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Determination of lead, cadmium and copper in roadside soil and plants in Elazig, Turkey

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Abstract The concentrations of lead, cadmium and copper in roadside soil and plants in Elazig, Turkey were investigated. Soil samples were collected at distances of 0, 25 and 50 m from the roadside. The concentrations of lead, cadmium and copper were measured by Flame Atomic Absorption Spectrophotometry (FAAS). A slotted tube atom trap (STAT) was used to increase the sensitivity of lead and cadmium in FAAS. Lead concentrations in soil samples varied from 1.3 to 45 mg kg^{-1} while mean lead levels in plants ranged from120 ng g^{-1} for grape in point-4 to 866 ng g^{-1} for apple leaves in point-2. Lead analyses showed that there was a considerable contamination in both soil and plants affected from traffic intensity. Overall level of Cd in soil samples lies between 78 and 527 ng/g while cadmium concentration in different vegetations varied in the range of 0.8–98.0 ng g^{-1}. Concentrations of copper in soil and plant samples were found in the range of 11.1–27.9 mg kg^{-1} for soil and 0.8–5.6 mg kg^{-1} for plants. Standard reference material (SRM) was used to find the accuracy of the results of soil analyses.

Keywords Cadmium · Copper · Lead · Plant leaves · Roadside soil · Traffic contamination

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Introduction

Toxic effects of heavy metals have been well studied (Flora 2002; Yang et al. 2002; Nordberg 2003; Massadeh et al. 2006). Heavy metals may enter the food chain as a result of their uptake by edible plants. So, determination of heavy metals in environmental samples is very important. Some of these metals have significantly toxic and hazardous effects on human health. It is known that lead is health-endangering metal for human and its effects include blood enzyme changes, anemia, hyperactivity, and neurological disorders (Flora 2002). Excessive Cd exposure may give rise to renal, pulmonary, hepatic, skeletal, reproductive effects and cancer. The major effects of this metal poisoning are experienced in the lungs, kidneys, bones and overexposure. However, skeletal and reproductive effects are also discussed as possible critical effects (Nordberg 2003). Also, it is known that Cu is essential element yet it may be toxic to both humans and animals when its concentration exceeds the safe limits and its concentration in some human tissues such as thyroid can be change dependent on the tissue state including cancerous or non-cancerous (Yang et al. 2002; Yaman and Akdeniz 2004). Obviously, the monitoring of lead, cadmium and copper levels in the environment has a high importance. The World Health Organization (WHO) reported tolerable weekly intakes of Cd and Pb as 0.007 and 0.025 mg kg^{-1} body weight, respectively, for all human groups (WHO 2000). Briefly, it is seen that these two metals can dangerously affect human health even at ultra trace concentrations.

In our country, contamination of environment with heavy metals has been intensively studied (Soylak and Turkoglu 1999; Arslan 2001; Turkoglu et al. 2003; Muhammet et al. 2003; Koleli 2004; Oncel et al. 2004; Arslan and Gizir 2004; Aksoy et al. 2005; Ozkan et al. 2005; Kilicel 2006). It is known that the main sources of some heavy metals such as Pb, Cd and Cu are the traffic, domestic heating and long-range transport (Viard et al. 2004; Grigalaviciene et al. 2005). It is described that the changes in the lead levels of roadside soil and vegetation are directly related to traffic density in road (Olajire and Ayodele 1997; Othman et al. 1997; Carlosena et al. 1999; Swaileh et al. 2001; Viard et al. 2004; Grigalaviciene et al. 2005, Hjortenkrans et al. 2006). The dispersion of contaminants is influenced by meteorological conditions like wind, rainfall and traffic intensity. The same meteorological conditions affect the concentration of same contaminants in the roadside soil (Viard et al. 2004).

Although Pb has been banned in petrol for a several years in Turkey, the concentration of Pb in urban soils still reflects the significant degree of historical Pb contamination and the long half-life of Pb in soils because lead was used in fuel during long-time period in Turkey. Lead contamination of roadside soil and vegetation is considered to arise mainly from motor vehicle exhaust lead sourced from organic tetraalkyl lead additives: tetramethyl lead, tetraethyl lead and mixed alkyls triethylmethyl lead, diethyldimethyl lead and ethyltrimethyl lead. Methylcyclopentadienyl manganese tricarbonyl (MMT) has now largely replaced with lead additives as the antiknock compound in regular leaded gasoline. Motor vehicle tire wear and fossil fuel combustion are also other sources for lead and cadmium in roadside environment (Ozkan et al. 2005). Also, cadmium is used in accumulators of motor vehicles or in carburetors as alloys and it is released after combustion (Olajire and Ayodele 1997; Arslan 2001).

