

Heavy metals contamination of irrigated soils around highways

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Abstract. The article provides information on the influence of the Tashkent-Termiz M-39 highway of the Republic of Uzbekistan on the amount of copper, zinc and lead in the irrigated meadow soils around the road. The total amount of copper, zinc and lead in the soil has increased due to the emissions of motor vehicles traveling on the highway. Heavy metal pollution has a maximum value at a distance of 20 m from the road. In the Tashkent-Termiz direction, lead in the soil on the left side of the road has a maximum value of 68.2 mg/kg at a distance of 25 m from the road; and the maximum value of copper and zinc was determined at a distance of 20 m from the road and they are 85.3, respectively; equal to 127.4 mg/kg. The total amount of copper, zinc and lead decreases with distance from the above mentioned distances. Heavy metals accumulate mainly in the upper layer rich in organic matter of the studied soils and decrease toward the lower layers according to a certain law.

1 Introduction

Globally, motor transport has become one of the main sources of environmental pollution. The number of cars that are driven by the combustion of petroleum products is constantly increasing, and the emissions released from them cause pollution of air, soil and water sources. Among the sources of environmental pollution, motor transport is of particular importance. Because the pollution of industrial enterprises is local, the road stretches for a long distance, on which vehicles move non-stop throughout the day, and is one of the main sources of soil pollution near the road. [1].

Soils around highways are mainly contaminated with heavy metals such as lead, copper, zinc, cadmium, nickel, and chromium. Among them, the most toxic metal is lead. [2].

Soil pollution is mainly airborne and accumulates and persists longer in the soil than in other layers of the biosphere, and has a greater negative impact on the ecosystem. [3].

Contamination of soils around highways with various harmful compounds and heavy metals has been studied by researchers. Soil pollution with heavy metals is caused by fuel burning of cars, wear and tear of tires, and emissions from explosions during braking [4-7].

Road traffic soil pollution has been studied by many researchers [8,9]. According to the literature, the widespread use of cars significantly pollutes the environment, including soil, air and water bodies with heavy metals [10].

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Zn, Cd, Cu, Ni, Cr enter the soil as a result of the activities of motor vehicles, and the most widespread and harmful among them is lead. Contamination of the soil surface with traffic emissions varies depending on the number of vehicles and continues for some time even after traffic stops on the road [11-13].

Heavy metals are distributed in the soil mainly in two ways - natural and man-made. The man-made share of environmental pollution of copper and zinc is 75 percent, the share of cadmium and mercury pollution is 50 percent, the share of nickel pollution is 30 percent, cobalt pollution is 10 percent, and lead pollution is 50-80 percent [14,15].

Contamination of the soil of the natural environment with heavy metals has a negative impact on the stability and productivity of the existing ecosystems and on the number and diversity of plants. Therefore, monitoring soil contamination with heavy metals is one of the important tasks [16,17].

Heavy metal contamination of irrigated soils in the conditions of Uzbekistan was determined by the amount of heavy metals such as Zn, Cu, Pb, Cr, Ni in Samarkand chemical plant "Shortangazkimyo" gas processing enterprise, Almalyk mining and metallurgical combine, Angren state station. [18,19]. The level of heavy metal pollution of the soil around the studied industrial enterprises mainly depends on the wind direction, and the increase of metals in the soil had a negative effect on its ecological status and productivity [20,21].

The higher the speed of the cars, the greater the amount of harmful substances emitted from them. Soils around high-traffic roads are also more heavily contaminated with heavy metals [22].

The release of heavy metals into the environment as a result of motor vehicle activity depends on the fuel consumption, engine oil, tire wear, braking process, road condition and a number of other factors. Cadmium is released as a result of engine oil wear, zinc as a result of tire wear, copper and lead as a result of brake pad wear [23-25].

Bituminous and mineral aggregates (gravel, crushed stone) of asphalt pavements contain various heavy metal compounds such as Cu, Zn, Cd and Pb. They mainly fall into roadside soils through precipitation or other water flow [26,27].

