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Heavy Metal Pollution Around International Hatay Airport

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Abstract
In this study, it was aimed to determine the heavy metal pollution in the agricultural lands around Hatay airport and travel possible alteration in the amount of heavy metal on the land in accordance with the distance to the airport. For this purpose, the airport was chosen as the center and 27 soil samples were obtained around the airport at 2 km intervals in depth ranging from 0 to 30 cm. Lead (Pb), cadmium (Cd), nickel (Ni), chrome (Cr), cobalt (Co), aluminium (Al), iron (Fe), copper (Cu), manganese (Mn) and zinc (Zn) elements in soil samples were analysed using MP-AES instrument by DTPA method. (3 repetition for each sample). As a result of the analysis, heavy metal concentrations were found as Pb 0-1.45 mg/kg, Cd 0-0.220 mg/kg, Ni 0-3.95 mg/kg, Cr 0-0.780 mg/kg, Co 0-0.270 mg/kg, Al 0-0.700 mg/kg, Fe 1.47-16.2 mg/kg, Cu 0.400-5.35 mg/kg, Mn 0-19 mg/kg and Zn 0.050-3.14 mg/kg. When comparing the obtained data through this study with allowable concentrations of heavy metals in soil of Environment and Forest Directorates Guidance, it was determined that the heavy metal concentration of the soil does not pose any problems in terms of heavy metal pollution. Besides, iron concentration was decreased when the distance to the airport is increased.

Keywords:
Soil pollution, Heavy metal, DTPA method, Hatay airport, Turkey

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Introduction

Environment is an important factor for human health. Human made activities and natural interactions usually cause negative effects on human health. Metals and heavy metal contaminations due to increase in agricultural activities and technological development have occupied our agenda for the last centuries (Kadir, 2009).

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Motor vehicles constitute the major part of heavy metal pollution. The pollutants, generated by motor vehicles are considered as carbon monoxide, carbon dioxide, hydrocarbons, nitrogen oxides, sulphur oxides, soot and various heavy metal particles (İlkılıç & Behçet, 2006).

Heavy metals are the metals whose densities are greater than 5 g/cm^3. More than 60 metals including Pb, Cd, Cr, Fe, Co, Cu, Ni and Zn are classified in this group (Haktanır & Arcak, 1998). The heavy metals which are generated by motor vehicle originated pollution are sorted as Pb, Ni, Hg, Cd, Cr, Fe, Cu, Mn and Zn, whereas the heavy metals which are generated by agricultural activities originated pollution are sorted as Cd, Cr, Cu and Zn.

Pb is a pollutant that is released from tetraethyl lead which is added to gasoline, diesel fuels and motor oil. Cd and Zn released from tires, oil, other vehicle equipment and phosphorous fertilizers (Li, 2001; Karataş at al., 2007). It is known that copper, iron, manganese and chrome pollutions are the results of motor vehicles and several agricultural activities (Zincirlioğlu, 2013). Besides, if chemical substances that are applied in agricultural lands and crucial for plant growth, fertilizers, are applied in appropriate methods with optimum amounts, they do not constitute soil pollution. However, higher doses of macro and micro elements which are applied to leaves and soil in order to increase plant growth cause soil pollution (TAGEM, 2009).

In case heavy metals in the soil reach to toxic levels, growth and quality of plant is disrupted, and then human and animals are affected through food chain (Karataş at al., 2007), and eventually this situation threatens human health (Zincirlioğlu, 2013).

In this study, an agricultural land around the Hatay airport was examined. There are vast agricultural lands around Hatay airport, which are actively used for domestic and international transportation. Local people have been using these agricultural lands and introduce the products to the market. It was determined that agricultural activities, industrial processes, land traffic and air traffic caused heavy metal pollution on these agricultural lands. Heavy metal pollution on these agricultural lands due to agricultural activities and airplane traffic was examined and its possible alteration in accordance with the distance to the airport was studied.

Material and Methods

Reagents and Standards

Multi-element standard solution IV was used for checking the accuracy of the measurements by Microwave Plasma-Atomic Emission Spectroscopy (MP-AES). All chemicals were obtained from Merck (Darmstadt, Germany). All chemicals used were of analytical reagent grade and were at least 99.5% pure.