It was investigated that the lead concentration in plants depended upon plant species, age and leaf morphology; and concentration of lead in leafy vegetables was higher than that one in tuberous root or fruits (Othman et al. 1997). Therefore, determination of heavy metals in the roadside vegetables gives information about the quality of them. There are a number of reasons for metal assessment, namely toxicological and nutritional effects related to the concentrations present (Carlosena et al. 1999).

Although there are many studies to detect concentrations of toxic trace metals in roadside environment in different parts of Turkey (Soylak and Turkoglu 1999; Arslan 2001; Turkoglu et al. 2003; Muhammet et al. 2003; Koleli 2004; Oncel et al. 2004; Arslan and Gizir 2004; Aksoy et al. 2005; Ozkan et al. 2005; Kilicel 2006), there are no results as yet to inform available trace elements originating from traffic pollution of Elazig that is the city in the east part of Turkey has a population of about 250,000 people. So, analyses of these metals were required for this city. The main polluting source of the trace metals in Elazig is road traffic crowded in the city center. Although there are many studies about lead contamination in roadside vegetation in different part of the World, studies on toxic metals in fruit leaves are seldom (Tumi et al. 1990; Onasanya et al. 1993; Oyedele et al. 1995; Singh et al. 1997; Swaileh et al. 2004). So, determination of these metals in different vegetations is still an obligation to eliminate any possible health risks coming from them. Due to very low levels of the studied metals in vegetations, the slotted tube atom trap (STAT) was used to improve the sensitivity of flame atomic absorption spectrophotometry (Yaman 1999; Yaman and Dilgin 2002; Yaman and Bakirdere 2003; Yaman 2005; Yaman et al. 2005).

The purpose of this study is to determine the concentrations of lead, cadmium and copper at roadside soil, vegetables, fruits and their leaves in Elazig, Turkey and to decide that in which vegetable, fruit or leaf accumulations of these trace metals are higher.

Apparatus and reagents

An ATI UNICAM 929 Model flame atomic absorption spectrophotometer (FAAS) equipped with ATI UNICAM Hollow cathode lamps was used for the determination of analytes. The optimum conditions for FAAS are given in Table 1. A slotted tube atom trap (STAT) was used to increase the sensitivity of lead and cadmium using FAAS.

Table 1 Operating parameters for FAAS

Parameters	Pb	Cd	Cu
Wavelength, nm	217	228.8	324.8
HCL current, mA	9.5	4.0	3
Acetylene flow rate, l/min	0.6	0.6	0.5
Air flow rate, l/min	4	4	4
Slit, nm	0.5	0.5	0.5

Unless stated otherwise, all chemicals used were of high-purity reagent grade. Throughout all analytical work, doubly distilled water was used. All glass apparatus have been kept permanently full of 1 M nitric acid when not in use. Stock solutions of metals (1,000 mg l^{-1}) were prepared by dissolving their nitrate compounds in 1.0 mol l^{-1} nitric acid. A solution of 1% w/v of $LaCl_3$ was used as the STAT coating material. This solution was sprayed on STAT when the flame of AAS was burning. So, the destruction of STAT by alkaline and earth-alkaline elements was delayed.

Procedure

Present study investigated the emission of Pb, Cu and Cd from the Elazig highway. The soil samples were collected from four different points in Elazig roadsides shown in Fig. 1, in summer 2002. Road transport pollution was studied on both right and left sides of the highway along transects with sampling pointed at 0–25–50 m (Fig. 1). Soil samples were taken from the upper soil layer of 0–5 cm because the higher concentrations of metals were present in the top 5 cm, and thereafter decreased with depth.

To make Pb, Cd and Cu analyses, firstly, each soil sample was homogenized and dried at 105°C. After that, 1.0 g of soil was taken and 3 ml of HNO_3/H_2O_2 mixture (2/1) were added to the soil. This mixture was slowly shaked and dried on a hot plate. After cooling, 2 ml of 0.75 mol l^{-1} nitric acid were added to the remainder and centrifuged. The clear digests were analyzed by using direct STAT-FAAS for Pb and Cd and FAAS for Cu. Blank analysis were carried out by using the same procedure.

