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- **HYDROLOGY AND WATER RESOURCES**
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SECTION OIL AND GAS EXPLORATION

SECTION HYDROLOGY AND WATER RESOURCES

CURRENT HYDROECOLOGICAL CONDITION OF THE NORTH-WESTERN PRYAZOVIE RIVERS

Assistant Professor, Oleksandr Nepsha
Associate Professor, PhD (Geography) Svitlana Hryshko
Bogdan Khmelnitsky Melitopol State Pedagogical University, Melitopol, **Ukraine**

ABSTRACT

The territory of the North-Western Pryazovie is adjacent to the northern coast of the Sea of Azov. There are 14 rivers flowing through the territory of the North-Western Priazovie with a total length of 944.1 km and a water intake area of 10.613 km^2. Territorially, the river network of the Sea of Azov can be divided into two parts: western and eastern, which differ from each other in the structure of the surface, climatic conditions and the nature of the hydrological regime. The rivers of the North-Western Pryazovie can be grouped according to the following characteristics: length, size of the basin, catchment area, nature of the flow, nature of the sources, tendency to dry out.

If in the early stages of economic development the rivers of the North-Western Pryazovie could meet all the needs of people and cope with anthropogenic pressure, now most rivers can no longer withstand these loads and have lost the possibility of environmental self-regulation. The concept of «economic burden» on the natural environment now does not fully correspond to the actual state of the smallest river and its catchment area. A more precise concept of «anthropogenic press», which should be understood not only as the direct economic use of the riverbed, its valley, shores and surrounding areas, but also the side (not infrequently contradictory or negative) consequences of such use.

When assessing the current or expected state of the steppe rivers of the North-Western Pryazovie, it is necessary to take into account the following features: these rivers are the main source of food for large rivers, so their preservation is essential to protect water resources from depletion; the watersheds of these rivers house a significant number of people, industrial facilities, agricultural lands, which determines the great economic importance of this category of rivers; due to their small size, these rivers are very sensitive to certain types of economic activity, which is particularly acute in the water regime of the territory.

Keywords: river, hydroecological condition, hydrological indicators, anthropogenic load, North-Western Pryazovie

INTRODUCTION

Rivers are closely connected with the economy of the surrounding areas and play a significant role in the development of the social environment. At the same time, the comprehensive use of river resources, their regulation, selection of water for irrigation and household needs, as well as the transformation of rivers into sewage collectors violated their natural state. Rivers have become polluted, upright, shallow, with poor water quality, depleted of plant and animal organisms. Excessive use of both rivers and watersheds in the national economy disrupts their natural hydrochemical and hydrobiological regimes, reduces water content and depth, rivers are silted up and overgrown, their eutrophication increases.

MATERIALS AND METHODS

The material for studying the problem was specialized arrays of long-term data on the hydrological regime of the rivers of the North-Western Priazovie, air temperature and precipitation by hydrometeorological stations (HMS) located in the northwestern part of the Sea of Azov, Central Geophysical Observatory and National Oceanic and Atmospheric Administration (open access).

During the study period (1960-2019), the most reliable and continuous data series were selected. From the point of view of hydrological research, the area of the North-Western Priazovie is one of the least studied. The distribution of stations on the territory is extremely uneven with frequent and long breaks in observations, which significantly complicates the study of the water regime of rivers. Thus, within the study area, systematic observations of the hydrological regime of rivers were conducted only at 4 stations with the longest observation periods – 49 years (Table 1).

Table 1

List of operating hydrological station on the rivers of the North-Western Priazovie

№	River-station	Validity		Years, *n*
		Opened	Closed	
1	Molochna River – Terpinnia village	01.01.1952	operates	60
2	Lozuvatka River – Novooleksiivka village	30.10.1974	operates	38
3	Obytichna River – Prymorsk town	28.09.1936	operates	76
4	Berda River – Osypenko village	17.05.1962	operates	51

DISCUSSION

The North-Western Pryazovia occupies the northern coast of the Sea of Azov and, as the geographical territory, it is limited: it is the line of the watershed of the Berda, Kalmius and Kalchyk rivers from the east; it is the line of the watershed of the Dnipro and the Molochna from the west and north-west (taking into account the basin of the Velykyi Utliuk): it is the line of the watershed of the Pryazovia crystalline massif between the Berda in the north (with the Karatysh and the Karatuk rivers) and the system of the confluents of the Mokra Konka and the Sukha Konka rivers, the Haichur and Kamyanka rivers. From the south, the territory is limited with the coastline of the Sea of Azov with its gulfs and the limans (Fig. 1) [11].

