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Heavy metal concentrations in roadside soils of Lithuania's highways

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With the number of vehicles increasing, the analysis of highway roadside soils for contamination by heavy metals becomes expedient. This article deals with contamination by heavy metals of the roadsides of the Vilnius–Kaunas–Klaipėda (A1), Vilnius–Panevėžys (A2), Vilnius–Varėna–Grodno (A4), Vilnius–Utena (A14) and Vilnius–Prienai–Marijampolė (A16) highways. The analysis covers six heavy metals – nickel (Ni), copper (Cu), chromium (Cr), lead (Pb), zinc (Zn), and manganese (Mn), – the contaminants most often emitted by vehicles. The results have shown the maximum permissible concentrations (MPC) of the heavy metals in question to be not exceeded in any of the samples, but the concentrations of some heavy metals in the highway roadsides exceeded the background concentrations 1.3 to 6.7 times.

Key words: heavy metals, pollution, highway roadsides, soil

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INTRODUCTION

Heavy metal pollution is one of the main ecological problems in the whole world (Gardea-Torresdey et al., 2005; Claus et al., 2007). Soil is contaminated by sour rains, boiler-house emissions and exhaust gas discharged from vehicles. Heavy metals are detected in farming lands and plants therein as well as various food chains, which finally cause serious ecological and human health problems (Malik, 2004; Zheljazkov et al., 2006). The major part of chemical element emissions accumulates in soil and in deposits of water basin bottom. Soil is treated as a medium of both contaminant accumulation and contaminant transport. Upon getting into soil with dust, precipitation or in any other way, contaminants accumulate in it in the form of different combinations. From soil, they can enter plants and through them the food chains. They can also migrate to surface, ground and underground waters and spread at large distances, re-enter food chains and poison live organisms (Idzelis et al., 2004). Heavy metals can migrate within soil, some of them accumulate in it and often disturb soil processes and sometimes can even cause soil degradation (Baltrėnas et al., 2003; Poszyler-Adamska, Czerniak, 2007). Inter-spherical migration of chemical elements and their accumulation depend on a lot of environmental factors, such as meteorological conditions, the chemical and mineralogical composition of soil-forming rocks, the textured composition of the soil, soil solution pH, sorption, the content of organic matter, etc. The toxic and hazardous compounds cause various diseases and mutations. Lead, mercury, cadmium and zinc belong to the most toxic compounds. Most of the heavy metals – mercury, lead, cadmium, chromium, copper, nickel, zinc, cobalt, vanadium, molybdenum, beryllium, uranium, strontium, arsenic and others – are highly hazardous to human health. They are carcinogenic, mutagenic, teratogenic, also gonadotoxical, embryotoxical, nephrotoxical, neurotoxical. Particularly dangerous is the general, synergetic effect of the metals, when the combined damage is realized through their separate concentrations which do not exceed the normative values. Depending on soil characteristics and the humidity mode, these materials can cause acidification or alkalification of soil and cause various diseases and intoxication (Taraškevičius, Radzevičius, 1998). Metals are non-biodegradable and therefore persist for long periods in aquatic as well as terrestrial environments. They may be transported also through soils to reach groundwater, or may be taken up by plants, including agricultural crops (Boularbah et al., 2006).

Soil may be the most important sink of metals and other pollutants. Trace metal contaminations are introduced into soil environment through a variety of human activities, such as waste disposal, mining and smelting (Wu et al., 2006).

The aim of the present study was to analyse the influence of motor vehicles on soil and to evaluate the level of contamination with heavy metals in the upper roadside layer of highways. Soil contamination with heavy metals was studied in the nearest road environment, i. e. up to the end of the external slope of a road ditch.

METHODS

To find out the intensity of atmospheric contamination loading, samples were taken from the surface soil layer at a depth of around 10 cm (Jankauskaitė et al., 2008). Each sample was taken according to the principle of "envelope", i. e. by covering the entire elementary area (1 × 1 m) designed for it with sub-samples taken from at least five spots situated at equal distances from each other (Zinkutė et al., 2007). The use of stainless steel instruments is recommended for taking soil samples for determining heavy metal concentrations; therefore, the sampling was done with stainless steel rings and samples were put into polyethylene string bags (Baltrėnas et al., 2001). Soil samples were taken on both sides of the highway by making transverse profiles in January 2008 because a stable coat of snow was not formed. The first transverse profile point was located close to a roadway, the second being at a 2-meter distance and the 3rd one at a 5-meter distance from the roadway. Soil contamination was examined in the nearest road environment, i. e. up to the external slope of a road ditch.

The collected soil samples in string bags (around 500 g in weight) were transported to the laboratory of the Vilnius Gediminas Technical University Department of Environmental Protection and analysed by determining the content of Cr, Cu, Mn, Ni, Pb and Zn by the atomic absorption spectroscopy technique. The analysis covered these particular heavy metals as they are the main elements-indicators of contamination caused by motor vehicles (Baltrėnas, Vaišis, 2006; Zinkutė et al., 2007).

Prior to chemical analysis, the soil samples were dried, larger roots, other organic inserts and stones were removed from them, and the samples were crushed. The soil samples were homogenised by passing them through a sieve with 1 mm^2-sized mesh. 10 g of sieved out soil was dried at a temperature of 105 °C for 2 h and cooled in a desiccator. 0.5 g of the sieved out soil was weighed with the Kern 770–60 analytical electronic balance (with the accuracy of 0.0001 g). The weighed samples were placed in the Mildestone mineraliser's flask. Acids were slowly poured into it: 2 ml of hydrogen peroxide (H_2O_2) and 10 ml of nitric acid (HNO_3). The sample was mineralised in a mineraliser for 1 h at 200 °C. After mineralisation, the vessel with the sample was cooled to a temperature of 50–70 °C. The obtained soil extract was filtered through a paper filter into a glass flask and diluted with deionised water up to the mark on the flask (50 ml). Metal concentrations were measured with the Buck Scientific 210 VGP spectrometer using the acetylene-air flame. The determination of heavy metal concentrations in soil using the flame atomic absorption spectroscopy technique is based on measuring the absorption of heavy metal atoms. The absorption was measured by selecting a short length of the wave (LAND 28–98/M-08; Vandens kokybė..., 2002).