The maximum amount of zinc in the forest-podzol soils around the highway of the Republic of Belarus was recorded from 8.86 to 41.05 mg/kg. The maximum pollution with zinc was observed at distances of 5-25 meters from the road.

At this distance, the mobile form of zinc was found to be higher than its permissible limit (23 mg/kg). In the studied plots, the amount of lead varied from 25.79 to 15.97 mg/kg at a distance of 200 meters from the road, and it was 215-130% more than that of lead (12 mg/kg). However, it did not exceed sanitary standards (32 mg/kg) [28].

The maximum amount of gross lead was 55 mg in 1 kg of soil at a distance of 30 meters from the highway, and the amount of zinc was equal to 74 mg. The increase in the amount of heavy metals in the soil. it is noted that it disrupts the ecological status and, as a result, has a negative effect on the amount of nitrate and nitrogen in the form of ammonium in the soil [29,30].

The maximum amount of lead and nickel in the irrigated grassland soils of the M-39 international highway "Tashkent-Termiz" was 61 and 78 mg/kg, respectively, 25 meters away from the highway, and zinc was 76 mg/kg, 10 meters away. The maximum amount of mobile lead in these soils was 24.0 mg/kg, 5 meters away from the highway, and 28 mg/kg of mobile zinc, 20 meters away. The maximum amount of mobile nickel at a distance of 10 meters from the road is 19.5 mg/kg [31,32]. The given information There is very little information about the impact of vehicle emissions on roadside soils in the territory of Uzbekistan.

The purpose of the study. Determination of the total amount of heavy metals in the soils of the Bakhmal massif, Sirdarya region, the largest Tashkent-Termiz M-39 highway in Uzbekistan.

2 Research object and methods

Natural conditions of the researched area: The research was conducted in the conditions of irrigated gray-meadow soils in the part of the "Tashkent-Termiz" international M-39 highway, Sardoba district, Sardoba region, which passed the border of the Bakhmal massif.

According to the information of "Syrdarya Meteorological Station", the average annual air temperature of the Syrdarya region is around $+13.5^{\circ}$ - 14.8° C. The highest temperature is July, and the coldest is December. The duration of frost-free days is 200-236 days. Syrdarya region is located in the zone where strong winds cross, and the area is strongly influenced by the north and east (Bekabad wind). The main part of the wind blows more from the east and is most common in May-June. Wind speed reaches 3.2 m/sec. The annual average wind speed is as follows N-22%, NE-18%, E-40%,SE-18%, S-34%,SW-16%, W-28%, NW-28%.

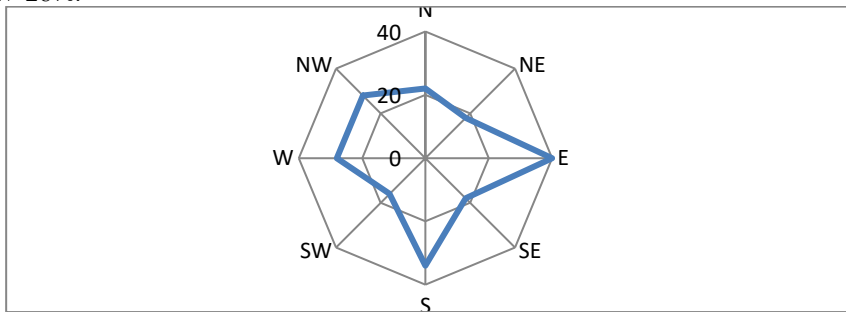


Fig. 1. "Windflower" graph of the area

3 Research methods

Soil sampling: 50 meters from the highway in order to study the granulometric composition, physical and agrochemical properties of irrigated gray-meadow soils distributed in the section of the M-39 highway "Tashkent-Termiz" beyond the border of Bakhmal massif, Sardoba district, Syrdarya region, and to study the distribution of heavy metals along the soil profile. a soil section was taken at a distance.

