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Heavy Metal Contamination in Soils of Garbage Area in Van, Turkey

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In this study, some heavy metal concentrations in soils of the garbage area in Van, Turkey, by flame atomic absorption spectrometry (FAAS) have been determined. Ni, Co, Cr, Cd and Ca concentrations are the highest; Zn, Cu, Mn and Fe concentrations are higher than control sample concentrations. Metal concentrations in the spring season are higher than in the autumn season except Cd. Wastewater of this garbage area enters into the soil and Puddle Sihke where the water of Puddle Sihke is used as irrigation water and arrives at Lake Van.

Key Words: Garbage, Garbage water, Soil and water pollution, Heavy metals, Van, Turkey.

INTRODUCTION

In the past, municipal landfills were treated as all-purpose dumping grounds but were not designed to contain the leachate coming from the waste or to prevent gas build-up. They were often situated in old gravel pits or wetlands where contaminants were rather easily transferred to the groundwater with the possibility of getting into drinking water. The leachate from municipal landfills has been found to contain high levels of heavy metals such as lead, cadmium, arsenic and nickel. Exposure to these metals may cause blood and bone disorders, kidney damage, decreased mental capacity and neurological damage. Movement of these metals in the soil and groundwater is slow due to the soil particles. Volatile organic compounds They are more of a potential hazard once in the groundwater since they have relatively high mobility. Also, in the old landfills, the metan gas formed was not vented to the outside and this increased the possibility of explosions or fires[1].

Many toxic chemicals, including heavy metals, accumulate in soil and sediments. Heavy metals tend to remain in the upper soil layers and can be metabolized into plant tissues, especially since heavy metals have a high affinity for certain organic materials. Ions of heavy metals can be readily absorbed into organic particles either in soils or in water systems, ultimately becoming deposited as sediments. With their high affinity for organic materials (such as those seen in sewage sludge) there is concern that food crops with such natural fertilizing agents may absorb some of these compounds[2].

Water pollution is the contamination of water by sewage, toxic chemicals, metals, oils or other substances. It can affect such surface waters as rivers, lakes and oceans, as well as the water beneath the earth's surface, called ground water. Soil pollution is the destruction of earth's thin layer of healthy, productive soil, where much of our food is grown. Without fertile soil, farmers could not grow enough food to support the world's people. Solid waste is probably the most visible form of pollution. Solid waste from homes, offices and stores is called municipal solid waste. Hazardous waste is composed of discarded substances that can threaten human health and the environment. A waste is hazardous if it corrodes (wears away) other materials; explodes; ignites easily; reacts strongly with water; or is poisonous. Sources of hazardous waste include industries, hospitals, and laboratories. Such waste can cause immediate injury when people breathe, swallow or touch it. When buried in the ground or left in open dumps, some hazardous waste can pollute ground water and contaminate food crops.

EXPERIMENTAL

Soil samples were collected from 8 sample centres in Van Solid Waste Region in the spring and the autumn seasons (Figs. 1, 2). The control soil samples were collected from Mountain Erek and Mountain Nemrut (volcanic area) at East Anatolia of Turkey. Soil samples represent the upper soil layer with thickness of 20 cm. A plastic spoon was used to transfer *ca.* 100 g of each soil sample into ultraclean glass containers[3]. The samples were dried at room temperature for 7 d[4]. After that the samples were oven-dried at 105°C for 24 h again[5] and ground to pass through 200 mesh (0.075 mm) sieve and homogenized for analysis. One g of sieved samples (3 parallel for every sample) was dissolved in 15 mL aqua regia

