

SEASONAL DYNAMICS OF CADMIUM AND PLUMBUM IN THE TURIYA AND PRIPYAT RIVERS

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Abstract – The anthropogenic pressure on aquatic ecosystems leads to a significant transformation of their quantitative and qualitative composition. Many rivers of Ukraine are polluted. The object of research was the surface waters of the rivers Pripyat and Turiya (Volyn region, Ukraine). Analysis of the qualitative and quantitative composition of toxicants (Cd, Pb) showed that the waters of the rivers have high level of pollution. A negative phenomenon in the studied reservoirs is a significant excess of concentrations of heavy metals: lead in 118 times and cadmium in 110 times in August.

Introduction

The constantly growing anthropogenic pressure on aquatic ecosystems Plumbum to disruption of the natural regimes of rivers development and a significant transformation of their quantitative and qualitative composition. Rivers play a very important role in the life of the city's communities, satisfying household, industrial and technical needs, and recreation. Today, most of the rivers in Ukraine in general and in Volyn region in particular, are polluted. The rivers Pripyat and Turiya are not exception. They belong to the Dnieper basin. In recent years, in particular in 2012, 2015, and in 2016, the media discussed issues of environmental degradation of the main waterway of the Kovel district – Turiya river and identifying sources of its pollution. Now, in the context of the economic crisis, the production activities of most enterprises in Kovel and in particular Platan-enterprise, have drastically reduced water demand and, accordingly, reduced wastewater volumes. At the same time, the acute problem of Turiya river - widespread violation and non-compliance with the water protection regime in the settlements of its basin, in particular in the Kovel city [1, 2, 3].

Heavy metals (HMs) are one of the most dangerous components of surface water pollution in Ukraine. They differ from organic substances, are not susceptible to degradation and are constantly in one form or another in aquatic ecosystems and therefore significantly affect the quality of water and the functioning of biotas. Accumulation of HMs in water bodies depends not only from the geological structure of the rocks, but also from the type of water body, its hydrological regime, and seasonal fluctuations of the physicochemical parameters of water. The most bioavailable and dangerous are metal compounds dissolved in water [9, 13].

Nonessential heavy metals, especially those with variable valences, such as Cadmium and Plumbum, exhibit a direct toxic effect on organisms.

Materials and methods of research

The objects of research were the surface waters of the Pripyat and Turiya rivers of the Volyn region.

Water samples were taken from the surface horizon of water bodies in the middle of the river at a depth of $0.5 \div 0.7$ m using plastic samplers with a volume of 1 dm^3 .

To study the content of heavy metals in water, samples were taken in 5 different places of the Turiya river (Fig. 1). Also, samples were taken for study in 5 different places of the Pripyat River (Fig. 2).



Figure 1 - The beginning of the Shchytyń village; 2 – near the buildings; 3 - near the beach; 4 - near the watering place; 5 - the mouth of Turiya river falls in the Pripyat river.

Water was filtered through a membrane filter with a pore diameter of $0.45 \mu\text{m}$. The concentrations of heavy metals were determined by the ion-selective potentiometric method using the EB-74 ion meter [14, 15].

Statistical processing of the data was carried out using the software package Statistica 5.5 and Microsoft Office Excel 2010.

