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The Assessment of the State of Pollution of the Waters of the Trascarpathian Rivers with Heavy Metals

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Abstract—The paper has given an assessment of the state of pollution of the Transcarpathian surface waters with heavy metals Pb(II), Cu(II), and Zn(II), which penetrate as a result of technogenic disasters, anthropogenic loads, with runoffs from floods in the basin of the Tisa River and as a result of natural anomalies caused by snow melting, shower rains in the Rika River over the period 2005–2009.

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INTRODUCTION

A complex ecological situation has taken shape in Ukraine. This is the situation whereby effectively all surface, and in individual region underground waters, by the level of pollution do not meet standards of quality for sources of water supply [1].

The state of water supply in the rural area causes a special concern since only 26% of the rural population is using services of the centralized water supply systems, while the rest use local sources of drinking needs—mine and tubular wells, makeshift cappings, river bed dig-outs, and also water brought to homes [1–3]. Therefore, in most cases rural population has to drink water, which does not meet a number of requirements of hygienic indicators, which lead not only to the propagation of various diseases and deterioration of epidemiological situation, but also to an increase of social stress in the rural area, restriction of agricultural development in the regions of the country with scant water resources [2–5].

One of the ecologically unfavorable areas is Western Ukraine, which belongs to the most flood-prone regions of Europe. A large part of the Transcarpathian terrain is a catchment area of the river Tisa basin. The second water objects, which gets into the river Tisa basin is the river Rika (the right-hand tributary) flowing in the Mezhgorsk and Khust regions of the Transcarpathian region. Hydrological posts are located near the villages Verkhnii Bystrii (1954) and Nizhnii Bystrii (1956) in the towns of Mezhygirya (1946) and Khust (1946).

Part of the runoffs of the river Tisa basin is being formed in Romania, Hungary, and Slovakia. In this case 75% of the runoff falls on spring and fall floods and only 25% account for other seasons [6]. Various toxicants, including heavy metals (HM), get directly into surface waters of the river Tisa basin due to technogenic disasters, which occur in Romania, and also due to untreated or insufficiently treated public, household, and industrial wastewaters. In addition, HM penetrate the waters of the river Tisa during floods due to the erosion of soils with waters of small rivers.

Technogenic disasters and unpredicted emissions of wastewaters, which occur yearly at the stations of purification of sludge waters of the SC Cartel Bau SA mining enterprise, Baja Borsha (Romania) [7, 8] are one of the main sources of the pollution with HM of the waters of the river Tisa. As a result of it disaster HM emissions—copper, iron, zinc, etc.—enter the transborder waters of the Transcarpathian region. For instance, according to the data of the State Ecological inspection in the Transcarpathian region in 2009 the concentration of Cu(II), Fe(II) and Zn(II) in the river Tisa exceeded permissible standards 2–4 times [9] due to which for two weeks it was banned to use the water for drinking and household water supply,

The basin of the river Rika is used for hydropower (Tereble-Ritskaya hydropower plant) and water supply. The town of Khust and numerous tourist summer camps are located on its banks. Most river sections are abundant with structures for strengthening banks including zinked metal hardware, which also may serve as a source of ingress of zinc compounds into the water [9].

The network of observations, in existence today, over the level of HM pollutions of surface waters of the Transcarpathia does not allow one to conduct a real ecological assessment of the state of the basin of the Tisa River since most of it is outside Ukraine and is under a substantial anthropological load.

The objective of the present paper is the assessment of the state of pollution by the compounds of lead, copper, and zinc of the waters of the rivers Tisa and Rika based on the periodic analysis of the waters on the content of HM and standards—maximum allowable concentrations in terms of using these waters for drinking purposes, management of fishery and as surface waters over the period from 2005 to 2009. The concentration of HM ions in the water with the use of the improved methodology of inverse chronopotentiometry [10] and an M-XA1000-5 analyzer of the salts of heavy metals [11].

The station for hydrochemical monitoring of the waters of the rivers Tisa and Rika is in the Town of Khust.