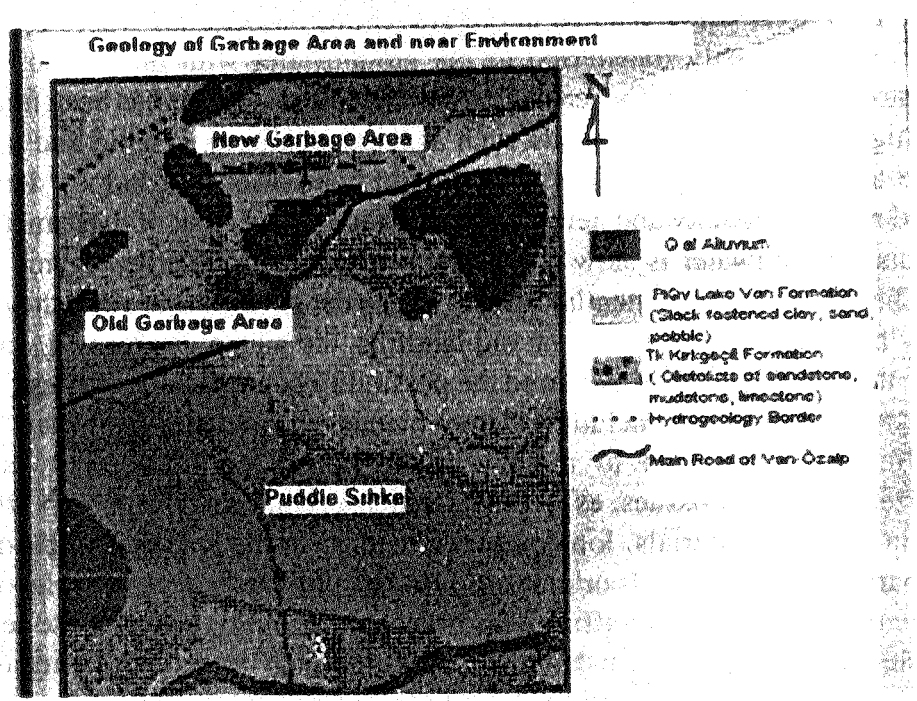

Fig. 1. Geology of garbage area of Van city and near environment

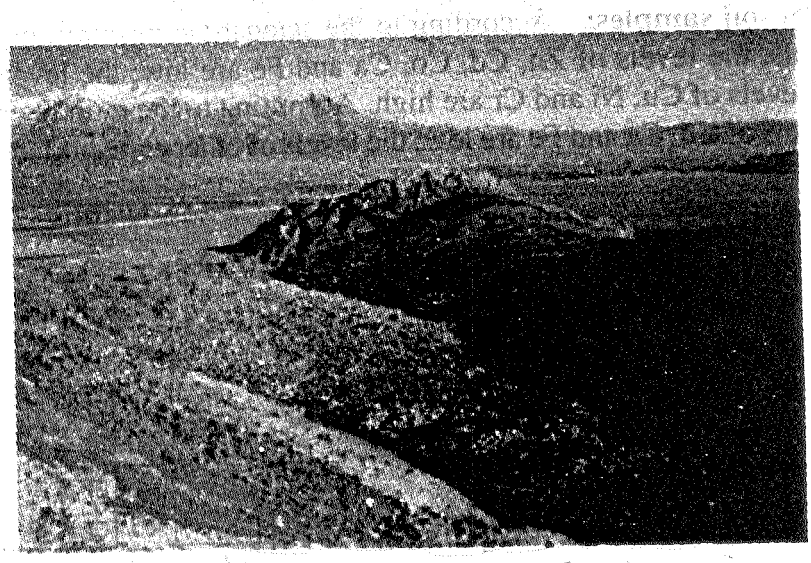

Fig. 2. A view of garbage area of Van city, Puddle Sihke and Erek mountain

and each sample was evaporated to dryness on a sand bath[6]. The residue was treated with 10 mL HNO_3 (2 M) and the suspension was filtered in a blue band filtering paper. The filtrate was evaporated to 15–17 mL and then diluted to 20 mL with double-distilled water. The concentrations of some heavy metals in soils were measured by flame atomic absorption spectrometry (FAAS, UNICAM 929) and graphite furnace and flame atomic absorption spectrometry (Thermo Solaar Electron Corporation).

The mean values of between groups were compared by one-way ANOVA.