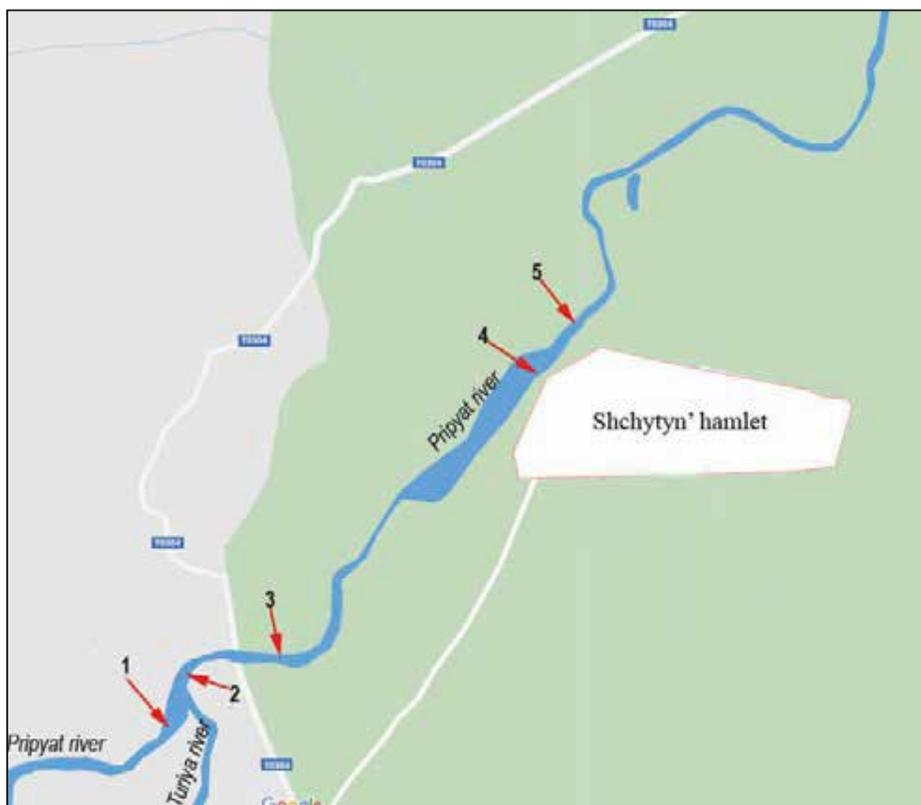


Figure 2 - 1- The Pripyat river before the mouth of Turiya river; 2 - near the beach; 3 - near the watering place; 4 - near the buildings; 5 - the end of the Shchytyyn' village.

Results of research and discussion

The natural waters are a dynamic chemical system that contains a complicated complex of gases, mineral and organic substances in the form of true solutions, suspensions and colloids. Its condition depends not only from environmental conditions, but also from various processes occurring both from outside and inside the hydrosystem [5].

Metal ions are integral components of the chemical composition of surface waters. Unlike organic pollutants, they do not decompose, but undergoing changes, are redistributed between the components of the ecosystem, constantly being in it [7].

Plumbum is one of the most toxic and most dangerous heavy metals. It enters river waters together with aerosol particles from industrial enterprises resulting from the combustion of coal and oil products, with waste water from the metallurgical and chemical industries. Plumbum mainly is absorbed in water systems. It is associated with suspended particles. Plumbum may also be in the form of soluble complexes with humic acids [13].

The features of the distribution and migration of Plumbum are due to the intensity of deposition and complexation. In addition, significant amounts of heavy metal enter in aquatic ecosystems as part of automobile emissions.

The most important role among various migratory forms of HMs, including Plumbum, belongs to water-soluble compounds. Exactly their number determines the intensity of the inclusion of Plumbum in a small biological cycle.

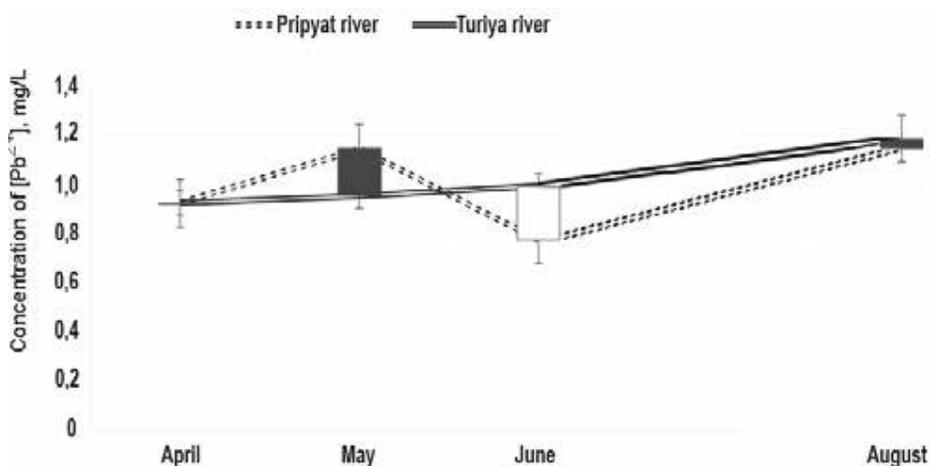


Figure 3 - The Plumbum content in the water of the rivers of the Volyn region, in April-August 2018, ($M \pm m$; $n = 5$)

In all water bodies of the studied territories, an excess of the *maximum permissible concentration* (MPC) of Plumbum was found ($MPC (Pb) = 0.01 \text{ mg/dm}^3$) [4].