Soil samples were taken every 5 meters from the highway up to 100 meters, every 10 meters up to 200 m, every 25 meters up to 300 m, every 50 meters up to 500 m, and every 100 meters up to 1000 meters. The weight of each average sample was 1000 grams. [33,34].

4 Laboratory analyses

The mechanical composition of the soil - according to Kachinsky, by the pipette method; specific mass of the soil-by the pycnometer method; volume mass of the soil-cylinder method; soil porosity - by calculation, soil humus - by the Tyurin method; gross NRC - by the Maltseva-Gritsenko method in one sample; N-NO₃-Grandwald-Lyaju method; N-NN₄-Nessler reagent; mobile phosphorus - according to the Machigin-Protasov method in an alternating potassium-flame photometer; total amount of copper, zinc and lead was determined by dissolving in HCl:HNO₃ (3:1) solution in ICP-OES.

5 Discussion of the research results

According to the results of the conducted research, the volume mass of gray-meadow soils spread around the section of the Tashkent-Termiz highway passing through the area of Bakhmal massif, Sardabo district, Sirdarya region, varies between 1.28-1.59 g/cm³ along the horizons. In this case, the smallest indicator of density was recorded in the top 0-30 cm soil layer and increases downwards along the soil section (Table 1).

Under the impact of agricultural machines, the sub-layer is denser (1.38 g/cm³). The volume mass of the horizon after the driving sublayer has decreased again (1.35 g/cm³). Starting from the lower 87-130 cm layer, the volume mass increased again, and the highest density index was recorded in the lower 130-190 cm layer (1.59 g/cm³).

Table 1. M-39 General physical properties of soils around the highway

Depth, cm	Relative mass, g/cm ³	Bulk density, g/cm ³	Total porosity, %
0-30	2,60	1,28	50,7
30-47	2,61	1,38	47,1
47-87	2,64	1,35	48,8
87-130	2,64	1,45	45,0
130-190	2,67	1,59	40,4

The total porosity of the soil varies depending on its volume and specific mass. The highest porosity was observed in the upper 0-30 cm layer of the soil (50.7 %), and the porosity decreased from the upper layer to the lower layer, and the smallest porosity was recorded in the 130-190 cm layer of the section. Here, the porosity was 40.4 percent.

According to the analysis, the amount of humus in the studied soils is around 1.02 percent in the upper 0-30 cm layer of the soil and decreases downwards along the soil profile. These soils are low in gross and mobile nutrients (NPK) necessary for plants. In the upper 0-30 cm soil layer, total nitrogen content is 0.11%, total phosphorus content is 0.12%, and total potassium content is 1.87%. It was noted that the amount of nutrients in mobile form is: N-NO₃ -17.0 mg/kg, N-NH₄ -20.2 mg/kg, P₂O₅ -24.2 mg/kg, K₂O -260 mg/kg. The absorption capacity of the soil is 16 mg/eq in the 0-30 cm layer and decreases downwards along the soil cross-section.

Table 2. Agrochemical properties of soils around the M-39 highway

Depth, cm	Humus, %	Total, %			Mobile N, P, K mg/kg				Absorption capacity mg/eq
		N	P	K	N-NO ₃	N-NH ₄	P ₂ O ₅	K ₂ O	
0-30	1,02	0,11	0,12	1,87	17,0	20,2	24,2	260	16
30-47	0,77	0,08	0,09	1,71	8,6	17,2	18,1	200	14
47-87	0,61	0,071	0,075	1,51	5,0	10,5	15,4	100	10
87-130	0,50	0,068	0,061	1,22	4,7	8,0	15,0	104	8
130-190	0,40	0,057	0,047	0,87	4,0	7,6	10,2	85	7