For the analysis of vegetations, plant parts were collected from four different points in Elazig roadsides shown in Fig. 1. All samples were washed with tap and double distillated water and then dried at 100°C. Approximately, 5.0 g of each dried sample were taken and put into 250 ml of pyrex beaker and about 0.5 ml of conc. H_2SO_4 was added to each sample to minimize the volatilization losses during ashing

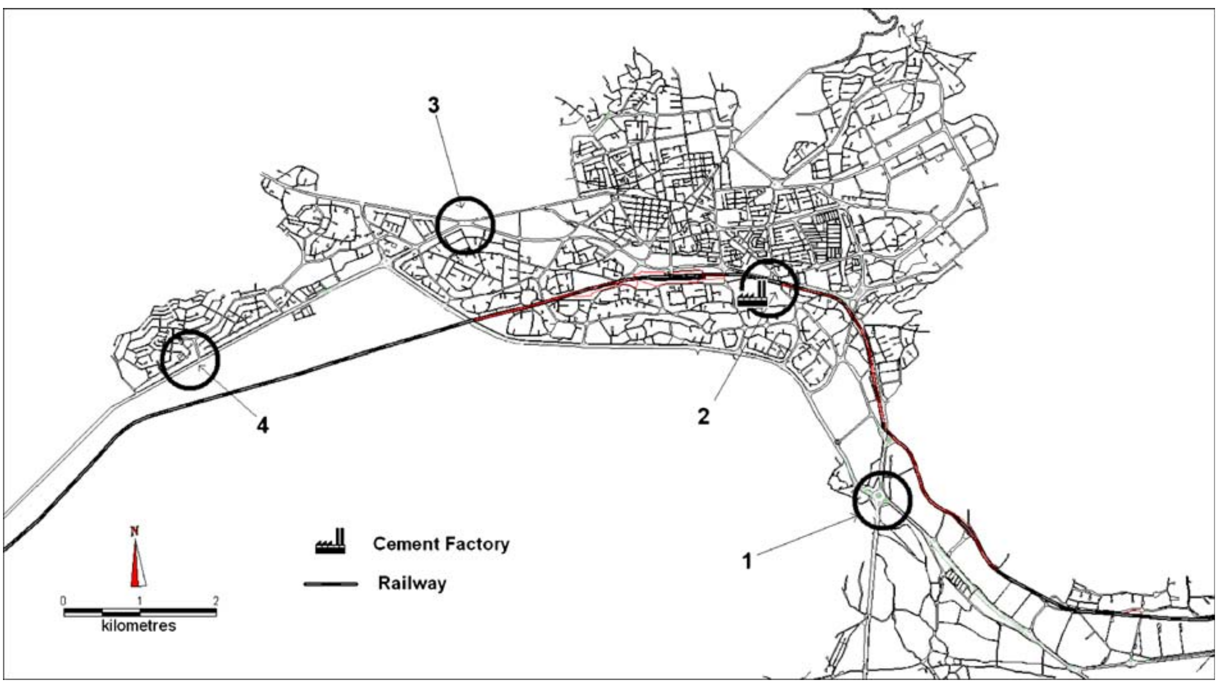


Fig. 1 Schematic representation of the studied sites of Elazig-road

process. Beaker containing sample was placed into ashing furnace and the sample was ashed at 480°C for 4–5 h. This process was repeated if necessary until a white ash was obtained. After ashing procedure, 3.0 ml of conc. HNO_3/H_2O_2 mixture (2/1) was added to the ashed samples and dried with occasionally stirring on a hot plate with low temperature. After that, the residue was dissolved by using 2.0 ml of 1.0 mol l^{-1} HNO_3 and, if necessary, diluted to suitable volume. Pb and Cd contents of clear digests were analyzed by using STAT-FAAS and Cu contents were analyzed by FAAS. Blank analyses were also carried out by using the same procedure.

Results and discussion

Calibration curves for Pb, Cd and Cu were obtained by using suitable standard solutions prepared from stock solutions. Although absorbances of appropriate copper solutions were measured by FAAS, absorbance measurements for suitable lead and cadmium solutions were made by using STAT-FAAS because of high sensitivity of this technique. The graphs obtained were rectilinear in the concentration ranges and the equations of the curves were found as follow:

$$Y = 0.2794X + 2.2026\ R^2 = 0.99 \text{ for Pb}$$

$$Y = 2.4972X + 1.12\ R^2 = 0.99 \text{ for Cd}$$

$$Y = 0.115X + 0.50\ R^2 = 0.99 \text{ for Cu}$$

Analytical performance

Standard reference material was analyzed to find the accuracy of the results of soil analyses. The results given in Table 2 were found to be in good agreement with the certified ones. Direct calibration method for each element was used for the analysis of Soil/ Sediment #4.