To evaluate the soil contamination level, the research findings were compared to the background levels of heavy metals in Lithuanian soils, approved in the hygiene norm "The Maximum Permissible Concentrations of Hazardous Chemical Substances in Soil" (HN 60: 2004). The soil samples taken for analysis from highway roadsides were of sand and sandy loam type. The standard background heavy metal levels in it are: Ni – 12 mg/kg, Pb – 15 Mg/kg, Cu – 8.1 mg/kg, Cr – 30 mg/kg, Zn – 26 mg/kg, Mn – 427 mg/kg. The maximum permissible concentrations (MPC) of heavy metals in soil are: Ni – 75 mg/kg, Pb – 100 mg/kg, Cu – 100 mg/kg, Cr – 100 mg/kg, Zn – 300 mg/kg, Mn – 1500 mg/kg (HN 60: 2004).

The obtained values of heavy metal concentrations in transverse profiles of both roadsides differed only by the size of an error, therefore, the results obtained from one roadside are presented.

RESULTS

The Vilnius–Kaunas–Klaipėda highway (A1). Soil samples were taken on the 61st km near the residential area of Žiežmariai. On the 61st km, the highway A1 borders the Strošiūnai Landscape Reserve. Bushes and trees grow on both sides of the roadside where samples were taken. A bus stop is at a distance of 70 m from the transverse profile on the right roadside. The locality is open.

On the highway A1, the highest concentration of Ni was detected in samples collected near the roadway; it was 1.6 times above the background quantity (12 mg/kg). Samples collected at a 2-m distance from the roadway showed that Ni concentration was decreasing and did not exceed the background level. The concentration of Ni was nearly 1.5 times lower than the background level in samples collected of at a distance 5 m from the highway. The concentration of Pb was very similar in the samples taken close to the roadway and at a distance of 2 m and 2.4 times exceeded the background level. Pb concentration in samples collected at a distance of 5 m was equal to 6.1 mg/kg. The concentrations of Cu exceeded the background level in samples collected closer to the roadway. Cu concentration by the roadway equalled 13.4 mg/kg. The concentration of Cu in the samples collected at a distance of 2 m from the road was nearly equal to the background level (8.1 mg/kg) and in those collected at a distance of 5 m was more than 2 times lower than the background level (Fig. 1).

Cr concentrations determined at the 61st km of the A1 highway 1.6 times exceeded the background level. Higher concentrations of Cr were determined in samples taken 5 m away from the roadway.

Cr concentration in samples taken at a distance of 2 m from the road was 39.5 mg/kg, i. e. 1.3 times higher than the background level. The Zn concentrations in all the samples exceeded the background level but did not exceed the MPC. The Zn concentration in the samples collected by the roadway reached 74.6 mg/kg, i. e. 2.9 times exceeded the background level. In samples gathered at 2 m from the road, Zn concentration fell to 68.2 mg/kg and in samples collected at a distance of 5 m was equal to 40.1 mg/kg, i. e. the background level was exceeded 1.5 times. Mn concentration exceeded the background level in none of the samples. Mn concentration in samples taken at a 5-m distance reached 199.8 mg/kg, in samples taken at a 2-m distance 84.7 mg/kg and by the road 165.4 mg/kg (Fig. 2).

As the data show (Fig. 1, 2), the heavy metal concentrations decrease with increasing the distance from the road. Since there is no road ditch in the sampling places, heavy metals are not transported with rain wastewater to the lower areas of the relief, and their concentrations decease with increasing the distance from the road.

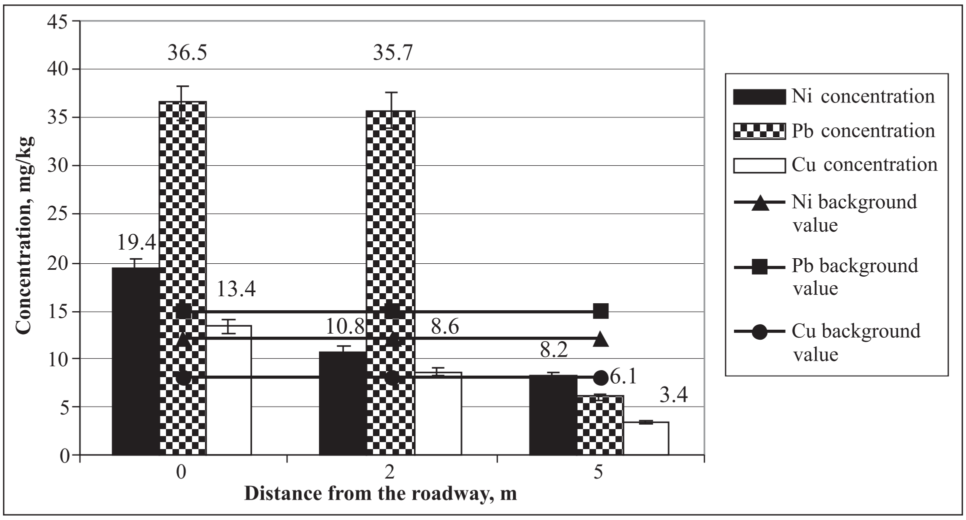

Fig. 1. Concentrations of Ni, Pb, Cu in the roadside soil of the Vilnius–Kaunas–Klaipėda highway (A1), 61st km
1 pav. Ni, Pb, Cu koncentracijos Vilnius–Kaunas–Klaipėda magistralės (A1) 61 km pakelės dirvožemyje