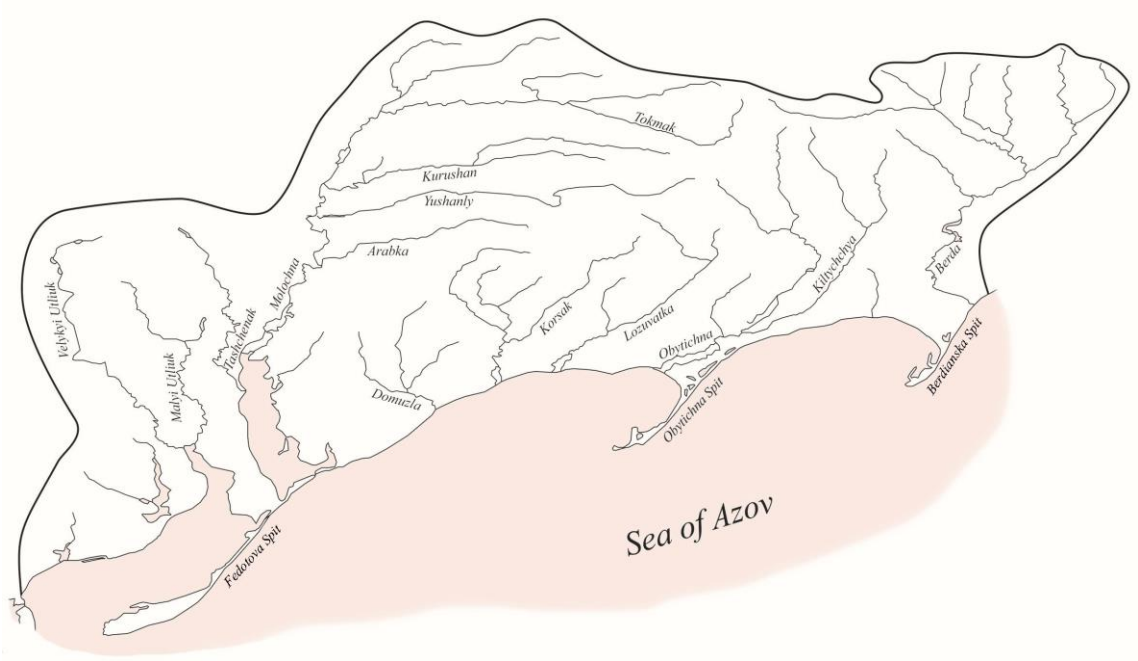

Fig. 1. The boundaries of the North-Western Pryazovia region [11]

There are 14 rivers with a total length of 944.1 km and a water intake area of 10.613 km^2 on the territory of the North-Western Priazovie [3]. The territory of the North-Western Priazovie is characterized by a developed, as for the steppe zone, river network with an increase in its density in the direction from west to east from 0.19 km/km^2 to 0.36 km/km^2 [2]. This change in the density of the river network is explained by the nature of the relief of river basins. A significant part of the area of river basins in the west and south of the studied region is located within the Black Sea lowlands, in the east – within the Azov Upland. Therefore, the territorial river network of the North-Western Priazovie can be divided into two parts: western and eastern. They differ from each other in surface structure, climatic conditions and the nature of the hydrological regime. Rivers in the western region have a flat flow, their channels are often formed by meanders, valleys have a wide floodplain. The rivers of the eastern region originate on the Azov Upland, in the upper reaches they have a semi-mountainous character, their channels are strongly incised, narrow, limited by the steep slopes of the valley, the banks are covered with ravines and gullies. Downstream, the valleys of these rivers become wider, the coastal slopes are gentle, the flow slows down, meanders are formed and floodplains in some places even become swampy. In the upper reaches, these rivers flow rapidly and develop intense erosion. Due to this, the density of the river network of the western part differs sharply from the eastern one. In the west it does not exceed 0.19 km/km^2, and in the east it reaches 0.36 km/km^2 [2]. The length of the river of the western basin is longer than the rivers of the eastern basin. The largest river flowing in the western part of the region is the Molochna River (198 km), and in the eastern part of the Obytichna River (100 km) and the Berda River (125 km) [7].