We didn't have any standard reference materials for vegetation analysis in our laboratories. So, we used different technique to confirm the results found. For this aim, suitable concentrations of Pb, Cd and Cu were added to the vegetations. The added Pb, Cd and Cu amounts were recovered after using same procedure was used for vegetation analyses to check the accuracy of the analyses performed. For these three elements, it was found that at least 92% of Pb, 94% of Cd and 95% of Cu were recovered by using the same procedure with real vegetation samples. In these analyses, the effects of different contaminants were eliminated or minimized by subtracting blank result from experimental values.

A comparison of heavy metal contents among the study sites strongly implicates automobiles as the source of contamination. The quality guidelines for soil heavy metal concentrations developed in certain countries indicate wide variations. For example, in France, the soil threshold levels of heavy metals are as mg kg^{-1}; 100 for Pb; 0.07 for Cd, and 100 for Cu (Ramakrishnaiah and Somashekar 2002). The mean and range of total heavy metal concentrations in normal soils reported by England (1984) were 35(2 to 300) for Pb, 0.35 (0.01 to 2) for Cd and 30 (2 to 250) for Cu, as mg kg^{-1}. In addition to this data, according to 1986 values of EEC, limits for the total concentrations of heavy metals in soil were 200 for Pb, 3 for Cd, 200 for Cu and 300 for Zn, while the Dutch reference values are 35, 0.8, 36, and 140 mg kg^{-1}, respectively (Ramakrishnaiah and Somashekar 2002). The reported lead concentrations in roadside soils from different parts of World were also given in Table 5.

Lead

In the studied sites, daily traffic density of road is about 10,000, but most of vehicles use diesel fuel

Table 2 The results of the certified and experimental values

Analyte	Reference material	Certified value	Confidence interval	Found
Lead	Soil/Sediment #4 (mg kg^{-1})	95.3	60.0–101	93.2±4.1
Cadmium	Soil/Sediment #4 (mg kg^{-1})	0.82	–	0.79±0.04
Copper	Soil/Sediment #4 (mg kg^{-1})	36.4	34.8–37.9	36.1±1.3

Table 3 Pb, Cd and Cu concentrations in surface soil depending on distance from road