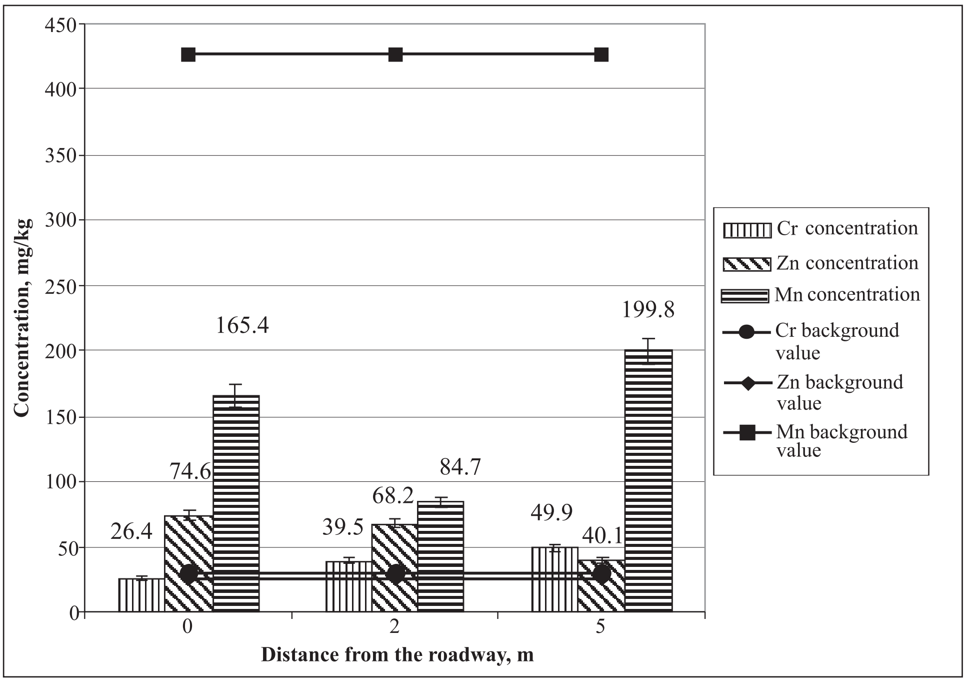

Fig. 2. Concentrations of Cr, Zn, Mn in the roadside soil of the Vilnius–Kaunas–Klaipėda highway (A1), 61st km
2 pav. Cr, Zn, Mn koncentracijos Vilnius–Kaunas–Klaipėda magistralės (A1) 61 km pakelės dirvožemyje

The Vilnius–Panevėžys highway (A2). Sampling was done at the 18th km. The highway goes along a low embankment; there is a 1.0–1.5 m slope on the left and on the right. The locality is open, a mixed forest grows on the right side of the road, high voltage electricity poles have been built. A viaduct has been built over the road 0.5 km from the transverse profiles (18.5 km from Vilnius). Individual trees grow on the left side of the road. Road ditches are conditional, roadsides have asphalt paving.

In the soil of the highway A2, Ni concentration exceeded the background level only in one sample, which was taken at a distance of 5 m from the roadway (15.7 mg/kg). In samples taken closer to the roadway, Ni concentration was lower than the background level. Pb concentration exceeded the background level in all the soil samples but did not exceed the MPC. In the samples taken by the road, Pb concentration was nearly 2.5 times higher than the background level. In samples taken at a 5-m distance from the roadway, Pb concentration 1.6 times exceeded the background level. Cu concentrations in this sampling profile did not exceed the MPC but 2.7 times exceeded the background level. Cu concentration in samples taken by the road was equal to 21.8 mg/kg and with increasing the distance from the roadway it was decreasing (Fig. 3).

Cr concentration exceeded the background level in samples collected by the roadway. Here Cr concentration was equal to 59.4 mg/kg, i. e. nearly two times more than the background level. Cr concentration in other samples did not exceed the background level and in samples taken at a 5-m distance was 6 times lower than the background level. Zn concentration did not exceed the MPC in any of the samples. The highest Zn concentration was recorded in samples collected by the roadway (175.2 mg/kg), where it was 6.7 times above the background level. With the distance from the roadway growing, Zn concentration decreased and at a 5-m distance was 24.5 mg/kg, i. e. lower than the background level. None of the Mn concentrations determined in the samples taken at the 18th kilometre of the A2 highway exceeded

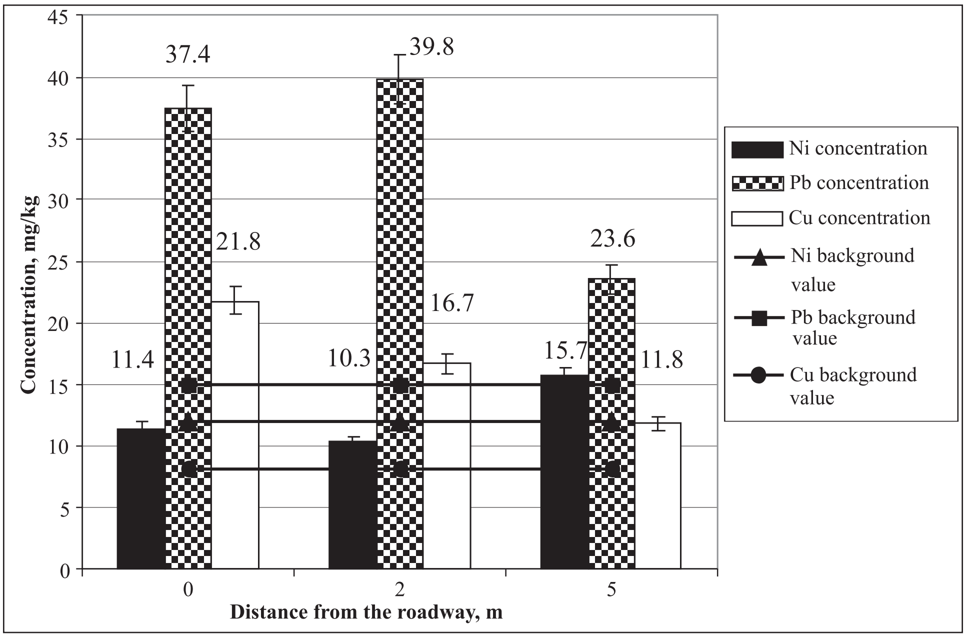

Fig. 3. Concentrations of Ni, Pb, Cu in the roadside soil of the Vilnius–Panevėžys highway (A2), 18th km

3 pav. Ni, Pb, Cu koncentracijos Vilnius–Panevėžys (A2) magistralės 18 km pakelės dirvožemyje

the background level. At a 2-m distance, Mn concentration was equal to 209.5 mg/kg, which was the highest Mn concentration recorded at the 18th km of the A2 highway (Fig. 4).

Considering the fact that the highway goes along a low embankment, the concentrations of heavy metals are distributed rather evenly and decrease with increasing the distance from the roadway.

The Vilnius–Varėna–Grodno highway (A4). Sampling was done at the 49th km. The road is at the same height as the road environment. The locality is even, a coniferous wood dominated by pine trees grows on both sides of the road. The wood grows by the road ditches, i. e. at a distance of 5–8 m from the roadway. The roadside is gravel, the way sides were mowed.

