The geochemical features of raised roadside bogs in the basin of the river Ket

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The geochemical features of raised roadside bogs in the basin of the river Ket

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Abstract. This paper provides a comprehensive assessment of four sites of roadside bog. The study was conducted at a distance of 20, 70, 120, 170 m from the road. Changes in the top layer of peat deposits and the current vegetation were detected at sites less than 120 m from the road. The results obtained showed that Zn and Cu were concentrated in plants at a distance of 120 m from the road, and that the Cd and Pb contents were highest at 70 m from the road. At 20 m from the road, the concentrations of all elements except Pb were at the background level. Proximity to the road increased the ash content of peat and reduced the biogeochemical activity of marsh plant species.

1. Introduction
In the Tomsk region, the total length of roads running through wetlands is 387 km [1]. During the construction of a roadway, the hydrological regime of the adjacent territory is disrupted, and long successions of plant communities occur [2, 3, 4]. Factors affecting plant growth include an increased level of pollution associated with road traffic [5, 6]. The aim of this study was to determine the degree of transformation of biogeochemical properties of plants and peat deposits under the influence of the road.

2. Method and data
Studies were conducted on a bog in the Kolpashevskiy district of the Tomsk region. The study sites were located on a line perpendicular to the Kolpashevo–Bely Yar road, at a distance of 20, 70, 120, 170 m from the roadway. The flow of mire waters in this segment is parallel to the roadway. The vegetation of the mire is a pine-shrub-sphagnum plant community. The tree tier is dominated by Pinus sylvestris L., the shrub layer by Chamaedaphne calyculata (L.) Moench, and the moss layer by Sphagnum fuscum (Schimp.) Klinggr. Each site was geobotanically described, the groundwater level was measured, and peat samples were taken to determine the botanical composition and ash content. To determine the heavy metal content, six plant species were sampled at each site: Pinus sylvestris, Pinus sibirica Du Tour, Chamaedaphne calyculata, Ledum palustre L., Andromeda polifolia L. and Sphagnum fuscum, along with the top layer of peat. Data from undisturbed areas were used as background values [7]. For each of the plant species, a mixed sample of shoots from the current year was selected. Selection of peat to determine the content of heavy metals was carried out in the root layer of the...
Determination of the botanical composition of the peat deposit was carried out in accordance with GOST 28245-89. Determination of the ash content of plants and peat was carried out in accordance with GOST 24027.2-80 and GOST 11306-2013, respectively. The content of heavy metals in plants and peat was determined by the method of inversion voltammetry at the Siberian Research Institute of Agriculture and Peat. The biogeochemical activity of plant species was calculated as the sum of the coefficients of biological absorption of elements Pb, Cu, Cd and Zn [8]. To compare the biogeochemical activity in each section, the mean values of this index for all plant species were calculated.

3. Results

Based on the analysis of field investigations and subsequent processing of the results, changes were observed in the peat deposit at the site closest to the road, as compared to more remote areas. In the upper part of the deposit (up to 70 cm), a change in the botanical composition of peat was detected. *Sphagnum fuscum* was replaced in peat and moss tier, in *S. angustifolium* and *S. magellanicum*. The vegetation of the first section closest to the road differed from the rest by a sharp increase in the abundance individuals of species of the woody and grassy shrub layer, and an increase in their height and projective cover. On the second site from the road in the botanical peat composition, the proportion of heather shrubs is highest, as compared with the rest of the plots. Such a transformation of the current vegetation cover and botanical composition of the upper layers of the peat deposit indicates a change in mineral nutrition in the areas located 20 and 70 m from the roadway. At the site nearest the road (20 m), the concentrations of all elements except Pb were at background level. The maximum concentration of Zn and Cu in plants was detected at a distance of 120 m, and Cd and Pb levels were highest 70 m from the roadway (Figure 1). The greatest increase in Pb concentration was observed in *Sphagnum*. A similar trend was observed in a previous study on dryland agrocenoses [9], which found that the concentration of heavy metals in plants was maximal not at the roadway, but at some distance from it.

![Figure 1](image.png)

*Figure 1.* The content of heavy metals in plants growing near the road (20, 70, 120, 170 m from the road; bac.–background)
When considering the upper layers of the peat deposit, there was a tendency for the ash content to decrease as the distance from the road increased, which also indicates a change in mineral nutrition along the roadside strip. The biogeochemical activity of species increased as distance from the road increased (Figure 2).

![Figure 2. Change in ash content of peat and biogeochemical activity of species with distance from road (BAS–biogeochemical activity of species; ash–ash content of peat)](image)

When considering peat ash content and the biogeochemical activity of species, a negative correlation of high strength was found between these indicators ($S = -0.99$ at $p<0.005$).

4. Conclusions
The results indicate that roads built along raised bogs influence the biogeochemical balance of the bogs. There were changes in the vegetation along the roadside and the botanical and chemical composition of the upper layer of the peat deposit, and an increase in the concentration of heavy metals in plants. The maximum content of Zn and Cu was found at a distance of 120 m from the road, whereas the concentration of Cd and Pb was highest in plants growing 70 m from the roadway. The highest Pb concentrations were found in the upper peat layer and in sphagnum mosses. Biogeochemical activity increased with distance from the road, while the ash content of the peat decreased.

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