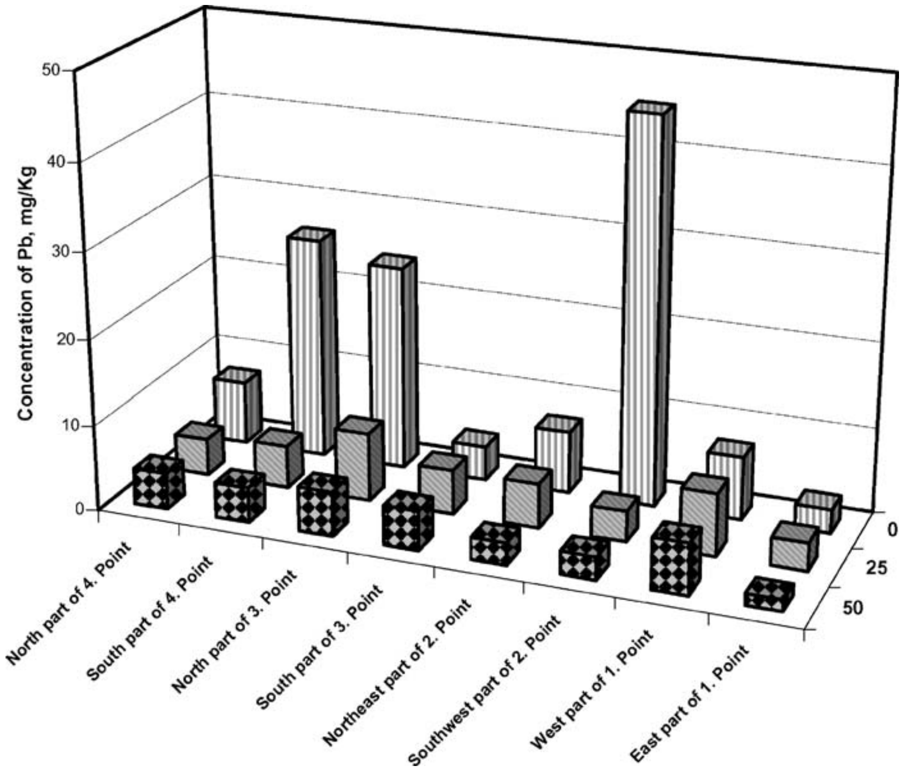
Sampling point	Distance from road, m	Pb, mg kg^{-1}		Cd, ng g^{-1}		Cu, mg kg^{-1}	
1	0	2.8±0.3 (E)	7.4±0.6 (W)	119±6 (E)	263±15 (W)	12.3±0.7(E)	16.3±1.2 (W)
	25	3.3±0.3 (E)	7.3±0.5 (W)	216±10 (E)	119±8 (W)	14.2±0.8 (E)	13.5±0.9 (W)
	50	1.3±0.1 (E)	6.0±0.5 (W)	78±4 (E)	97±7 (W)	17.7±1.1 (E)	12.7±0.8 (W)
2	0	45±3.7 (S.W)	7.3±0.5 (N.E)	527±48 (S.W)	168±14 (N.E)	27.9±1.8 (S.W)	17.0±1.2 (N.E)
	25	3.6±0.3 (S.W)	5.2±0.4 (N.E)	188± 13(S.W)	165±9 (N.E)	16.9±1.4 (S.W)	16.6±1.2 (N.E)
	50	2.7±0.2 (S.W)	2.6±0.2 (N.E)	148±12 (S.W)	125±10 (N.E)	20.6±1.9 (S.W)	11.1±1.0 (N.E)
3	0	4.0±0.3 (S)	24.0±1.8 (N)	93±5 (S)	168±17 (N)	11.6±0.5 (S)	25.0±2.2 (N)
	25	5.2±0.4 (S)	8.0±0.7 (N)	144±11 (S)	122±9 (N)	15.6±0.9 (S)	22.4±2.0 (N)
	50	4.6±0.3 (S)	5.2±0.4 (N)	132±7 (S)	154±11 (N)	16.7±1.0 (S)	14.8±1.6 (N)
4	0	26.0±2.0 (S)	7.4±0.6 (N)	245±18 (S)	179±8 (N)	17.4±1.1 (S)	17.6±1.3 (N)
	25	5.0±0.4 (S)	4.3±0.3 (N)	221±14 (S)	122±10(N)	14.0±0.9 (S)	18.3±1.8 (N)
	50	4.1±0.3 (S)	4.2±0.3 (N)	176±9 (S)	181±15 (N)	15.2±0.4 (S)	14.2±0.8 (N)

E East part of road, *S* South part of road, *S.W* South West part of road, *W* West part of road, *N* North part of road, *N.E* North East part of road

which does not contain lead additives. There appears to be clear spatial pattern of lead distribution in the roadside samples. There are areas like point 2 with high traffic density that exhibit high lead levels, and areas like point 1 with little traffic density that contain low levels of lead. With regard to Pb levels, the order was 0 m>25 m>50 m. This may show that contamination of lead is caused by road traffic. Concentration of lead, the most important roadside pollutant in soil, was found to decrease with increasing the sampling distance from both two sides of road (Table 3, Fig. 2). There are significant differences between the distributions of Pb among the roadside soil components for two sites in the upper 5 cm, which is the most contaminated layer, dominated by anthropogenic lead. It is known that lead containing dust particles have a relatively short residence time in the atmosphere, and deposit quickly in the near vicinity of the road, hence contributing to further accumulation of lead on the roadside soil surface (Al-Chalabi and Hawker 2000). Lead concentrations of road edge soil (0 m) in different sites were found to be between 2.8 and 45.0 mg kg^{-1}. In this sampling point, level of Pb was sharply decreased with increasing distance. In most sampling points, lead concentrations in two sides of road at the same distance were not found close to each other because of differences in directions and strength of winds in these regions. It is obvious that lead concentrations found in this study are coherent with those in the roadside soils of different parts of the World given in Table 5. Indeed, there are no other possible lead sources in sampling points. The nearest area where lead presents as different kind of mines is about 50 km away from the sampling points. Hence, contamination of sampling points with other lead, copper and cadmium sources is low if it is compared with contamination coming from traffic. In the southwest part of the second sampling point, concentration of Pb was found as 45.0±3.7 mg kg^{-1}. This concentration is higher than others obtained in the other sampling points. The higher concentration of lead at this distance may be explained by a secondary source of pollution which is the Cement Factory or high traffic density because of the closeness of this sampling point to the city center; but, lead concentration in cement was not determined. Thus, it is not clear that high level of lead in the southwest part of the second sampling point was caused by Cement Factory.