The analysis of soil samples taken by the highway A4 shows that Ni concentration exceeded the background level 1.3 times in one sample (at a 2-m distance from the roadway) and in other samples was lower than the background level. Pb concentration in all the samples exceeded the background level, but it was decreasing with increasing the distance from the road. The highest Pb concentration was determined in samples collected by the road, where it 2.1 times exceeded the background level, and at a 5-m distance it was 17.9 mg/kg, i. e. 1.5 times higher than the background level. Cu concentration insignificantly exceeded the background level only in one sample: at a 5-m distance from the roadway it was 1.05 times higher than the background level (Fig. 5).

Cr concentrations exceeded the background level only in samples collected by the roadway where it reached 40.8 mg/kg and was 1.4 times more than the background level. Cr concentration was decreasing in samples collected away from the roadway, and in samples taken at a 5-m distance it reached 5.9 mg/kg, which is 5 times less than the background level. Zn concentrations in all the samples exceeded the background level (1.2 to 1.9 times) but did not exceed the MPC. Mn concentrations did not exceed the background level in any of the collected samples. The highest Mn concentration in this place reached 191.5 mg/kg, being 2.2 times lower than the background level (Fig. 6).

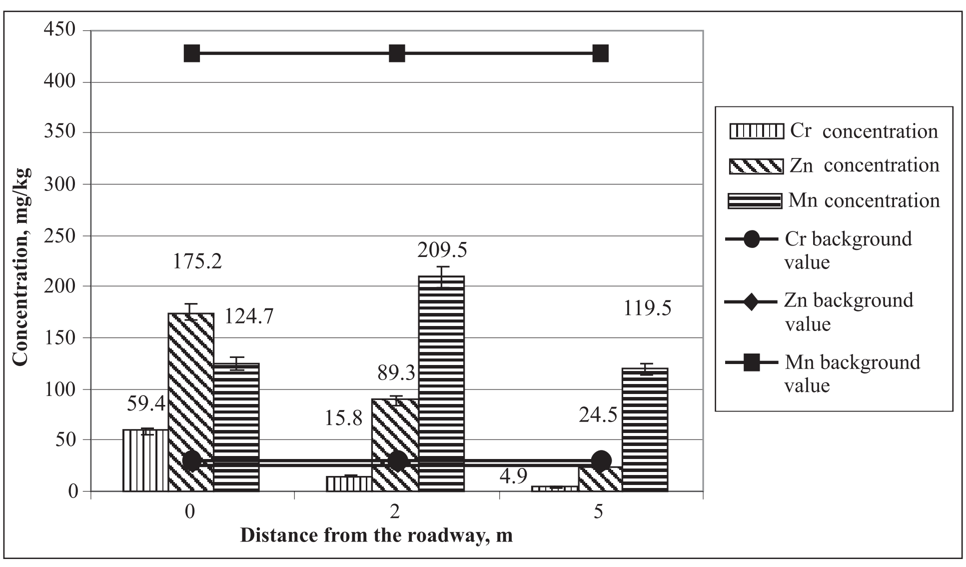

Fig. 4. Concentrations of Cr, Zn, Mn in the roadside soil of the Vilnius–Panevėžys highway (A2), 18th km

4 pav. Cr, Zn, Mn koncentracijos Vilnius–Panevėžys (A2) magistralės 18 km pakelės dirvožemyje

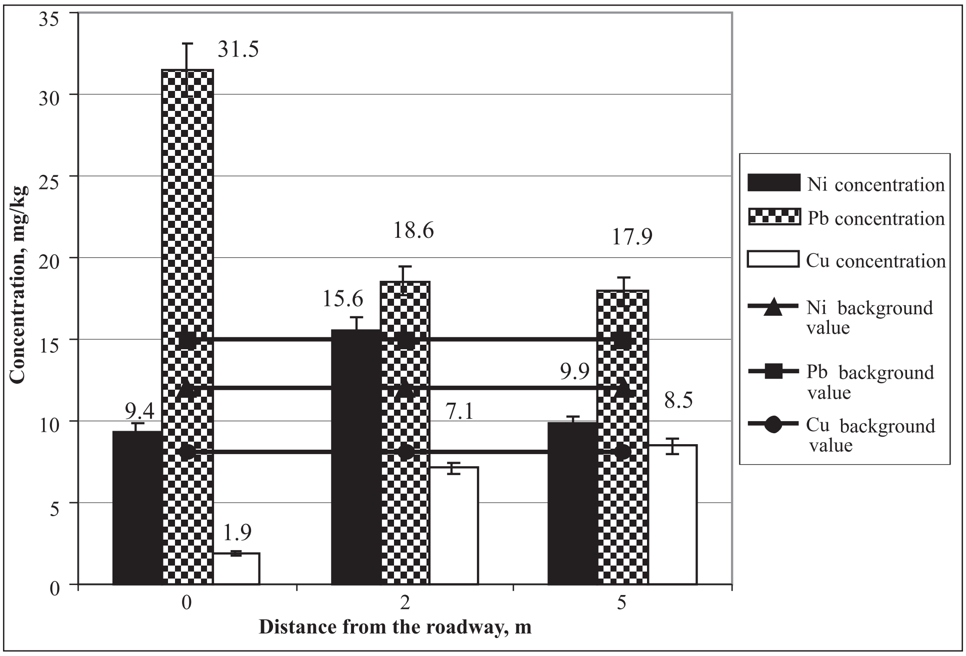

Fig. 5. Concentrations of Ni, Pb, Cu in the roadside soil of the Vilnius–Varėna–Grodno highway (A4), 49th km
5 pav. Ni, Pb, Mn koncentracijos Vilnius–Varėna–Gardinas magistralės (A4) 49 km pakelės dirvožemyje