1. Between sample centres (in the spring and the autumn seasons): Zn and Cu are non-significant ($p > 0.05$); Ni, Co, Mn, Cr, Ca and Fe are significant ($p < 0.05$).
2. Between sample centres and control samples: Zn, Cu, Ni, Mn, Cr, Ca and Fe are non-significant ($p > 0.05$); Co is significant ($p < 0.05$).

RESULTS AND DISCUSSION

The mean values of Zn, Cu, Cd, Ni, Co, Mn, Cr, Ca and Fe concentrations in soils of 8 sample centres and 2 control centres in Van region are given in Tables 1–3 and Figs. 3–8.

In soils: The levels of Zn, Cu, Ni, Co, Mn, Cr, Ca and Fe obtained from Van Solid Waste Region in spring season, 2003, are higher than in autumn season, 2002, but the level of Cd is lower. The mean levels of Zn, Cu, Ni, Co, Mn, Cr, Ca and Fe obtained from Van solid waste region are higher than obtained from control sample centres.

In main soil samples: According to the standard concentrations of heavy metals in soils, the level of Zn is low; the level of Fe is normal; the levels of Cu, Cd, Co, Mn and Ca are high; the levels of Ni and Cr are very high. According to the ratio in the crust of the earth, the levels of Cd, Ni, and Ca are high; the level of Fe is low; the levels of other elements are normal[7,8].

In control soil samples: According to the standard concentrations of heavy metals in soils, the levels of Zn, Cd, Co, Ca and Fe are low; the level of Mn is normal; the levels of Cu, Ni and Cr are high. According to the ratio in crust of the earth, the levels of Cd, Ca and Fe are low; the levels of other elements are normal[9].

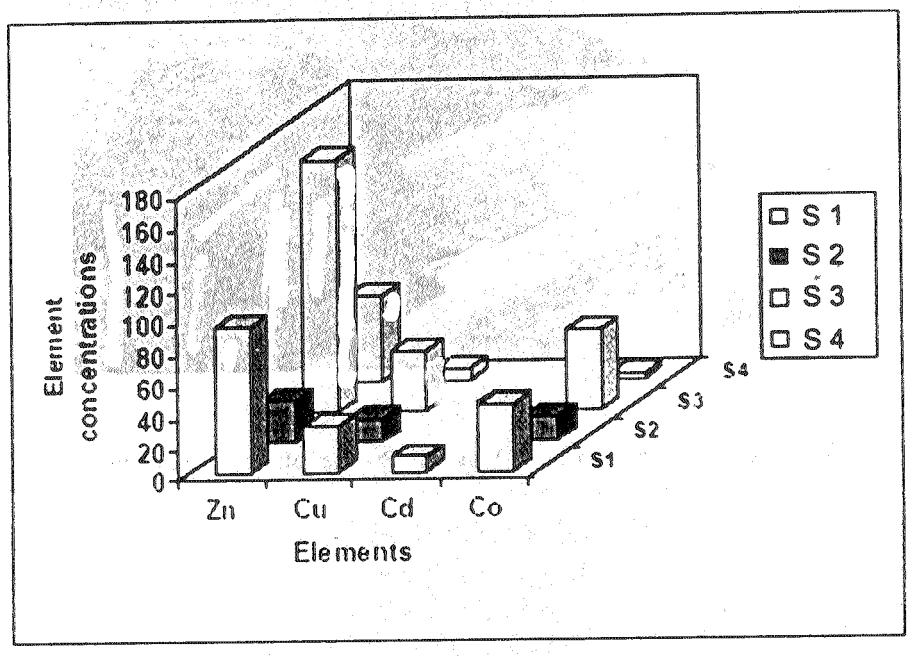

Fig. 3. Some heavy metal mean concentrations (according to seasons and control sample) in soils of garbage area of Van City, ppm. (S1: 2002, autumn season; S3: 2003, spring season; S2,4: control samples)