Concentrations of lead in plant samples collected roadside are shown in Table 4. It is seen that lead levels in apple, grape, apple leaves and grape leaves were varied in the range of 141–158, 120–213, 331–866 and 210–547 ng g^{-1}, respectively. Tomato, bell paper and parsley were only collected in the second sampling point. So, metal analyses for these vegetables were performed for entirely second point and we could not make any comparison for them. Lead levels in ng g^{-1} for tomato, bell paper and parsley were found as 175±14, 139±11 and 585±47, respectively. It is seen from Table 4 that concentrations of lead were higher in leaves than those in other vegetables

Fig. 2 Pb concentration of surface soil with distance from road



and fruits. This may be attributed to big surface area of these leaves. Contamination of any vegetables or leaves from lead caused by motor vehicle exhaust is directly related with surface area due to high interaction. So, concentrations of lead in leaves of apple and grape were found higher than others. Also, it was found that lead level in parsley was at least three times higher than other vegetables. Concentrations of analytes, especially lead, in same vegetation at different sampling point were generally different from each other. This may be explained by differences in traffic density, soil property like pH, the solubility of heavy metals in soil or biological feature of vegetation in each sampling point.

Table 4 Concentrations of Pb (ng g^{-1}), Cd (ng g^{-1}) and Cu (mg kg^{-1}) in different vegetations growing up around roadsides

	Pb concentration, ng g^{-1}				Cd concentration, ng g^{-1}				Cu concentration, mg kg^{-1}			
Sample	1. Point	2. Point	3. Point	4. Point	1. Point	2. Point	3. Point	4. Point	1. Point	2. Point	3. Point	4. Point
Apple	158±14 (50–75[a])	165±14	180±15	141±11	1.7±0.2 (1.3–3.3[a])	1.3±0.1	0.8±0.1	1.8±0.2	1.0±0.1 (3.0–3.4[a])	1.2±0.1	0.8±0.1	1.6±0.1
Grape	213±18 (41–60[a])	139±11	191±15	120±10	1.9±0.2 (1.5–2.1[a])	3.1±0.3	1.9±0.2	1.4±0.1	2.9±0.3 (4.0–4.3[a])	0.9±0.1	1.7±0.2	1.6±0.1
Apple's leaves	331±25	866±72	786±67	527±44	11.4±1.4	61.5±4.3	13.1±1.1	11.2±1.6	2.7±0.3	2.8±0.2	2.9±0.2	4.2±0.4
Grape's leaves	210±17	507±45	547±48	358±28	5.9±0.6	32.6±2.6	10.8±0.9	8.5±1.1	2.7±0.5	2.1±0.2	5.4±0.6	5.6±0.7
Tomato	–	175±14	–	–	–	98.0±8.9	–	–	–	2.2±0.3	–	–
Bell pepper	–	139±11	–	–	–	66.2±5.9	–	–	–	4.0±0.3	–	–
Parsley	–	585±47	–	–	–	61.4±5.5	–	–	–	3.7±0.4	–	–

[a] The results in parenthesis were taken from the coauthor for the same city as control values (Yaman 2000; Yaman et al. 2000; Yaman and Dilgin 2002).

Cadmium

The results of average Cd levels in roadside soil samples taken from four different sampling points were illustrated in Table 3 and Fig. 3. It is observed that the overall level of Cd lies between 93–527 ng g^{-1} for road edge (0 m), 119–221 ng g^{-1} for 25 m and 78–181 ng g^{-1} for 50 m distance. It is seen from Fig. 3 that cadmium pattern among the sites of road is not significantly different than from Pb pattern, generally. Cadmium levels in roadside soils were generally decreased with distance from the main road as similar to lead. This decrease in the cadmium levels with distance from the road indicated that vehicular emission played a significant role in the levels of cadmium in the roadside soil.

Cadmium levels in plant samples collected roadside are shown in Table 4. It is seen that cadmium levels in apple, grape, apple leaves and grape leaves were varied in the range of 0.8–1.8, 1.4–3.1, 11.4–61.5 and 5.9–32.6 ng g^{-1}, respectively. The levels of cadmium in ng g^{-1} for tomato, bell paper and parsley collected from second sampling point were found as 98.0, 66.2 and 61.4, respectively. This difference in cadmium level in different plants may depend upon genotype, development stage, and growth rate of the plants, the depth and distribution of the root zone, the transpiration coefficient and the nutrient requirement. Contaminants deposited on the surface of plants influence considerably their heavy metal content. Their amount mainly depends on the morphological characteristics of the plant (Naszradi et al. 2004). Contrary to lead, levels of cadmium in parsley and the leaves of apple and grape are not high if it is compared with other vegetables collected from same sampling point. As similar to Pb, Cd levels in the vegetations of second sampling point were considerably higher than those taken from other sampling points due to same reasons with lead.