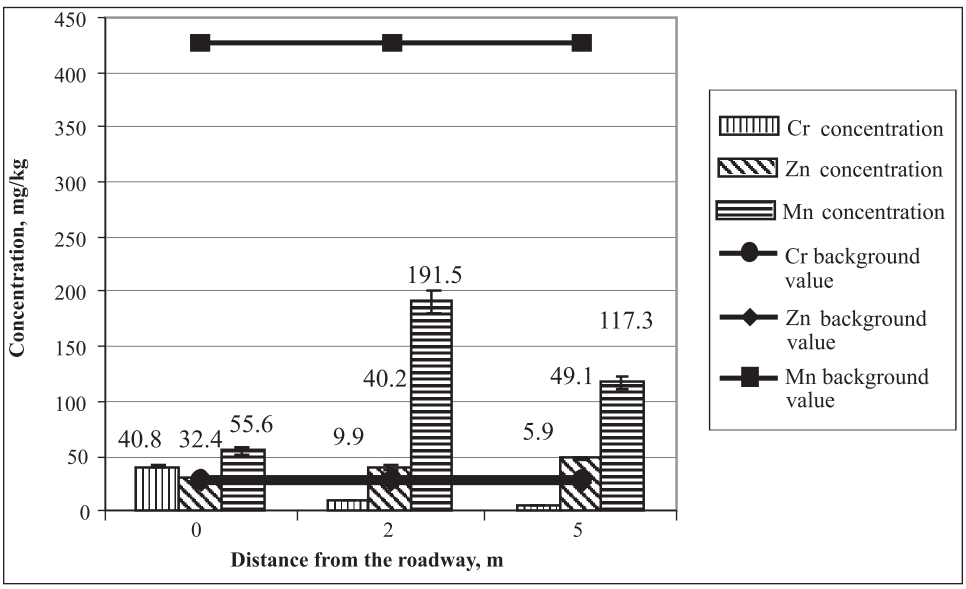

Fig. 6. Concentrations of Cr, Zn, Mn in the roadside soil of the Vilnius–Varėna–Grodno highway (A4), 49th km
6 pav. Cr, Zn, Mn koncentracijos Vilnius–Varėna–Gardinas (A4) magistralės 49 km pakelės dirvožemyje

As the above data show (Figs. 5, 6), concentrations of heavy metals are higher at a 5-m distance from the roadway. Since there is a road ditch in this place, it can be assumed that heavy metals are transported by rain wastewater or wind away from the roadway and settle on the external slope of the road ditch.

The Vilnius–Utena highway (A14). Sampling was done at the 17th km. The road goes along an embankment, localities are open, no road ditches are present. Individual mature pine-trees grow by the road.

Ni concentration determined in the soil samples collected by the roadway of the A14 highway did not exceed the background level. The background level in samples collected away from the road was exceeded 1.4 times. Pb concentrations did not exceed the background level in any of the samples. The highest determined concentration of this metal reached 14.5 mg/kg. Cu concentrations in all the samples were close to the background level. The highest Cu concentration 1.1 times exceeded the background level (Fig. 7).

The determined Cr concentrations vary from 5.1 mg/kg to 34.7 mg/kg. The highest Cr concentration exceeded the background level nearly 1.2 times, and the lowest concentration of Cr was nearly 6 times below the background level. The highest Zn concentration was determined in samples taken by the roadway. Here it reached 59.8 mg/kg, which is 2.3 times more as compared with the background level. Zn concentration was decreasing with increasing the distance from the roadway. Mn concentration did not exceed the background level in any of the collected samples. The highest Mn concentration reached 184.2 mg/ kg and the lowest 74.8 mg/kg (Fig. 8).

Based on the obtained findings (Figs. 7, 8), it can be concluded that the concentrations of the majority of heavy metals in this sampling profile decrease with increasing the distance from the roadway.

The Vilnius–Prienai–Marijampolė highway (A16). Sampling was done at the 24th km. There are no residential houses in

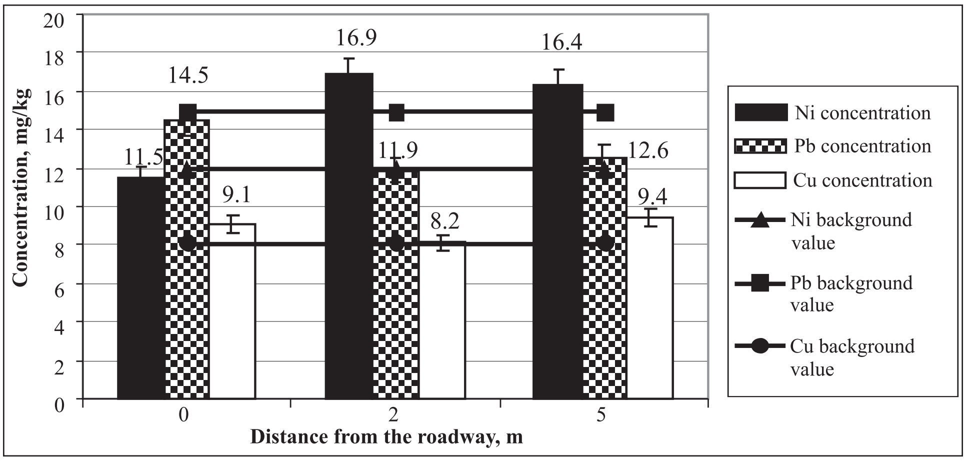

Fig. 7. Concentrations of Ni, Pb, Cu in the roadside soil of the Vilnius–Utena highway (A14), 17th km

7 pav. Ni, Pb, Cu koncentracijos Vilnius–Utena (A14) magistralės 17 km pakelės dirvožemyje