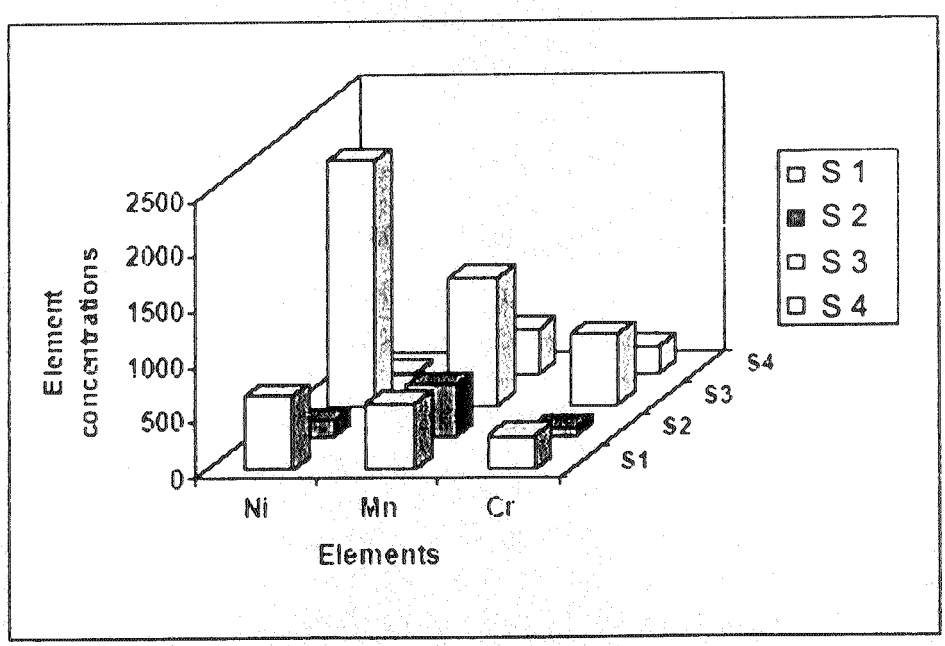

Fig. 4. Some heavy metal mean concentrations (according to seasons and control sample) in soils of garbage area of Van City, ppm (S1: 2002; autumn season; S3: 2003, spring season; S2,4: control samples)

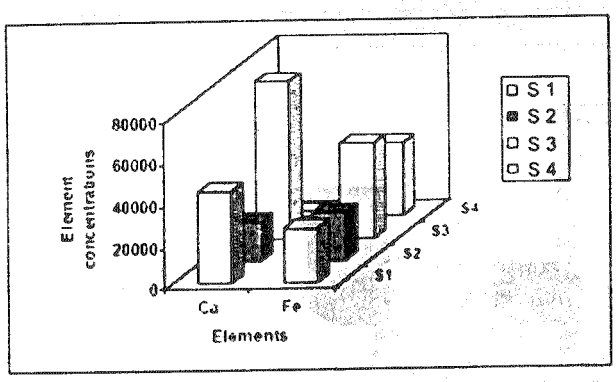

Fig. 5. Some heavy metal mean concentrations (according to seasons and control sample) in soils of garbage area of Van City, ppm (S1: 2002; autumn season; S3: 2003, spring season; S2,4: control samples)

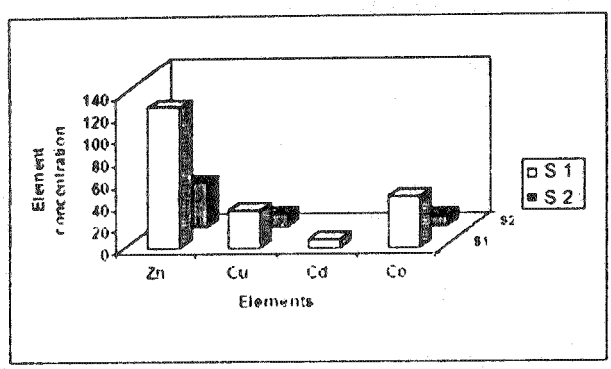

Fig. 6. Some heavy metal general mean concentrations (according to seasons and control sample) in soils of garbage area of Van City, ppm (S1: general mean values; S2: control sample mean values)