The amount of copper in these soils has increased due to emissions from vehicles. The amount of copper gradually increased up to 25 meters from the highway. For example, at a distance of 5 meters it is 71.3 mg/kg, and at a distance of 10 meters it is 72.1 mg/kg. The maximum amount of copper in the soil was 85.3 mg per 1 kg of soil, and this indicator was recorded 20 meters away from the highway (Figure 2.). At a distance of up to 75 meters from the highway, the total amount of copper was 70 mg/kg, and at a distance of 100 meters, it was 60 mg/kg. Assuming that the permissible limit for the total amount of copper in soil (REM) is 55 mg/kg, 100 meters from the highway is 1.5 times the REM. Soils

containing 40 mg/kg or more copper were monitored up to 700 meters away, and soils with 30 mg/kg or more copper were monitored up to 800 meters away.

The total amount of copper in the khaydov layer of soil 0-30 cm was 71.3 mg/kg at a distance of 5 m near the road, 72.1 mg/kg at 10 m, and 85.3 mg/kg at 20 m. The total amount of copper at a distance of 20 m corresponds to the maximum. This is 30.3 mg/kg more than REM. The total amount of copper (83.0 mg/kg) decreases from 30 m from the road and reaches 22.2 mg/kg at a distance of 1000 m. The gross amount of lead also initially increases with distance from the road. In the soil 5, 10, 20, 30 meters away from the road, the total amount of lead increases from 60.8 mg/kg to 65.2 mg/kg, and the maximum amount corresponds to the distance of 30 m. Then, from 40 m to 1000 m, the amount of total lead decreases from 59.2 mg/kg to 13.6 mg/kg. The maximum total amount of lead was observed at 10 m compared to the maximum amount of copper and was found to be 33.2 mg/kg compared to REM.

Total zinc, like copper and lead, increased gradually from 5 m to 20 m from the road, and a maximum of 127.4 mg/kg was recorded at 20 m from the road.

Total zinc content in the soil 20 m away from the highway exceeded its permissible limit by 27.4 mg/kg. From a distance of 40 meters from the road, the amount of zinc was less than the permissible limit of this element, and at a distance of 150 m from the road it was 50.3 mg/kg, and at 1000 m it was equal to 35.6 mg/kg. Total copper was below the REM (53.2 mg/kg) at 150 m from the road, for lead at 300 m (27.2 mg/kg) and for zinc at 40 m (98.2 mg/kg). kg) corresponded to. Therefore, the lowest level of zinc in relation to the total amount of REM is 40 m closest to the road, copper is 150 m, and lead is 300 m. The area of soil contamination with lead was found to be higher than that of copper and zinc.

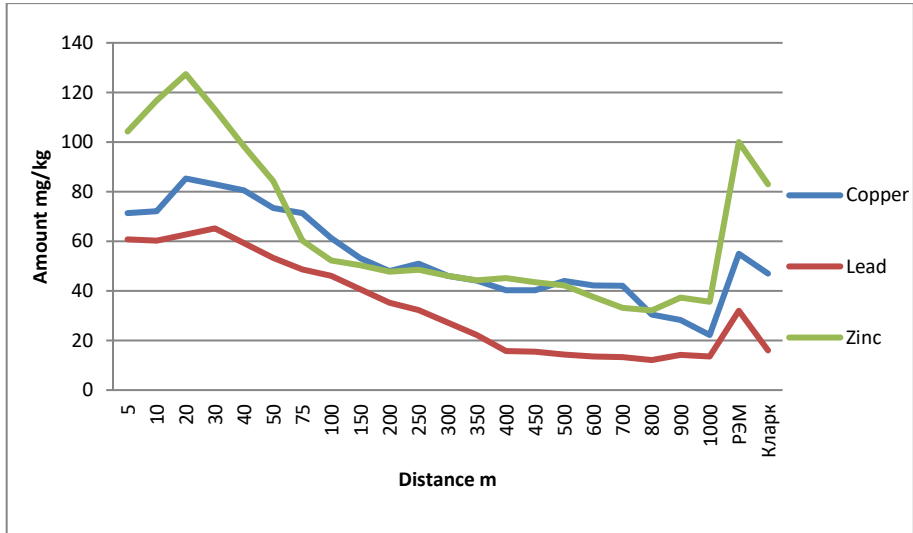


Fig. 2. Gross content of heavy metals in soils around Tashkent-Termiz M-39 highway. 0-30cm.