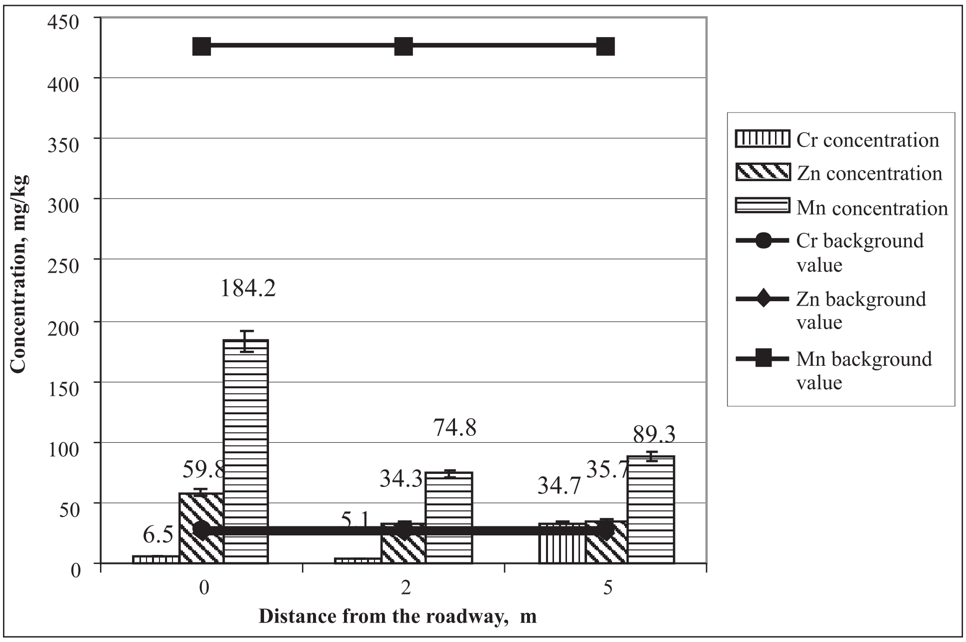

Fig. 8. Concentrations of Cr, Zn, Mn in the roadside soil of the Vilnius–Utena highway (A14), 17th km

8 pav. Cr, Zn, Mn koncentracijos Vilnius–Utena (A14) magistralės 17 km pakelės dirvožemyje

the sampling place. A small wood and buckthorn bushes stretch on the left side of the road, and there are many fir trees there. The right side of the road is dominated by open localities, young fir and birch tree woods and uncultivated lands there. There are no road ditches there. The roadsides are narrow, of technogenic soil.

Ni concentration determined in roadside soil of the 24st km of the A16 highway varied from 10.9 mg/kg to 18.2 mg/kg. The background level was exceeded 1.5 times. Pb concentrations in all the samples exceeded the background level but were not in excess of the MPC. The highest Pb concentration was recorded in samples collected by the roadway (22.9 mg/kg), where it was 1.5 times above the background level. The lowest Pb concentration was determined at a 5-m distance from the roadway. Here it reached 18.4 mg/kg and was 1.2 times higher than the background level. Cu concentrations determined in this profile exceeded the background level 1.1 to 1.4 times. With a distance from the roadway increasing Cu concentration was decreasing (Fig. 9).

Cr concentrations determined in this profile did not exceed the background level. The highest Cr concentration was 2.9 times below the background level. The highest Zn concentration was recorded by the roadway. Here it reached 170.5 mg/kg, which is 6.6 times above the background level, but the MPC was not exceeded. With increasing the distance from the roadway, Zn concentration was decreasing and at a 5-m distance reached 38.9 mg/kg, i. e. it was 1.5 times higher than the background level. Mn concentrations did not exceed the background level. The highest Mn concentration reached 375.4 mg/kg and the lowest 80.1 mg/kg and was 1.1 to 5.3 times lower than the background level (Fig. 10).

A comparison of heavy metal concentrations in soil on the roadsides of the Vilnius–Kaunas–Klaipėda and Vilnius–Panevėžys highways shows that Ni concentration did not exceed the MPC in any of the sampling profiles. The determined concentrations of this metal only slightly differ. Ni concentration determined by the roadway of the Vilnius–Kaunas–Klaipėda highway is up to 1.7 times higher than that recorded at the same distance from the Vilnius–Panevėžys highway. Ni concentration at a 5-m distance from the roadways of the mentioned highways differs more than 1.9 times. Pb concentrations did not exceed the MPC at the mentioned highways. A comparison of our find-

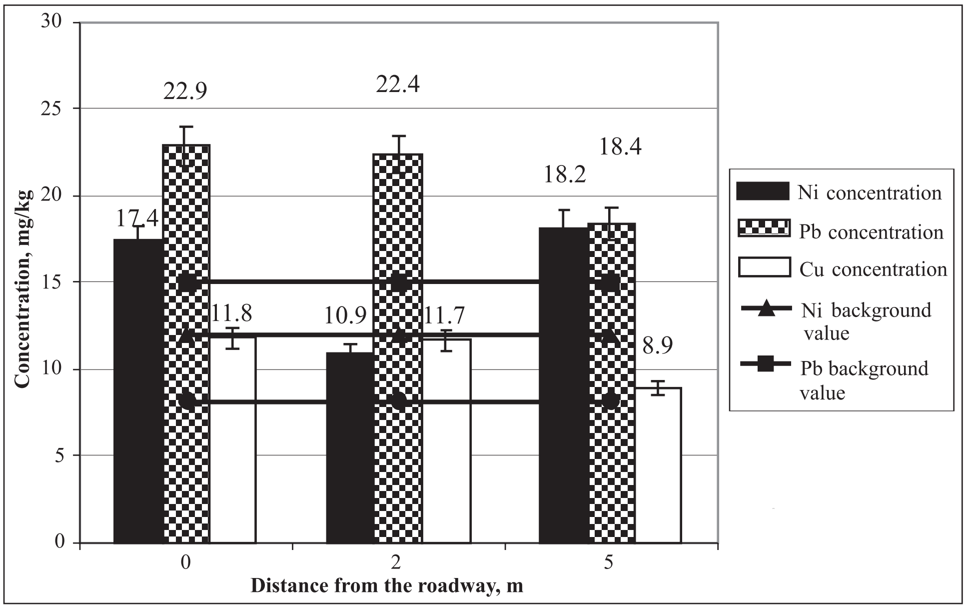

Fig. 9. Concentrations of Ni, Pb, Cu in the roadside soil of the Vilnius–Prienai–Marijampolė highway (A16), 24th km

9 pav. Ni, Pb, Cu koncentracijos Vilnius–Prienai–Marijampolė (A16) magistralės 24 km pakelės dirvožemyje