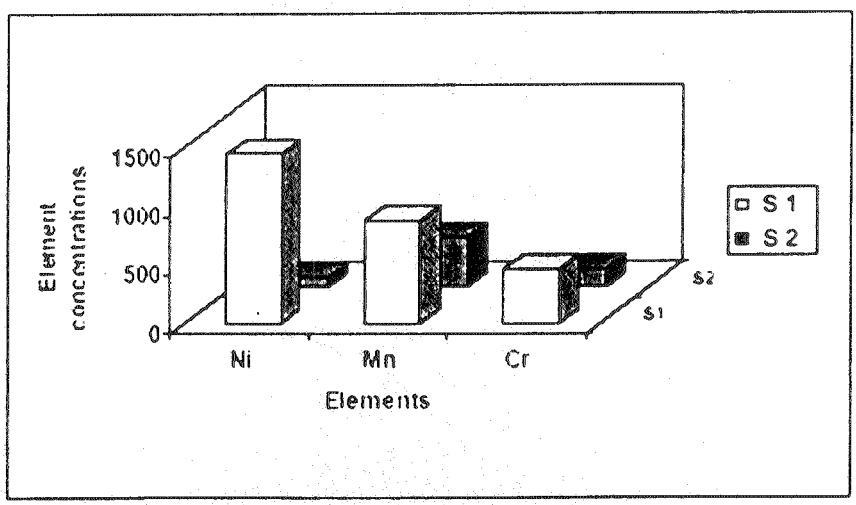

Fig. 7. Some heavy metal general mean concentrations (according to seasons and control sample) in soils of garbage area of Van City, ppm (S1: general mean values, S2: control sample mean values)

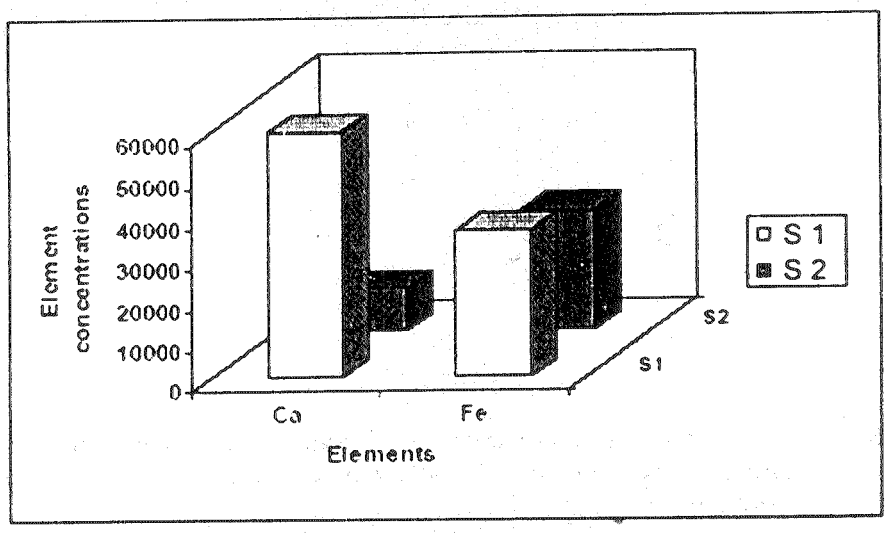

Fig. 8. Some heavy metal general mean concentrations (according to seasons and control sample) in soils of garbage area of Van City, ppm (S1: general mean values, S2: control sample mean values)

The obtained results indicate that investigated heavy metal contents in garbage area soils are very high and clearly depend on solid wastes of Van city. Pollution from solid wastes has reached the crisis point. Some element concentrations in some measuring centres (e.g. 3 and 8) are very high. These centres had the accumulation of garbage water. Solid waste or garbage water contains heavy metals and heavy metals accumulate in the upper soil layer. Wastewater of this garbage area enters into the soil and Puddle Sihke. Water of Puddle Sihke is used as irrigation water and arrives at Lake Van.