Study Area

The airport which is located in south of Turkey, Hatay province has terrestrial coordinates of the airport are 36° 14′ 8.9808" North and 36° 39′ 47.6856" East. The airport is surrounded by Amanos Mountains from west, Karasu from north, Afrin Valley from east, Asi Valley and Keldağ outcrops from South (www.dhmi.gov.tr). Hatay airport is surrounded by vast agricultural lands. Local people have been using these agricultural lands, and introduce the products to the market. These products might be exposure to heavy metal pollution due to air traffic and agricultural activities.

After Hatay airport was selected as the center, 27 soil samples in 0-30 depth and around the center were obtained by cleaning the soil surface. The collected soil samples were delivered to laboratory after putting in plastic bags and labelling (Kacar, 2009).

Preparation of Samples

Soil samples were dried in air and homogenized by pounding. After that the samples were sieved in 2 mm diameter stainless steel sieve (Kacar, 2013). The samples were weighed and separated into 10 grams, and 20 ml diethylenetriaminepentaacetic acid (DTPA) extract solution was added to each sample. DTPA extract solution was prepared by adding 1.967 g DTPA, 1.47 g $CaCl_2.2H_2O$ and 14.92 g triethanolamine (TEA) into 1 L of distilled water. pH of the solution was set to 7.30 by adding 1:1 diluted hydrochloric acid. Samples were rinsed for two hours and centrifuged. Then, the samples were filtered with Whatman 42 filter paper (Lindsay & Norwell, 1978) and analysed with MP-AES instrument.

Microwave Plasma-Atomic Emission Spectroscopy (MP-AES) Analysis

MP-AES analysis was performed on an Agilent 4100 instrument. The Agilent MP Expert software was used to automatically subtract the background signal from the analytical signal. A background spectrum from a blank solution was recorded and automatically subtracted from each standard and sample solution analysed. The software was also used to optimize the nebulization pressure and the viewing position for each wavelength selected to maximize sensitivity. The MP-AES wavelengths; Al 396.15 nm; Cr 425.43 nm; Cu 324.75 nm; Fe 259.94 nm; Mn 403.08 nm; Ni 352.45 nm; Pb 405.78 nm; Zn 213.86 nm; Co 340.51 nm; Cd 228.80 nm.

Quality Control

The calibration standards were prepared in the range of 1–5 mg L^{-1} using multi-element standard solution in a matrix of 5% HNO_3. In all cases, the correlation coefficients of linear function were better than 0.995. Limits of detection (LOD) and limit of quantification (LOQ) were calculated from ten times the standard deviations for 15 consecutive blank measurements divided by the calibration curve slope, respectively. The values obtained for all metals are listed in Table 1.

Table 1. The values of correlation coefficients, LOD, and LOQ of examined heavy metals

Heavy metals	Correlation coefficient (R^2)	LOD (mg kg^{-1})	LOQ (mg kg^{-1})
Fe	0.999	0.343	1.142
Zn	0.996	0.705	2.348
Cd	0.997	0.115	0.382
Cu	0.999	0.256	0.852
Co	0.999	0.202	0.673
Ni	0.999	0.118	0.393
Al	0.999	0.013	0.041
Mn	0.999	0.059	0.196
Pb	0.999	0.088	0.293
Cr	0.999	0.010	0.034

Results

Maximum accepted concentrations of heavy metals in soil in accordance with guidelines of Environment and Forest General Directorate of Turkey, and limit values of heavy metals in some European countries are given respectively in Table 2 and Table 3.

Table 2. Limit values of heavy metals in soil (COGM, 2010)

Heavy Metals	pH 5-6 mg/kg Oven-Dry Soil	pH>6 mg/kg Oven-Dry Soil
Pb	50**	300**
Cd	1**	3**
Ni*	30**	75**
Cr	100**	100**
Co	80**	80**
Cu*	50**	140**
Fe	4.5**	4.5**
Zn*	150**	300**
Mn	70**	70**

* If pH value is higher than 7, in the cases that heavy metal is not harmful for human health and groundwater, these values could be increased up to 50%. .

** These values could be increased for the specific conditions which heavy metal is approved not to be harmful for human health and environment scientifically.

