds in surface waters is associated with the discharge of wastewater by communal enterprises, as well as by private households, including private estates, hotels, hostels, in particular in the village of Yasinya and the village of Kvasy. Normative values for nitrogen-containing compounds are as follows: $N\text{-}NH_4^+$ 2.0 $mg \cdot dm^{-3}$, $N\text{-}NO_2^-$ 1 $mg \cdot dm^{-3}$ та 45 mg·dm-

^{3} by content NO_3^- (Ministry of Health of Ukraine, 2022). As can be seen from Table 1, the content of biogenic substances in the waters of the Black Tisza River did not exceed the average annual values in any of the analyzed points, which allows us to talk about a safe ecological environment for the existence of aquatic organisms from the standpoint of organic pollution of the river waters, in particular by tourist and recreational facilities.

Intra-annual fluctuations in the water mineralization values of the Black Tisza River during the study period are related to the hydrological regime - the minimum values were recorded during the spring flood, the maximum values - during the summer-autumn and winter low tide. Along with this, during 2020-2022, we record a constant excess of mineralization values downstream of the Black Tisza River, which may be related to the influence of wastewater, in particular, the sanatorium "Hirska Tisza", located in the village of Kvasy.

Conclusions. The basin of the Black Tisza River is located in the northern part of the Rakhiv district of the Zakarpattia region and includes territories with the Svydivets and Chornohora mountain ranges. As a result, the river flows in a narrow valley with steep banks and has a clearly defined mountain type with a characteristic steep slope and fast current.

The hospitality industry is widely represented within the Black Tisza river basin, which is due to both the natural resource potential and the historical and architectural resources of the region. Thus, a rather extensive network of tourist and recreational facilities within the studied territory includes 80% of all facilities within the Rakhiv district. As a result, surface waters in the basin of the Black Tisza River are under greater pressure than the waters of the White Tisza, Shopurka, and Kosivska - the largest tributaries of the Tisza River within the district.

The group of hydrochemical indicators of water quality chosen by us for analysis allows for a superficial assessment of the potential impact of hospitality industry facilities on surface waters in the Black Tisza river basin. The non-systematic construction of recreation and tourism facilities along with the mountainous nature of the river cause minor fluctuations within the normal limits of almost all selected hydrochemical parameters, with the exception of COD during the summer-autumn period.

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