It is known that all the elements in the soil are not evenly distributed along its horizontal layers, the main reason for the non-uniform distribution of the elements depends on its mineralogical, mechanical composition, humus content, environmental reaction and other factors.

The amount of heavy metals along the profile of gray-meadow soils decreases along the soil horizon from the tillage layer to the lower layers. In the upper 0-30 cm layer of the soil,

the total amount of copper was 75.7 mg/kg, lead was 55.2 mg/kg, and zinc was 82.6 mg/kg. (Figure 3).

The total amount of copper is 37.2 mg/kg in the 30-47 cm layer, 21.2 mg/kg in the 47-87 cm layer, 17.2 mg/kg in the 87-130 cm layer, and 10.4 mg/kg in the 130-190 cm layer. was kg.

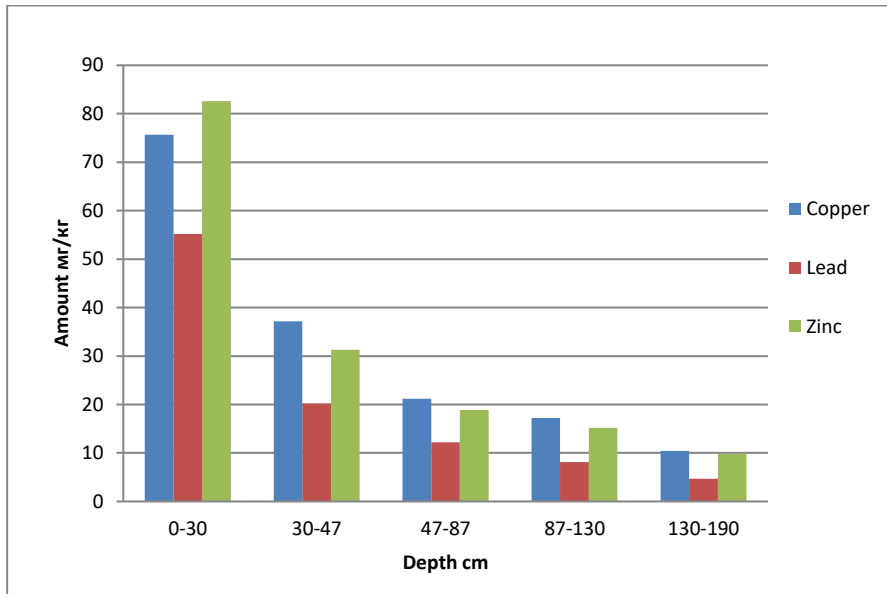


Fig. 3. Changes in the total amount of heavy metals in the soil profile.

Also, the total amount of lead and zinc decreased along the soil profile as it descended into the lower layers. The total amount of copper, lead and zinc in the 0-30 cm layer is 75.7, respectively; 55.2; 82.6 mg/kg, and their amount in the 130-190 cm layer is 10.4; 4.7; 9.8 was found to be mg/kg.

6 Conclusion

The amount of heavy metals in the irrigated grassland soils was influenced by the emissions released as a result of the activities of vehicles moving on highway roads, the emissions increased the content of copper, lead and zinc in the grassland soils. Heavy pollution with these elements was noted mainly at a distance of up to 30 meters from the highway. After this distance, the amount of heavy metals gradually decreases. Heavy metals accumulate in the upper organic matter-rich layer of gray-meadow soils and decrease according to a certain law.

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