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Assessment of heavy metals distribution in Barguzin River aquatic system (Lake Baikal basin)

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ABSTRACT. This study is devoted to the analysis of the distribution of heavy metals in the aquatic system of the Barguzin River. This is one of the largest rivers of the Baikal basin. The element composition of surface water, bottom sediments, water plants (*Potamogeton pectinatus* L., *Potamogeton perfoliatus* L., *Hippuris vulgaris* L., *Nymphoides peltata* (S.G. Gmelin) O. Kuntze) and fish (*Abramis brama, Cyprinus rubrofuscus, Perca fluviatilis, Rutilus rutilus lacustris*) of the Barguzin River is studied. The following sequence of the accumulation of metals in aquatic plants: Mn > Fe > **C**u (Zn) > **C**r > Ni > **C**o > Pb > Cd > Hg is established. *Hippuris vulgaris* L. contains the highest concentration of the studied metals. In the distribution of metals over the body of the studied fish species the following sequence Zn ≈ Fe > Cu ≈ Mn ≈ Cr > Pb > Ni ≈ Cd > Hg is observed. There is an accumulation of zinc, manganese and chromium in fish scales, and iron, lead in the liver. The obtained data of the distribution of heavy metals broadens and clarify the understanding of the biochemical characteristics of aquatic system components. This research provides one of the important steps for the development of environmental standards and environmental risk assessments.

Keywords: heavy metals, water, sediments, aquatic plants, fish, distribution

Due to the technogenic pollution of surface waters with pollutants, the issue of availability and the quality of fresh water is becoming more acute for humanity. Inorganic pollutants, including heavy metals and metalloids, such as Cr, Ni, Cu, Zn, Cd, Pb, Hg, As, do not decay, unlike organic pollutants. Heavy metals emitted into the ecosystem, due to significant geo-, bioaccumulation and biomagnification, cause a potential risk to human health and the ecosystem.

This study was devoted to the analysis of the distribution of metals in the aquatic system of the Barguzin River. This is the third largest rivers of the Baikal lake system. Thus, significant attention to the environmental state of this great lake is a reason for the controlling each component of the Baikal catchment area. As a result of the intensive use of water resources of the Barguzin basin (agriculture and forestry), there has become a distinguishable trend in the change of water natural composition and the decrease of their quality, especially pronounced in the lower reaches of the river (Drucker et al., 1997). Water and bottom sediments, plant material samples were collected near Barguzin village (N 53°36'7,4'' E 109°36'20,0''). The distribution of metals in aquatic plants of the Barguzin River has been studied for the first time. The water and sediments samples were collected seasonally during 2019 year. The plant materials were collected on July 25-27, 2019, without reference to the plant's age. Catching fish was made a standard set of nets at the same time. Wide-spreaded fish (*Abramis brama, Cyprinus rubrofuscus, Perca fluviatilis, Rutilus rutilus lacustris*) with differences in composition in the food bolus were researched. Sample preparation of bottom sediments, plant materials and fish samples (fish scales, muscles and liver) was carried out using appropriate methods in MARS 6 microwave system. The metal content in the samples was determined by atomic absorption spectrometry of an air-acetylene flame on Solaar M6. The mercury content was determined by the cold steam method using a VP-100 hydride attachment to Solaar M6.

In 2019 the concentrations of Fe, Mn, Zn, Cu, Cr, Pb, Cd and Ni in the surface waters of the river Barguzin varied within the range, mg/dm^3: 0.01-0.12; 0.001-0.026; 0.001-0.005; 0-0.001; 0-0.004; 0-0.005; 0-0.0015; 0-0.007, respectively. The pollution of the surface waters of the Barguzin River with iron was observed during the spring flood, which is associated with the arrival of this element from the adjacent territories. For manganese, the maximum concentration

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values were observed in the winter and spring periods, which is associated with the penetration of the element from underground horizons, mobilization from silt deposits during the period covered with ice, and leaching from adjacent territories during floods. During these periods, the content of iron (0.12 mg/dm^3) and manganese (0.026 mg/ dm^3) exceeded the MPC values for fishery reservoirs. Bottom sediments were examined for the content of heavy metals. According to the classification of heavy metal pollution of natural waters' bottom sediments the Barguzin river can be classified as unpolluted water body.

The following sequence of metal accumulation in aquatic plants was observed: Mn > Fe > Cu (Zn) > Cr > Ni > Co > Pb > Cd > Hg (except for the accumulation in *Potamogeton pectinatus* and *Nymphoides peltata*). The highest concentration among the studied metals was determined in *Hippuris vulgaris* L., the lowest - in *Nymphoides peltata.* The concentration of lead (0.49-3.68 mg/kg) in comparison with literature data was much lower than indicated in plants of *Potamogeton*, *Hippuris* and *Nymphoides* genera from other reservoirs. The concentration of cadmium (0.43-0.70 mg/kg) was higher than those indicated in the literature. The concentration of cadmium in plants of *Potamogeton* genus was higher than that indicated for plants from Siberian water bodies, but significantly lower than from European water bodies (Li et al., 2015; Harguinteguy et al., 2016). The mercury content (0.015-0.162 mg/kg) was comparable to the concentration in plants of the Bratsk reservoir with high mercury pollution (Azovsky et al., 2010). In the distribution of metals over the body of the studied fish species, the same tendencies were observed, presented in the following range: in muscles - Zn > Fe > Cu > Cr > Mn > Pb > Ni > Cd > Hg, in liver - Zn ≈ Fe > Cu > Mn > Cr > Pb > Ni ≈ Cd > Hg, in scales - Zn > Fe > Mn > Cu > Cr > Pb > Ni > Cd > Hg. There was an accumulation of zinc, manganese and chromium in fish scales, and iron, lead - in the liver. The content of heavy metals in fish muscles was minimal and did not exceed the permissible residual concentrations of these elements in fresh fish products existing in Russia. Thus, the obtained data of the distribution of heavy metals broadens the understanding of the biochemical characteristics of aquatic system components. This research provides one of the important steps for the development of regional environmental standards and environmental risk assessments.

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