Analyzing the hydrological features of the rivers of the North-Western Priazovie, it should be noted that the relief in which the river network, climatic conditions and power source formed have the greatest influence on the water content of rivers. The main source of food for the rivers of the North-Western Priazovie is precipitation, which averages 250-300 mm in the west and 400-450 mm in the east in the study area

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(Table 2). That is, precipitation changes from west to east as well as the nature of the current. They are distributed not evenly not only in space but also in time: the largest number falls in summer, mainly in the form of showers, the smallest – winter. The smallest amount falls in the basins of the Velykyi Utliuk and Malyi Utliuk – on average 350 mm, further to the east the amount of precipitation increases and on the Priazovska Upland they can reach 550 mm in some years. In summer, very high evaporation from the territory up to 890 mm, so a significant role in feeding the rivers play along with the rains of melt spring water and groundwater. The nature of the water regime of rivers is determined by the characteristics of floods, its duration. Thus, in the annual course of water levels in the rivers of the Azov Sea basin, there are usually two highs (during spring floods and during summer floods) and two lows (late summer and early autumn and winter). In the spring (February – April) is 45-60% of annual runoff [4, 9].

Table 2

Statistical analysis of average annual precipitation amounts at hydrometeorological stations during 1960-2019

Station	n	M±	Min	Max
Melitopol	64	465.6±98	287	741.7
Berdyansk	64	475.1±118.9	223	894
Botieve	64	430.6±107.5	247	961.1

Intensive rise in spring floods begins in the second decade of February. The recession on the rivers of the North-Western Priazovie ends in the second half of March – early April. The limited runoff (January, May) is 40-45% per annum. The summer-autumn period is covered by rain floods, which are characteristic of all rivers of the North-Western Priazovie [8].

Annual values of the river runoff layer vary from west to 0.4-6.7 mm (for the Molochna River) to the east to 11-15 mm (Lozuvatka and Berda rivers) [6]. This change in river runoff is explained by the change in precipitation in the study area.

Based on the above, the rivers of the North-Western Priazovie can be grouped according to the following characteristics: the area of the river basin, length, nature of the flow, the nature of the sources, the tendency to dry out.

Types of rivers by river basin area:

а) rivers with a catchment area of 100-1000 km^2 (the Apanly, Velykyi Utliuk, Malyi Utliuk, Domuzla, Korsak, Lozuvatka, Kiltychia rivers);

б) rivers with a catchment area of 1000-2000 km^2 (the Obytichna, Berda);

в) rivers with a catchment area of more than 2000 km^2 (Molochna).

Types of rivers by length according to the Water Code of Ukraine [10]:

а) small rivers – rivers with a catchment area of less than 2000 km^2 (all rivers of the North-Western Azov Sea, except the Molochna River).

б) medium rivers – rivers with a catchment area from 2000 km^2 to 50,000 km^2 (Molochna River).

There are no large rivers in the North-Western Priazovie.

Types of rivers by the nature of the flow:

a) plain rivers with slow flow – typical steppe (the Domuzla, Velykyi Utliuk, Malyi Utliuk, Tashchenak, Molochna, Lozuvatka, Korsak);

b) rivers, which in the upper reaches have the form of a semi-mountain river (the Berda, Obytichna).

Types of rivers by the nature of sources:

a) rivers that originate on the slopes of the Azov crystalline massif, their sources exceed a height of 200 m above sea level, and are fed by springs originating from crystalline rocks (the Berda, Obytichna, Lozuvatka, Molochna, Korsak and their tributaries);

b) rivers, which originate at 50-55 m above sea level, and are fed mainly by precipitation (the Domuzla, Jakelnya, Tashchenak, Velykyi Utliuk, Malyi Utliuk and their tributaries).

