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Migration of heavy metals in the soil profile of machine

Maharramova Sevinj Gizi Telman

Department of Biology and Ecology, Odlar Yurdu University, Baku, AZ1072, **Azerbaijan**

***Correspondence:** sevinc.m63@gmail.com **Received: Aug., 22, 2024 Revised: Oct., 10, 2024, Accepted: Oct., 12, 2024 e-Published: Oct., 20, 2024**

This article is about soil pollution and focuses specifically on the effects of heavy metals on this pollution. The article states that heavy metals can be a source of soil pollution and that this pollution can spread near roads in different ways. It is emphasized that heavy metal pollution can be caused by both natural and human factors. It is also reported that hydrometric conditions, climatic factors and air pollution can contribute to soil pollution by influencing vehicle emissions. It is also reported that this pollution can spread to a wider area through winds. This article examines the influence of conditions around the highway on heavy metal pollution. According to research, air masses moving along roadsides generally blow from the west and east. For this reason, roadsides are generally more affected by dust, mold and pollution. Humidity also affects the distribution of heavy metals. Precipitation decreases rapidly under the influence of moisture and washes away impurities. Studies show that zinc-contaminated soils are generally found in sandy layers. Zinc is more unevenly distributed in the soil profile. Zinc is more widely distributed through erosion in the soil profile, especially in fresh soils. Soils with high organic content and granulometry inhibit the downward movement of zinc within the profile. It should be emphasized that as zinc passes through the soil profile, its effect on microorganisms increases. Compared to lead and cadmium, it can be more harmful. It is known that migration of heavy metals in the soil profile depends on its density, granulometric composition and power of many organic compounds. In order to study the migration of heavy metals, soil sections were placed in the soil profile of the research areas. To characterise it by depth, soil samples were taken from several locations at a depth of one metre. The article discusses the migration of heavy metals and the factors affecting the types of soils located near

Keywords: Heavy metal, Pollution, Migration, Vehicle, Profile

INTRODUCTION

Heavy metals are defined as metallic elements that have a relatively high density compared to water Fergusson, 1990) With the assumption that heaviness and toxicity are inter-related, heavy metals also include metalloids, such as arsenic, that are able to induce toxicity at low level of exposure (Duffus, 2002). In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by these metals. Also, human exposure has risen dramatically as a result of an exponential increase of their use in several industrial, agricultural, domestic and technological applications (Bradl, 2002). Reported sources of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources (He and Yang, 2005). Environmental pollution is very prominent in point source areas such as mining, foundries and smelters, and other metal-based industrial operations (Fergusson, 1990, Bradl, 2002, He et al., 2005).

Although heavy metals are naturally occurring elements that are found throughout the earth's crust, most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds (He ZL and Yang XE,2005–6). Environmental contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water (Nriagu, 1989). Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution (Fergusson, 1990, Bradl, 2002, He et al., 2005, Shallari et al.1998, Nriagu, 1989). Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high tension lines, plastics, textiles, microelectronics, wood preservation and paper processing plants (Arruti et al. 2010; Pacyna, 1998).

It has been reported that metals such as cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se) and zinc (Zn) are essential nutrients that are required for various biochemical and physiological functions (WHO/FAO/IAEA; 1996). Inadequate supply of these micro-nutrients results in a variety of deficiency diseases or syndromes (WHO/FAO/IAEA; 1996).

Heavy metals are also considered as trace elements because of their presence in trace concentrations (ppb range to less than 10ppm) in various environmental matrices (Kabata, 2001), Their bioavailability is influenced by physical factors such as temperature, phase association, adsorption and sequestration. It is also affected by chemical factors that influence speciation at thermodynamic equilibrium, complexation kinetics, lipid solubility and octanol/water partition coefficients (Hamelink et al.1994). Biological factors such as species characteristics, trophic interactions, and biochemical/physiological adaptation, also play an important role (Verkleji, 1993).

The properties and nature of heavy metals released from vehicle emissions near highways and deposited on the soil surface may migrate downward depending on the characteristics and nature of the soil profile. This mobility can lead to pesticide contamination of plants. Contamination accumulates more densely and can enter the food chain, with 200 mg/kg of contamination in grass plants being considered harmful to animals. This amount of contaminants gradually penetrates the soil profile and can remain there without changing the effect for a long time. Recently, tetraethyl lead remains a compound in all gasoline products, increasing combustion pressure and deformation and releasing 300-500 mg of lead into the atmosphere.