Table 3. Heavy metal limits for some European countries (mg/kg) (Öztürk & Bildik, 2005)

Country	Quality Standards of Countries	Cd	Cr	Cu	Ni	Pb	Zn
Austria	Compost Ordinance Class A	1	70	150	60	120	500
Belgium (FL)	Ministry of Agriculture	1.5	70	90	20	120	300
Denmark	Ministry of Agriculture	0.4	-	1000	30	120	4000
Germany	The Biowaste Ordinance Type II	1.5	100	100	50	150	400
Ireland	Draft	1.5	100	100	50	150	350
Luxemburg	Ministry of Environment	1.5	100	100	50	150	400
Netherlands	Class 2 Compost	1	50	60	20	100	200
Spain	Class A	2	100	100	60	150	400
Sweden	Quality Assurance Organization	1	100	100	50	100	300
UK	TCA Quality Label	1.5	100	200	50	150	400

According to the findings of the physical and chemical analysis of the soil samples: acidity (pH) values are between 7 and 8.8, lime contents are between 14.0% and 32.5%, organic matter contents are between 1.10% and 4.55%. The majority of the soil samples are neutral, moderately alkaline and slightly limed whereas the organic matter content of soil ranges from low to high. Texture of the samples has a variation of sandy clayey loam to sandy clay.

Heavy metal contents (all results of were given with standard deviation) of the soil samples which were collected near Hatay airport is shown in Table 4. Average heavy metal contents of all analysed soil samples were found within the following intervals: 0-1.45 mg kg^{-1} Pb, 0-0.220 mg kg^{-1} Cd, 0-3.95 mg/kg^{-1} Ni,0-0.780 mg kg^{-1} Cr, 0-0.270 mg kg^{-1} Co, 0-0.700 mg kg^{-1} Al, 1.47-16.2 mg kg^{-1} Fe, 0.400-5.35 mg kg^{-1} Cu, 0-19 mg kg^{-1} Mn and 0.050-3.14 mg kg^{-1} Zn.

Table 4. Heavy metal contents of analysed soil samples (mg.kg^{-1})