Copper

Copper levels of soil taken from four different sampling points in roadside are shown in Table 3 and Fig. 4. It is observed that the overall level of Cu lies between 11.6–27.9 mg kg^{-1} for road edge (0 m), 13.5–22.4 mg kg^{-1} for 25 m and 11.1–20.6 mg kg^{-1} for 50 m. Concentration of copper was found to be

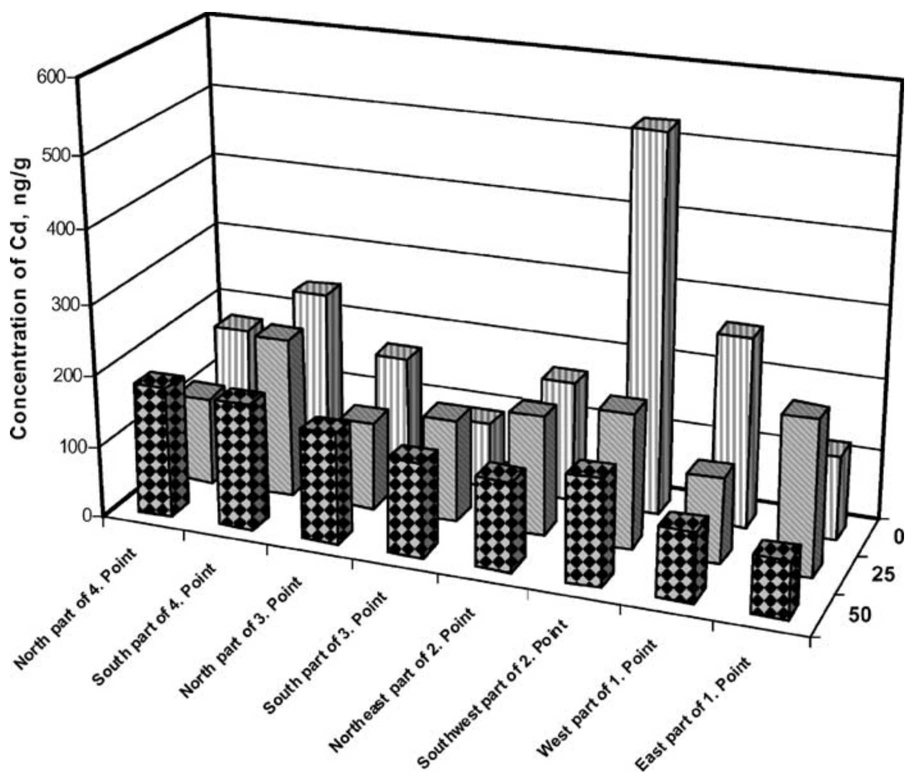


Fig. 3 Cd concentrations of surface soil with distance from road

Fig. 4 Cu concentration of surface soil with distance from road

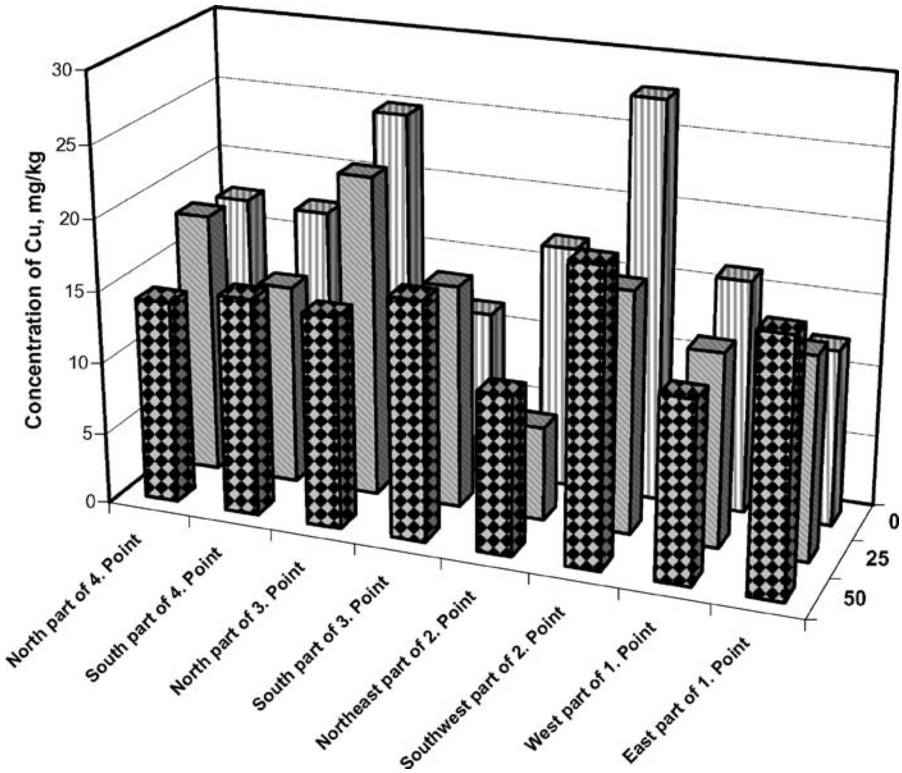


Table 5 Concentration of lead at roadside soil in different regions of the World

Place (year)	Traffic density	Method	Pb conc., mg kg^{-1}	References
Mission Peninsula, Michigan (1997)	8,200–16,000 vehicles per hour	Flame AAS	90–210	Francek 1997
La Coruna, Spain (1998)	20,000 vehicles per day	Flame AAS	24.0–554.3	Carlosena et al. 1998
Ljubljana to Zagreb, Slovenia (1999)	10,000–15,000 vehicles per day	No Information	16–644	Zupancic 1999
Cincinnati, Ohio (2001)	156,670 vehicles per day	AAS, ICP and X-Ray	17–1,980	Turer et al. 2001
Brisbane, Australia (2000)	69,000 vehicles per day	Flameless AAS	1,950–3,800	Al-Chalabi and Hawker 2000
Osogbo, Nigeria (2003)	56–3,700 vehicles per hour	Graphite Furnace AAS	9.8–136.1	Fakayode and Olu-Owolabi 2003
Budapest, Hungary (2004)	22,860 vehicles per day	ICP Spectrophotometry	12–24	Naszradi et al. 2004
Tallinn, Estonia (2004)	3,400–49,600 vehicles per day	Flame AAS	7.4–108	Haal et al. 2004
Port Harcourt Metropolis, Nigeria (2004)	>200,000 vehicles per day	Flame AAS	15.9–169.5	Ideriah et al. 2004
Bursa, Turkey (2001)	2,187–50,581 vehicles per day	Flame AAS	~210	Arslan 2001
West Bank, Palestine (2001)	No Information	ICP Spectrophotometry, FAAS	89.1–245	Swaileh et al. 2004

independent of distance from road. This may show that Cu contamination in this region is not due to road traffic.