Studies show that the particle size, density, thickness and pH value of the soil profile of various components affect the mobility of heavy metals.

MATERIALS AND METHODS

In the western region, soil sections were placed at intervals of 50, 100 and 200 meters to study the mobility of heavy metals. To determine soil depth, three soil samples were taken simultaneously. The concentration of heavy metals such as haze, zinc, lead, chromium, cobalt and mercury in soil samples was determined using atomic absorption spectrometry (Ning and Huang 1996).

RESULTS AND DISCUSSION

Studies show that irrigated gray-brown soils generally have slopes and surface runoff. As a result, the layers located in the 50 m interval and between 40-65 cm contain less zinc than the upper and lower layers. Since there was significant surface current, zinc did not penetrate much into the interlayer. In general, the zinc level generally increases up to a depth of 200 cm in all cases.

One of the most pressing problems in the world is the study of environmental pollution with heavy metals and the preparation of standards depending on the type and use of soil. Many scientific researchers around the world are working on this problem. In the Federal Republic of Germany, when environmental regulations are being developed, soil contamination with heavy metals and its distribution along the profile are taken as a basis (Bradl, 2008). In the Netherlands, one of the main criteria for the economic assessment of land is its pollution with heavy metals. And in the United States of America, when determining soil quality indicators, the degree of contamination with heavy metals in its profile and the degree of danger of the chemical compounds created by it are indicated. In many cases, its polluting capacity and potential harm to human health are calculated (Anderson et al.1973). US law requires that pollution standards be developed based on the use of each land. In particular, the limit of soil contamination along the profile is shown here.

In the Russian Federation it is considered necessary to characterise heavy metal contamination of soils by profile in order to use and control nature. When heavy metals migrate through the soil profile it is considered important to determine its granulometric composition and pH values.

According to the legislation of the Russian Federation heavy metals are divided into two groups. The first group includes zinc, lead, cadmium, lead and mercury, which are considered more dangerous for the living world, including humans. The second group includes heavy metals such as nickel and copper, which are relatively less dangerous for nature and human health.

Soil zinc contamination is observed predominantly in the soil layer. The scientific results of many researchers also confirm this regularity (Korgachina et al. 2014). Zinc distribution along the soil profile is more mobile. Especially in wet soils and as a result of erosion process zinc is more intensively distributed along the profile. Its migration through the profile is weaker in soils with heavy granulometric content and in soils with higher organic content. It is also important to note that zinc has a greater effect on microorganisms when it migrates through the soil profile. This effect can be considered more harmful than copper and cadmium.

Those who study soil contamination around the city and the highway also show that zinc contamination is observed in the first metre layer of the soil profile.

Arzhanova, 1977 on the basis of lysimetric studies established the migration of heavy metals along the soil profile that easily soluble metals can migrate deep. The main feature of heavy metals forming permanent compounds is that they are more concentrated in the upper soil layer. It may be noted that the probability of migration is high in irrigated lands as well as on sloping slopes prone to erosion. Including zinc, although it is difficult to form a compound, it can migrate to depth. For example, in ordinary grey-brown soils 50 metres or even 100-200 metres from the track, the amount of zinc increases with depth along the profile . A similar pattern is observed in dark grey-brown soils. It can be said that zinc content generally increases with depth. However, in the 45-90 cm layer at 200 metres from the route its amount is much less, which is due to poor movement of contaminants at this distance.

In irrigated grey-brown soils, the amount of zinc in the middle layer of 20-45 cm at 50 metres from the route is less compared to the upper and lower layers, which is due to the high gradient and surface runoff in this part. As the surface flow is high, migration of zinc to the middle layer is difficult. In general, in all cases, the increase in zinc is observed predominantly up to a depth of 100 cm, which is similar to the findings of many researchers (Korgachina et al. 2014).

The study of lead migration in the soil profile shows that it is significantly different from zinc. The downward migration of lead is influenced by many factors. In particular, soil density and compaction hinder its migration, as a result of which lead concentrates on the soil surface to a greater extent than zinc. Arzhanova, 1977 showed that the inability of lead to migrate below the lower layer of six crop layers is due to excessive formation of this layer (Korgachina et al. 2014, Arzhanova 1977). In irrigated soils, the amount of lead around highways can vary greatly depending on depth and distance. However, in many cases, the amount of lead around a motorway can be 100 times higher than the background amount (Dobrovolsky 1985; Korgachina et al. 2014; Smagin et al. 2008) show that the decrease of lead to the depth of the soil profile in many soils is weak depending on the conditions of formation and parent rock.