Sample Location	Distance to Airline (km)	Pb	Cd	Ni	Cr	Co	Al	Fe	Cu	Mn	Zn
East 1	2	1.45±0.11	0.220±0.09	3.95±0.13	0.780±0.06	0.270±0.12	0.700±0.05	16.2±1.18	5.35±0.12	19.0±0.34	3.14±0.11
East 2	4	0.740±0.01	0.200±0.05	3.40±0.10	-	0.180±0.05	0.652±0.06	12.3±0.81	5.20±0.11	15.2±0.67	3.04±0.11
East 3	6	0.550±0.01	0.221±0.04	3.05±0.11	-	0.105±0.02	0.641±0.07	13.3±0.05	3.46±0.11	14.9±0.24	2.96±0.10
East 4	8	0.480±0.03	0.192±0.05	3.05±0.11	-	0.060±0.01	0.603±0.11	14.6±0.19	1.88±0.16	13.5±0.07	2.91±0.06
East 5	10	0.611±0.03	0.181±0.05	2.35±0.08	-	-	0.411±0.11	7.49±0.93	1.68±0.21	15.5±0.23	1.40±0.01
East 6	12	0.501±0.01	0.173±0.09	2.16±0.10	-	-	0.382±0.09	6.83±0.06	1.67±0.15	15.1±0.11	1.35±0.03
East 7	14	0.492±0.03	0.180±0.04	2.25±0.16	-	-	0.311±0.05	7.63±0.11	1.01±0.13	11.1±0.28	1.33±0.03
East 8	16	0.491±0.01	0.180±0.06	1.95±0.09	-	-	0.254±0.06	6.37±0.13	1.08±0.09	13.5±0.19	1.25±0.01
West 1	2	0.535±0.09	0.205±0.05	3.14±0.07	-	-	-	5.47±0.12	1.32±0.06	12.7±0.16	0.148±0.03
West 2	4	0.510±0.05	0.201±0.04	2.94±0.06	-	-	-	4.34±0.10	1.28±0.05	12.8±0.14	0.111±0.06
West 3	6	0.530±0.04	0.192±0.07	2.96±0.10	-	-	-	5.38±0.20	1.57±0.10	12.1±0.14	0.101±0.05
North 1	2	1.11±0.21	0.681±0.03	3.81±0.08	0.105±0.005	-	-	6.32±0.13	1.81±0.13	11.8±0.17	0.640±0.11
North 2	4	0.650±0.06	0.615±0.05	3.14±0.07	-	-	-	3.83±0.08	1.65±0.08	7.92±0.09	0.460±0.11
North 3	6	0.600±0.15	0.610±0.03	2.44±0.07	-	-	-	7.24±0.11	1.50±0.16	7.89±0.08	0.385±0.10
North 4	8	0.480±0.15	0.506±0.05	2.37±0.10	-	-	-	5.61±0.16	1.25±0.14	7.51±0.11	-
North 5	10	0.461±0.09	0.682±0.11	1.75±0.12	-	-	-	5.89±0.11	1.73±0.06	5.65±0.10	-
North 6	12	0.455±0.05	0.651±0.14	1.73±0.10	-	-	-	5.51±0.13	1.64±0.17	5.16±0.16	-
North 7	14	0.521±0.10	0.672±0.12	1.95±0.05	-	-	-	5.65±0.11	1.40±0.10	5.16±0.14	-
North 8	16	0.601±0.05	0.701±0.10	2.00±0.09	-	-	-	5.16±0.16	1.35±0.08	5.05±0.09	-
South 1	2	0.182±0.03	0.085±0.01	2.83±0.15	-	-	0.080±0.03	5.47±0.15	1.87±0.04	14.5±0.19	-
South 2	4	0.150±0.05	0.055±0.03	2.80±0.15	-	-	0.065±0.02	3.34±0.18	1.81±0.16	14.4±0.16	-
South 3	6	0.131±0.01	0.065±0.01	2.75±0.13	-	-	0.060±0.01	5.68±0.12	1.65±0.08	11.1±0.14	-
South 4	8	0.130±0.04	0.035±0.01	2.75±0.10	-	-	0.051±0.01	4.47±0.22	1.50±0.18	13.8±0.18	-
South 5	10	0.080±0.01	0.101±0.01	1.87±0.09	-	-	0.651±0.01	6.88±0.41	3.14±0.08	15.3±0.16	1.87±0.09
South 6	12	0.155±0.03	0.093±0.03	1.81±0.13	-	-	0.645±0.03	7.89±0.24	3.10±0.05	16.0±0.20	1.81±0.11
South 7	14	0.065±0.01	0.090±0.01	1.65±0.11	-	-	0.640±0.03	7.51±0.12	3.15±0.03	16.0±0.23	1.65±0.08
South 8	16	0.035±0.01	0.089±0.01	1.50±0.10	-	-	0.640±0.01	5.65±0.11	3.24±0.04	16.9±0.21	1.50±0.13

Discussion

There has been no any scientific work in the literature about environment pollution caused by airway transport. But there are many studies on heavy metal pollution from road transport. For example, Gülser et al. (2004) collected samples at 3 different locations in Van province at which there was heavy traffic, assuming the roadside as initial point and taking samples at 15 m and 30 m away from the roadside. As a result of their examination, Pb and Cd content are found to be decreased when distance of sample location to road increases. Öztemel et al. (2012) took samples at 0-15 m depths from six different locations that are 0, 15, 30 metres far away from each other in the east and north sides of Şanlıurfa-Viranşehir highway routing which was perpendicular to the highway. Bilge et al. (2013) made a study about heavy metal pollution in the soil of Viranşehir-Kızıltepe highway. According to the results, heavy metal concentration in the soil samples were determined as Pb 0.64-2.24, Cd 0.26-0.40, Ni 27-42, Cr 17-28 and Cu 9.9-14.12 mg.kg^{-1}. These results showed that the heavy metal concentrations stand in the allowable threshold limit values and decreases while the distance to road increases.

When comparing the obtained data through this study with allowable concentrations of heavy metals soil of European countries' heavy metal limit values and Environment and Forest Directorates guidance, all heavy metals concentrations except iron were found within the allowable limits. The iron concentrations were found to be above the allowable limits, but no precautions are needed to be taken. The source of higher concentrations of iron in the soil could be agricultural fertilizers. On the other hand, iron concentration was decreased when the distance to the airport is increased.

In conclusion, it was determined that agricultural lands near Hatay airport do not have heavy metal pollution, except iron.

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