TABLE-1
SOME HEAVY METAL CONCENTRATIONS IN SOILS OF GARBAGE AREA OF VAN CITY (2002, THE AUTUMN SEASON, ppm)

Elements	Measuring Centres									
	1	2	3	4	5	6	7	8	Mean ± S.D.[a]	CS[b]
Zn	30.3	44.0	118.9	51.5	75.4	64.8	77.0	283.8	93.2 ± 81.5	26.7
Cu	16.6	20.4	27.5	25.2	20.0	32.2	30.8	61.1	29.3 ± 13.9	14.8
Cd	ND	ND	1.3	ND	ND	ND	ND	18.1	9.7 ± 11.9	ND
Ni	927.4	411.7	805.6	377.3	991.1	439.1	508.8	879.3	667.5 ± 257.2	161.2
Co	52.8	27.7	46.2	33.9	67.0	32.8	35.5	43.6	42.4 ± 12.9	15.8
Mn	525.2	541.3	545.5	575.7	690.9	583.7	615.5	621.8	587.5 ± 54.2	469.1
Cr	328.5	238.5	296.1	241.1	484.4	241.0	274.6	302.8	300.9 ± 81.2	89.7
Ca	48182	22827	57076	80780	14111	32186	45786	54148	44387 ± 21137	18445
Fe	26983	21122	25071	14776	13789	31944	36639	39554	26235 ± 9505	23239

a: Mean value and standard deviation; b: Control Sample; ND: Non-detected.

TABLE-2
SOME HEAVY METAL CONCENTRATIONS IN SOILS OF GARBAGE AREA OF VAN CITY (2003,THE SPRING SEASON, ppm)

Elements	Measuring Centres									
	1	2	3	4	5	6	7	8	Mean ± S.D.[a]	CS[b]
Zn	68.0	36.9	261.2	71.9	52.4	84.4	166.6	550.3	161.5 ± 173.7	54.6
Cu	32.8	8.6	38.8	27.0	26.1	43.7	43.9	83.8	38.1 ± 21.8	7.7
Cd	0.1	0.1	4.5	ND	ND	ND	1.9	21.1	5.5 ± 8.9	ND
Ni	690.7	2064.9	2671.9	2149.2	1113.0	2442.6	2830.3	3677.8	2205.1 ± 951.9	16.8
Co	33.1	65.3	91.2	69.5	33.7	17.0	40.7	56.4	50.9 ± 24.1	3.8
Mn	959.9	1163.4	1250.4	1436.7	850.4	651.4	1204.6	1674.4	1148.9 ± 326.2	403.6
Cr	493.3	495.1	894.2	818.4	685.3	321.1	808.5	566.6	635.3 ± 198.7	239.0
Ca	97529	27493	42908	56013	157856	59667	62496	100712	75584 ± 41524	2652
Fe	48168	40494	44829	50476	34187	27288	53779	65486	45588 ± 11862	35196

a: Mean value and standard deviation; b: Control Sample; ND: Non-detected.

TABLE-3
SOME HEAVY METAL GENERAL MEAN CONCENTRATIONS (ACCORDING TO SEASONS, SAMPLE CENTRES AND CONTROL SAMPLES) IN SOILS OF GARBAGE AREA OF VAN CITY (ppm)

	Elements								
	Zn	Cu	Cd	Ni	Co	Mn	Cr	Ca	Fe
Samples:									
Mean	127.3	33.6	6.7	1436.3	46.7	868.2	468.1	59986	35912
SD[a] (±)	135.7	18.2	8.9	1041.2	19.2	367.5	226.5	35675	14412
Control Samples:									
Mean	40.7	13.1	ND[b]	89.0	9.8	436.4	164.4	10549	29218
SD (±)	19.7	7.6	—	102.1	8.5	46.3	105.6	11167	8455

a: Standard deviation; b: Non-detected

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