It has been established that the migration of lead and zinc in the soil profile differs significantly. The downward migration of output is influenced by various conditions. Because soil movement is limited, lead leaches to the soil surface to a greater extent than zinc. Due to the strong compaction of the lead, it cannot migrate below the surface layer. Lead levels in flooded soils often vary significantly depending on the depth and distance of the main road. However, the lead concentration near the road is often 100 times higher than its neighbours. In many soils, lead levels do not decrease significantly with function depending by soil profile depth.

Studies on grey-brown soils show no change in mulch profile. As can be seen from Table 1, the concentrations were 68.20 mg/kg on the surface at a distance of 50 m from the surface, 69.89 mg/kg in the 20-45 cm layer and 79.80 mg/kg in the 45-90 cm layer. see moving part of the road. On the other hand, if in the near-surface layer at a distance of 45-90 cm it was 57.22 mg/kg, then at a depth of 200 meters it decreased to 33.41 mg/kg in the surface layer. In total, a subsidence of the surface layer of approximately 200 meters was observed.

Laboratory test results Dark gray-brown soil differ little from the previous soil (Table 2). Copper concentration was determined at 57.00 mg/kg in the 50-meter cross section, and 32.66 mg/kg in the 20-45 cm layer. As it went deeper, the numbers increased. At a depth of two hundred meters, the results were similar.

Table1: Migration profile of heavy metals in ordinary gray-brown soils (in mg/kg)

Heavy metals	Depth, cm	Distance from the asphalt surface of the highway, in m		
		50	100	200
Zinc	0-20	17,65	16,44	13,37
	20-45	21,36	19,91	15,97
	45-90	20,39	19,81	17,21
Lead	0-20	8,36	7,10	5,16
	20-45	12,62	7,98	8,87
	45-90	3,91	3,15	0,39
Copper	0-20	68,20	57,00	36,86
	20-45	69,89	59,90	33,41
	45-90	79,80	57,22	45,12
Mercury	0-20	0,035	0,020	0,014
	20-45	0,029	0,015	0,021
	45-90	0,035	0,020	0,020
Chromium	0-20	176,80	261,0	202,9
	20-45	207,80	242,0	98,41
	45-90	87,65	99,61	-
Cobalt	0-20	16,17	14,15	11,35
	20-45	19,98	13,98	12,98
	45-90	16,25	10,99	10,22

Table2:Profile migration of heavy metals in dark gray-brown soils (in mg/kg)

Heavy metals	Depth, cm	Distance from the asphalt surface of the highway, in m		
		50	100	200
Zinc	0-20 20-45 45-90	21,78 22,69 21,67	21,58 22,69 20,73	20,48 22,00 10,14
Lead	0-20 20-45 45-90	20,16 17,78 10,06	16,17 11,82 16,64	18,82 7,91 8,02
Copper	0-20 20-45 45-90	57,00 32,66 45,36	47,11 40,42 53,75	42,78 44,89 50,00
Mercury	0-20 20-45 45-90	0,060 0,050 0,050	0,040 0,060 0,030	0,040 0,029 0,029
Chromium	0-20 20-45 45-90	246 241,70 97,80	204,00 121,5 88,64	95,77 93,87 70,85
Cobalt	0-20 20-45 45-90	8,88 14,24 13,92	10,17 12,18 11,98	8,95 12,48 3,18

Table3: Profile migration of heavy metals in irrigated gray-brown soils (in mg/kg)

Heavy metals	Depth, cm	Distance from the asphalt surface of the highway, in m		
		100	**150**	**200**
Zinc	0-20 20-45 45-90	17,65 15,90 17,20	16,44 21,36 19,26	13,37 19,26 -
Lead	0-20 20-45 45-90	8,36 12,62 9,40	7,98 7,10 11,97	5,16 7,98 -
Copper	0-20 20-45 45-90	36,55 70,20 88,20	55,61 77,67 33,41	36,85 47,12 25,51
Mercury	0-20 20-45 45-90	0,040 0,030 0,040	0,050 0,065 0,050	0,050 0,065 -
Chromium	0-20 20-45 45-90	246,00 241,70 97,80	204,0 121,5 88,64	50-77 86,65 83,65
Cobalt	0-20 20-45 45-90	14,17 18,97 15,31	15,11 15,49 15,08	13,33 15,08 -

There are various interspecies differences in fish composition in irrigated gray-brown soils (Table 3). At a distance of 50 meters, the concentration was determined to be 36.55 mg/kg in the lower layer, 70.20 mg/kg in the middle layer, and 88.20 mg/kg in the upper layer. At a distance of 100 meters, it was 55.61 mg/kg in the lower layer, 77.67 mg/kg in the soil layer, and 33.41 mg/kg in the upper layer. It was determined that it is deeper, in the top layer of the soil, in an area of 200 meters.