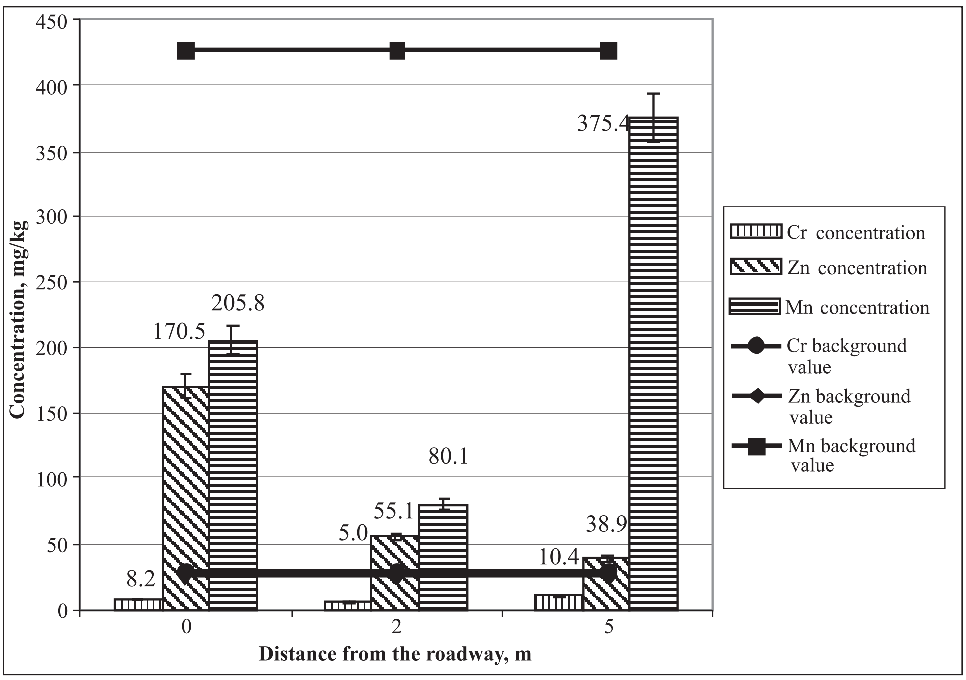

Fig. 10. Concentrations of Cr, Zn, Mn in the roadside soil of the Vilnius–Prienai–Marijampolė highway (A16), 24th km

10 pav. Cr, Zn, Mn koncentracijos Vilnius–Prienai–Marijampolė (A16) magistralės 24 km pakelės dirvožemyje

ings shows that a somewhat bigger amount of Pb has accumulated by the Vilnius–Panevėžys highway, but there is no great difference between Pb concentrations at a distance of 0 and 2 m from the roadways of these highways. These concentrations are up to 3.9 times higher in samples taken at a 5-m distance by the Vilnius–Panevėžys highway as compared with the Vilnius–Kaunas–Klaipėda highway.

The determined Cu concentrations did not exceed the MPC. Higher Cu concentrations were recorded by the Vilnius–Panevėžys highway. The highest concentration of this metal was determined by the roadway of this highway (21.8 mg/kg), and that of 13.4 mg/kg was recorded by the Vilnius–Kaunas–Klaipėda highway. The lowest Cu concentration (3.4 mg/kg) was recorded in soil at a 5-m distance from the roadway of the A1 highway.

The determined Zn concentrations did not exceed the MPC. Zn concentrations by the roadways of the Vilnius–Kaunas–Klaipėda and Vilnius–Panevėžys highways were equal to 74.6 mg/kg and 175.2 mg/kg, respectively, and were lower at a distance of 5-m (40.1 mg/kg and 24.5 mg/kg).

The determined Mn concentrations exceeded neither the MPC nor the background level in the roadside soil of the highways in question. The determined Mn concentrations only slightly differ in both roadsides. A comparison of heavy metal concentrations in the highways A1 and A2 shows that these concentrations in soils of both highway roadsides do not exceed the permissible norms.

A comparison of heavy metal concentrations in roadside soils of the Vilnius–Varėna–Grodno, Vilnius–Utena and Vilnius–Prienai–Marijampolė highways was done assuming that these highways are characterized by equal loading. Ni concentrations in the roadside soils of the mentioned highways differ insignificantly and are close to the background level. No excess of the MPC was recorded.

Pb concentrations did not exceed the MPC in any of the samples. In the roadside soils of the highways, they exceeded the background level up to 2.2 times (Vilnius–Varėna–Grodno). The Pb concentration determined by the Vilnius–Utena highway is nearly the same as the background level in all the collected samples. Somewhat higher concentrations were determined on the roadsides of the Vilnius–Varėna–Grodno and Vilnius–Prienai–Marijampolė highways, but the permissible values were not exceeded.

The determined Cu concentrations did not exceed the MPC. The lowest Cu concentration on the roadsides of these highways was up to 1.9 mg/kg (Vilnius–Varėna–Gardinas), and the highest Cu concentration reached 11.8 mg/kg (Vilnius–Prienai–Marijampolė).

The determined Cr concentrations did not exceed the MPC. Somewhat higher Cr concentrations were recorded on the roadsides of the Vilnius–Varėna–Grodno highway where the background level (30 mg/kg) was exceeded up to 1.3 times. The lowest Cr concentration (5.0 mg/kg) was determined in the roadsides of the Vilnius–Prienai–Marijampolė highway. This concentration is 6 times lower than the background level.

The highest Zn concentration reached 170.5 mg/kg (in the roadsides of the Vilnius–Prienai–Marijampolė highway), but the MPC (300 mg/kg) was not exceeded. The lowest concentration of this metal (32.4 mg/kg) was recorded in the roadsides of the Vilnius–Varėna–Grodno highway.

Zn concentrations in all the samples exceeded the background level but did not exceed the MPC. Mn concentration in soil samples collected near the highways in question exceeded neither the MPC nor the background level. The lowest concentration of this metal (55.6 mg/kg) was determined in the roadside soil of the Vilnius–Varėna–Grodno highway, and the highest (375.4 mg/kg) by the Vilnius–Prienai–Marijampolė highway.

CONCLUSIONS

Analysis of data collected in the present study shows that the concentration of heavy metals (Ni, Pb, Cu, Cr, Zn, Mn) did not exceed the MPC in any of the samples, indicating that pollution with heavy metals on the roadsides of Lithuanian highways is not high, but roadside monitoring is necessary because the transport flows are growing.

The highest determined Ni concentration in the roadsides of the Vilnius–Kaunas–Klaipėda highway is 1.6 times above the background level. The concentration of Pb exceeded the background level up to 2.4 times and that of Cr up to 1.65 times. On the roadsides of this highway, Cr concentration exceeded the background level up to 1.6 times, Zn concentration up to 2.9 times. Mn concentration did not exceed the background level in any of the points.