Types of rivers by tendency to dry out:

a) rivers that partially dry up in the upper reaches (the Kurushan, Apanly, Metrozly, Kurkulak, Akchokrak, Arabka);

b) rivers that dry up in the lower reaches (the Chingul, Jakelnya, Tashchenak, Kiltychia, Velykyi Utliuk, Lozuvatka);

в) rivers that do not dry up (the Molochna, Berda, Obytichna).

The most important factors influencing the hydrological regime of rivers are irreversible intake, removal of runoff when filling ponds and reservoirs. In addition to irreversible water intake, river flow is affected by over-regulation of riverbeds. However, about 87 ponds and reservoirs with a total water surface area of more than 1000 ha have been created on the Molochna River [5] (Table 3).

Table 3

Availability of ponds and reservoirs in the river basins of the North-Western Priazovie

River basin	Ponds			Reservoirs	
	number	area, ha		number	area, ha
Velykyi Utliuk and Malyi Utliuk	23	561.7		–	–
Molochna	81	536.2		6	497
Obytichna	56	472.1		4	215.2
Lozuvatka	12	180.0		1	40.0
Berda	56	375.6		5	491.8
Other rivers	42	579.2		–	38.5
Total	270	2704.8		16	1282.5

The assessment of the state of ecosystems of the vast majority of rivers of the North-Western Priazovie shows that it is currently critical, and water quality is much lower than natural [1]. The main reasons that led to this state of the rivers of the North-Western Priazovie are:

- pollution of rivers by industrial, agricultural and municipal effluents;
- increase of polluted surface runoff due to plowing of floodplains, ravine slopes, beams, river sources, intensive use of floodplains for construction;
- siltation of riverbeds due to pollution and changes in the state of the catchment surface due to deforestation and increasing the area of arable land;
- reduction of drainage capacity of riverbeds due to their siltation;
- use of runoff for economic needs, which reached 25% of the annual volume;
- high degree of runoff regulation, which causes an increase in water mineralization in reservoirs and ponds due to water losses due to evaporation from the surface of the water mirror.

To preserve the ecosystems of the rivers of the North-Western Priazovie, improve their condition and restore water content, it is necessary to take a number of urgent measures, in particular:

- at the state level to identify agencies that will be responsible for the condition of rivers, especially small ones;
- get the results of the certification of rivers and complete it;
- in order to determine the feasibility of maintaining a number of reservoirs and ponds in riverbeds to conduct an examination and assessment of their condition;
- to take measures to restore the ecological functions of coastal protection strips in river floodplains, in particular their afforestation, silting, removal of ecologically dangerous objects;
- prohibit the use of riverbeds as sewage systems for direct discharge of polluted water, regardless of the length of the river and its water content;
- begin work to restore the natural state of river valleys;
- liquidate summer camps for farm animals within the coastal protection strips of rivers and move their buildings beyond the floodplain, set up treatment facilities in them;
- increase the area of forests in river basins, especially small ones;
- flood river floodplains with meadow grasslands;
- to prohibit the extraction of sand and gravel in the channels of small rivers, which will preserve the structure of bottom biocenoses, etc.

These measures are a priority and do not require significant funds. They will allow to some extent to preserve the water content of rivers, rational use of their water resources, stimulate natural processes of self-purification in the riverbeds, and so on.

CONCLUSION

Analysis of literature sources and our own field research allowed us to combine the rivers of the North-Western Priazovie into separate groups according to the following features: river basin area, length, flow nature, source nature, tendency to dry out. Such comprehensive studies of the rivers of the North-Western Priazovie allow to assess their current ecological condition and to develop specific measures for their rational use and protection. The main factors that currently determine the state of river hydroecosystems

of the North-Western Priazovie are the following: pollution of rivers by industrial, agricultural and municipal effluents; increase of contaminated surface runoff; siltation of riverbeds due to pollution and changes in the state of the catchment surface; reduction of drainage capacity of riverbeds due to their siltation; use of runoff for economic needs; high degree of overflow regulation. In order to preserve the river ecosystems of the North-Western Priazovie and improve their ecological status, it is necessary to identify agencies at the state level that will be responsible for the state of rivers, complete the process of their certification and propose a set of remedial measures.

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