Typical gray-brown soils contain 0.040 mg/kg in the top layer (0-20 cm), 0.030 mg/kg in the 20-45 cm layer, and 0.040 mg/kg in the 45-90 cm layer. The soil was excavated from the asphalt covering at 50-meter intervals. At a distance of 100 meters, the amounts in the upper and lower layers were the same. The results of laboratory analyzes showed that there was no noticeable change along the profile at a depth of 200 meters.

The distribution and levels of mercury in tund gray-brown soils around the highway are compared with those in typical gray-brown soils. For example, the concentration at the depths of 0-20 cm, 20-45 cm and 45-90 cm was determined to be 0.060 mg/kg, 0.050 mg/kg and 50 m deep from the asphalt surface, respectively. Its amount in a 100-meter section was determined to be 0.050 mg/kg at a depth of 0-30 cm, 0.065 mg/kg at a depth of 30-55 cm, and 0.050 mg/kg at a depth of 45-90 cm deep soil. At a depth of 200 meters, 0.050 mg/kg was determined in the upper layer of 0-20 cm, and 0.065 mg/kgwas 20-45 cm in the outer layer.

As shown above, there is no significant difference in the distribution of mercury across the profile between these soils and gray-brown soils irrigated along the ridge (Table 3).

Chromium, which has a specific distribution pattern in the soil profile, is one of the heavy metals released into the air and soil as a result of vehicle waste and vehicle use. The researchers believe that the main processes to which the soil is subjected have a greater effect on the amount of chromium in the soil.

Emissions and vehicle use lead to soil chromium contamination.

Tables 1, 2 and 3 show that the distribution of chromium was different among the studied soils. In typical gray-brown soils, chromium content varies with depth; In the soil layer at a depth of 50 meters, it varies from 246 mg/kg at 0-20 cm to 241.70 mg/kg at 20-45 cm and 97.80 mg/kg at 45-90 cm. 204.0, 121.5 and 88.64 mg/kg were determined at a distance of 100 meters, respectively. After about 200 meters, all symptoms begin to disappear. 50.77 mg/kg was found in the soil layer at a 86.65 mg/kg in the 20-45 top layer, and 83.65 mg/kg between 45-90 cm.

The characteristic distribution and mobility of cobalt in the soil profile is very different from other heavy metals discussed previously. Similarly, like chromium, cobalt can be obtained from a variety of sources and contributes to metal contamination in soil. However, it is equally important to highlight the important role that vehicle emissions play in this process.

The amount of cobalt in typical gray-brown soils was determined to be 24.37 mg/kg in the upper layer, 28.88 mg/kg in the middle layer, and 34.55 mg/kg in the lower layer at 55-80 cm. In the 200-meter section, the upper layer was 25.16 mg/kg, the middle layer was 25.82 mg/kg, and the lower layer was 21.81 mg/kg. At a depth of 200 meters, it is 22.52 mg/kg in the lower layer, 45.77 mg/kg in the middle layer, and 23.43 mg/kg in the upper layer. Here, the cobalt content shows a consistent pattern, increasing from the upper layer to the middle layer and then falling to the lower layer.A similar trend is shown for dark gray-brown soils in Tables 1, 2 and 3.

CONCLUSIONS

Based on the results of the research in the article, it can be said that in the western the movement of the solution in the soil profile along the highway is practically not observed. The amount of fish in the surrounding soil affects migration and profile changes around the highway. Based on the results of the research, it was determined that the most pollution of zinc occurs in the deeper layers of the soil. Downward migration of lead is affected by many factors. Because soil mobility is limited by compaction and compaction, lead accumulates at the soil surface more than zinc. Cobalt concentration increases from the top soil layer to the intermediate soil layer and then decreases in the lower soil layer.

Studies show how the distribution of chromium varies depending on the soil type. Most of the chromium is found in the upper layers of these soils. These are tires used by vehicles whose environmental conditions are contaminated with chromium.

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