In August, the concentration of Plumbum in the Pripjat River exceeded the maximum permissible concentration by 118 times. In both reservoirs, the concentration of Plumbum increased from April to August, which may be due to rains and flushing from the soil surface. In our opinion, a significant concentration of Plumbum in August is associated with the process of methylation of inorganic compounds of Plumbum in bottom sediments, contributes to the mobilization of this element from the sludge. As you know, plants absorb a certain amount of HMs and at the end of the growing season fall into the lower parts of the reservoir. They decompose there and cause secondary pollution of the water, giving it HMs, nutrients and organic matter [8].

Cadmium is one of the most harmful substances that pollute the aquatic environment (Fig. 4). For Cadmium (II), unlike Plumbum (II), weighted forms of migration are less characteristic, which on average account for about 65 % of the world's river flow [10]. Cadmium migrates in a dissolved state, because it binds to complexes weakly [11, 12].

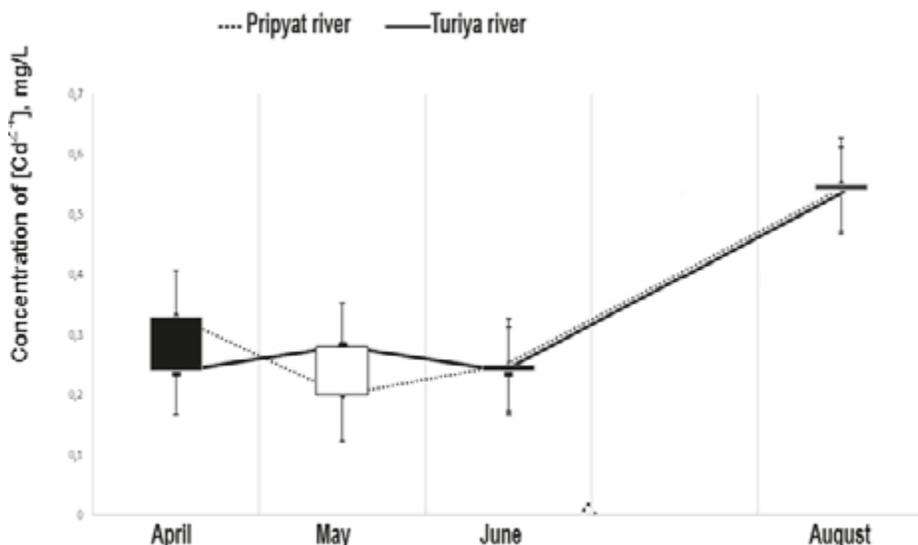


Figure 4 - Cadmium content in the water of the rivers of the Volyn region in April-August 2018, ($M \pm m$; $n = 5$).

In all water objects of the studied territories, an excess of the MPC for Cd was founded (MPC (Cd) = 0.005 mg/dm³ in norm [4, 6]).

In particular, in August in the Pripjat River we observed the concentration of Cadmium MPC exceeding 110 times the norm. The Cadmium concentration is quite high and biohazardous due to the extremely high toxicity of this metal, which is also a mutagen. The increase in Cadmium content can be caused by a relatively low oxygen content during this period, which causes the influx of metals from bottom sediments as a result of their recovery (under conditions of oxygen deficiency) and good solubility of its compounds in water.

Conclusions

So, taking into account the qualitative and quantitative composition of toxicants (Cd, Pb), it can be argued that the waters of the studied small Volyn rivers have a rather high level of pollution. A negative fact in the studied reservoirs is a significant excess of heavy metal concentrations: Plumbum by 118 times and Cadmium by 110 times in August.

According to the environmental classification of surface water quality in Ukraine according to the degree of anthropogenic pollution of the Turiya and Pripjat rivers belong to category V (very dirty).

Knowledge of the spatial and temporal distribution of heavy metals among the components of aquatic ecosystems is important for assessing the quality of natural waters, identifying pollution sources and assessing the level of their impact on aquatic ecosystems.

This allows rationally organize a system of environmental monitoring of the state of the water objects.

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