EXPERIMENTAL

Water sampling was carried out four times a year (every quarter) according to [12, 13]. Water samples of the river Tisa were taken in the area of the Velyatinsk bridge near which very often the waters of this river burst in, which inundates fields and grazing lands of private agricultural lands. Such a large inundation took place, for example, in 2006.

Water samples of the river Rika were taken in the region of the city beach, under the highway bridge at the exit from the town of Khust. Boreholes for drinking water intake were located nearby (depth: 60–70 m) for the town water supply.

Water sample preparation for the analysis was conducted according to the technique developed by us, while the concentration of heavy metals was determined in accordance with the necessary electrochemical preparations [14].

RESULTS AND DISCUSSION

Figure 1 shows the results of determining the Pb(II) concentration in the rivers of Tisa and Rika. From the viewpoint of using these waters for drinking water supply we established the norms of exceeding MAC and the maximum values of the Pb(II) concentrations in the water of the Tisa River: 3rd and 4th quarters of 2005—respectively 4.2 MAC and 1.15 MAC; 2nd and 3rd quarters of 2005—1.17 MAC and 1.8 MAC; 2nd quarter of 2008—3.2 MAC.

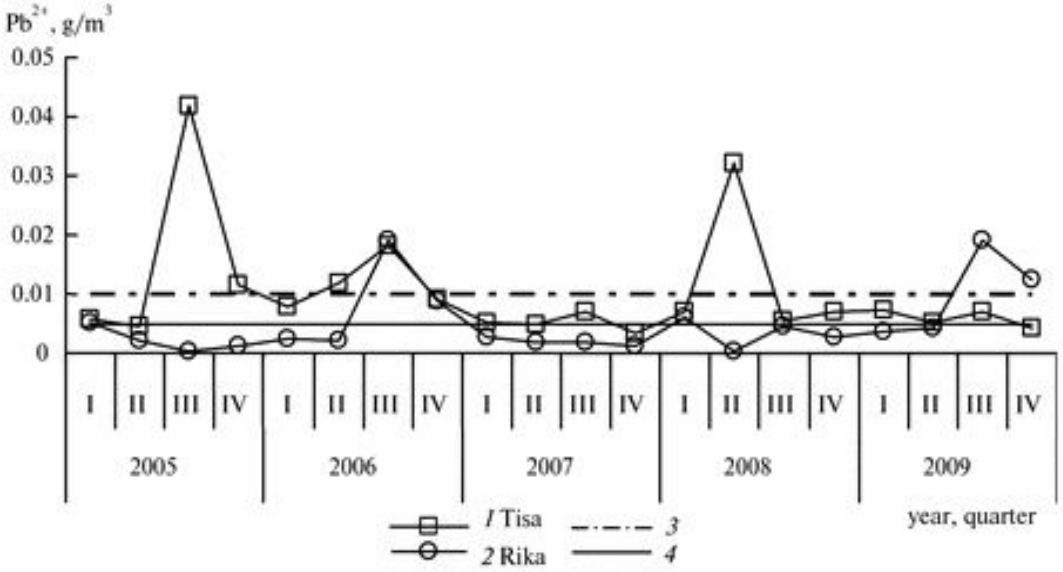

Fig. 1. Lead content in the waters of the Tisa River (*1*) and Rika River (*2*): lead MAC for drinking water—0.01 g/m^3 (*1*) [12]; the same for surface waters—0.005 /m^3 [13].

Similar fluctuations of the Pb(II) concentration in the waters of the river Rika were observed in the 3rd quarter of 2006—1.2 MAC and also in 3rd and 4th quarters of 2009—respectively 1.9 MAC and 1.3 MAC. However the Pb(II) concentration in the water of the river Tisa was much higher than in the river Rika, which, perhaps, is related to the influence of anthropogenic loads, territorial features of the given region and its geochemical structure and also with the nature of precipitations. In this case an excess of the Pb(II) concentration in the water of the river Tisa did not always coincided with such in the water of the river Rika.

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