Copper levels for vegetations can be seen in Table 4. In this table, it could be illustrated that copper levels in apple, grape, apple leaves and grape leaves were varied in the range of 0.8–1.6, 0.9–2.9, 2.7–4.2, 2.1–5.6 mg kg^{-1}, respectively. The copper levels for tomato, bell paper and parsley collected from second sampling point were found as 2.21, 3.96 and 3.66, respectively.

Conclusion

Soil and different vegetations taken from roadside in Elazig, Turkey were examined for Pb, Cd and Cu. The rate of heavy metals contents at the same distance from the road was found in the following order: Cu>Pb>Cd. Also the same order in terms of Pb, Cd and Cu at the same sampling points was observed for vegetations. The greater concentrations in soils near the highway could represent long-term contamination of heavy metal from transport in a roadside environment. Examining the lead content of roadside soil, it can be concluded that it generally decreases with increasing distance from the motorway and there were big differences in the concentration of lead in two sides of road due to strength and direction of the wind and height of the buildings near the road (Table 5). Usually more lead is found in plant leaves and parsley due to larger surface area than other plants. The magnitude of Cd contamination in soil was generally in the decreasing order of distance from road. This may show that existence of Cd in roadside soil may be due to the lead sources and this major effect of traffic in terms of cadmium is limited to narrow zone from the road. It was investigated that Cd concentrations varied from plant to plant. These dissimilarity in Cd and Pb uptakes by plants may be explained by differences in some plant characteristics such as genotype, development stage and growth rate. The concentration of copper was found to be independent of distance from road. This may show that Cu contamination in this region is not due to road traffic. The current levels of heavy metals, especially lead and cadmium, in those places are expected to have fallen drastically due to the complete or gradual phasing out of leaded gasoline in our country.

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