On the roadsides of the Vilnius–Panevėžys highway, Ni concentration exceeded the background level 1.3 times. The concentration of Pb exceeded the background level 2.5 times and that of Cu 2.7 times. Cr concentration determined by this highway was 2 times higher than the background level. The highest concentration of Zn exceeded the background level up to 6.7 times, and Mn concentration did not exceed the background level.

The highest concentration of Ni determined by the Vilnius–Varėna–Grodno highway 1.3 times, that of Pb up to 2.1 times, Cr up to 1.4 times, Zn up to 1.9 times exceeded the background level. Cu concentration was nearly equal to the background level, and Mn concentration did not exceed the background level.

Pb and Mn concentrations in the roadside soil of the Vilnius–Utena highway did not exceed the background level. The concentration of Ni exceeded the background level up to 1.4 times, that of Cu 1.1 times, of Cr up to 1.2 times, of Zn up to 2.3 times.

Cr and Mn concentrations in the roadside soil samples of the Prienai–Marijampolė highway did not exceed the background level. The concentration of Pb exceeded the background level up to 1.5 times, of Cu up to 1.4 times, Zn up to 6.6 times.

The concentrations of some heavy metals (Mn, Pb, Ni) at a 5-m distance from the roadway were higher than those by the roadway or at a 2-m distance from it (Figs. 2, 3, 9, 10). This allows us concluding that higher concentrations of heavy metals may also be detected at larger distances from the road. The distribution of heavy metals in soil is predetermined by traffic intensity on the road (number of vehicles / day), predominant wind direction, soil type and vegetation (Zinkutė et al., 2007). Another important factor is the geomorphologic position of a road (whether the road is built along a bed or a pit, the presence or absence of road ditches, whether the road is surrounded by a wood or is in an open locality) as well as the values of atomic masses of heavy metals (Cr – 52, Mn – 55, Ni – 59, Cu – 63, Zn – 65, Pb – 207). Under favourable conditions of spreading, heavy metals, even with bigger atomic masses, can spread to larger distances from a roadway.

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SUNKIŲJŲ METALŲ KONCENTRACIJŲ TYRIMAI LIETUVOS MAGISTRALIŲ PAKELIŲ DIRVOŽEMYJE

Santrauka

Didėjant transporto priemonių skaičiui, tikslinga nagrinėti magistralių pakelių dirvožemio taršą sunkiaisiais metalais. Straipsnyje nagrinėjama magistralių Vilnius–Kaunas–Klaipėda (A1), Vilnius–Panevėžys (A2), Vilnius–Varėna–Gardinas (A4), Vilnius–Utena (A14) bei Vilnius–Prienai–Marijampolė (A16) pakelių tarša sunkiaisiais metalais. Analizuojami šeši sunkieji metalai – nikelis (Ni), varis (Cu), chromas (Cr), švinas (Pb), cinkas (Zn) ir manganas (Mn), dažniausiai išsiskiriantys autotransporto priemonių eksploatavimo metu. Tyrimais nustatyta, jog analizuojamų sunkiųjų metalų koncentracijos dirvožemyje neviršijo didžiausių leistinų koncentracijų (DLK), tačiau skirtingi sunkieji metalai magistralių pakelėse foninius kiekius viršijo 1,3–6,7 karto.

Nustatyta, jog kai kurių sunkiųjų metalų (Mn, Pb, Ni) koncentracijos, rastos 5 m atstumu nuo važiuojamosios kelio dalies, yra didesnės nei prie važiuojamosios kelio dalies ar 2 m atstumu nuo jos. Tai leidžia daryti prielaidą, jog didelės sunkiųjų metalų koncentracijos gali būti aptiktos ir toliau nuo kelio. Sunkiųjų metalų koncentracijų pasiskirstymą dirvožemyje lemia eismo intensyvumas kelyje (automobilių skaičius / parą), vyraujanti vėjų kryptis, dirvožemio tipas, auganti augalija, taip pat kelio geomorfologinė padėtis (ar nutiestas sankasoje, ar iškasoje, ar yra kelio grioviai ir koks jų nuolydis, ar kelią supa miškas, ar jis yra atviroje vietovėje) bei sunkiųjų metalų atominės masės reikšmės. Esant palankioms sklaidos sąlygoms, sunkieji metalai net su didesne atomine mase gali pasklisti didesniu atstumu nuo važiuojamosios kelio dalies.

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ИССЛЕДОВАНИЕ КОНЦЕНТРАЦИЙ ТЯЖЕЛЫХ МЕТАЛЛОВ В ПОЧВЕ ОБОЧИН МАГИСТРАЛЬНЫХ ДОРОГ

Резюме

В связи с увеличением количества транспортных средств целесообразно исследовать загрязнение почвы обочин магистральных дорог тяжелыми металлами. В статье осуществлен анализ загрязнения тяжелыми металлами почвы около магистральных дорог Вильнюс–Каунас–Клайпеда (A1), Вильнюс–Панявежис (A2), Вильнюс–Варена–Гродно (A4), Вильнюс–Утена (A14) и Вильнюс–Пренай–Мариямполе (A16). Исследованы шесть тяжелых металлов: никель (Ni), медь (Cu), хром (Cr), свинец (Pb), цинк (Zn) и марганец (Mn), чаще всего выделяемые транспортными средствами. Установлено, что концентрации названных тяжелых металлов в почве не превышали максимальных допустимых концентраций, однако в целом концентрации тяжелых металлов в почве обочин магистральных дорог превышали фоновые значения в 1,3–6,7 раза. Исследованиями установлено, что концентрации некоторых тяжелых металлов (Mn, Pb, Ni) на расстоянии 5 м от проезжей части дороги выше, чем около проезжей части или на расстоянии 2 м от нее. На этом основании можно предположить, что высокие концентрации тяжелых металлов могут скапливаться и на бóльших расстояниях от дороги. Распределение концентраций тяжелых металлов в почве обусловлено интенсивностью движения на дороге (число автомобилей / сутки), господствующими направлениями ветров, типом почвы, растительностью. Имеют значение также геоморфологическое расположение дороги (проложена по ровному полотну или по выемке, имеются ли на ней канавки, каков уклон канавок, окружена дорога лесами или проложена по открытой местности), а также значения атомных масс тяжелых металлов. При благоприятных условиях распределения тяжелые металлы даже при бóльших атомных массах могут оказаться на значительно больших расстояниях от проезжей части дороги.