DOI: 10.1051/matecconf/20166402001

Heavy metal concentrations of selected public parks of Istanbul City

Goksel Demir[1], H. Kurtulus Ozcan[2], Huseyin Ozdemir[3], Ali Osman Pektas[3], Ilker Oruc[4] *and* Muhammet Buyukyildiz[5]

[1]*Kirklareli University, Architecture Faculty, Department of Urban and Regional Planning, Kirklareli- Turkey*
[2]*Istanbul University, Engineering Faculty, Department of Environ. Engineering, 34320 Avcilar, Istanbul-Turkey*
[3]*Bahcesehir University, Faculty of Engineering, Department of Environ. Engineering, 34349 Besiktas, Istanbul-Turkey*
[4]*Kirklareli University, Vocational College of Technical Sciences, Kirklareli-Turkey*
[5]*Istanbul Grater Municipality Quality Control Laboratory, Istanbul-Turkey*

Abstract. Many cities, especially larger metropolises, parks are very important recreational areas where people usually have closer contact with flora. Therefore, the pollution level in the parks can have a greater effect on human health. Heavy metals are ubiquitous with the environment, as a result of both natural and anthropogenic activities, and humans are exposed to them through various pathways. Essentially, these areas are assumed to be less exposed to routine contaminants, but especially in metropolises, this assumption could prove false considering these areas are stuck within the confines of a city full of pollutant activity such as intense traffic. In this study; the relationships between heavy metal pollution levels (Cd, Cr, Cu, Ni, Pb, Zn) and the pH and electrical conductivity (EC) of soil samples were investigated from the parks on the Asian side of Istanbul. For this purpose, the most frequently visited 16 parks were selected as sampling sites. In the second part of the study, linear correlation is used for the data analysis.

1 Introduction

In addition to air and water, living organisms also need soil to survive. Land is an important environmental component for the future of living organisms. Unfortunately, the land is contaminated by different sources gradually. One of the most significant types of pollution on land is heavy metal pollution, thus this subject has become a focus point of environmental science. Among all of the researched heavy metal pollutants, Cu, Cd, Ni, Zn, Co and Pb become the most frequently examined, as they have a wide range of applications [1, 2, 3, 4]. Because of crop production over contaminated soils and contaminated pastures, heavy metals are carried up the food chain, and this process is therefore significantly affecting all living organisms in the ecosystem – with human beings as no exception – in a dangerous manner [5].

The earth on which we live and produce our food is polluted for many reasons, such as irresponsible agricultural methods, mining operations, residential operations and industrial applications of methods in agriculture. When the soil is polluted by the wastewater, this situation can lead dangerous consequences via groundwater contamination. The most important and known effect of soil pollution by the perspective of environmental health is the mobility of pollutants from soil to plants and then from plants to animals and people. Additionally, there are many health risks associated with physical exposure to contaminated soil, or digestion of contaminated dust – especially digestion of evaporating mercury and arsenic, in the soil [6]. Some important physical and chemical properties of soil, such as texture, cation exchange capacity, pH value and the amount of organic matter within the soil, are important parameters that affect the heavy metal accumulation rate of the soil in question [7]. Heavy textured soils are particularly able to absorb high ratios of heavy metal since they have a high exchange capacity of cation. Furthermore, soils that are rich in organic matter can much more quickly absorb heavy metals and cause the formation of hard-soluble compound.

Heavy metals are spread into the atmosphere from many different sources and different processing stages. In particular, heavy metals released from various sources, such as petrochemical, paper, energy, transportation and fertilizer industries, can cause damage to the ecological balance by following the path of dry and wet deposition to the surface and surface waters, and then mixed up in groundwater [2-8]. Generally, soil is able to neutralize the high level elements in it and so prevent aquatic organisms from the toxic effects of these elements. But, there could be heavy metal contamination close to the domestic and industrial waste places, heavy traffic roads and the unconsciously fertilized agricultural areas [9]. Common activities that increase the heavy metal accumulation of soil include the use of heavy metal-containing fertilizers and pesticides in agricultural activities and landscape studies, using high content heavy metal surface waters for irrigation and the use of heavy metal contaminated sewage sludge and wastes in order to increase the soil productivity. Another increasing factor of soil heavy metal accumulation is rainwater that has been polluted by flue and exhaust gas emissions [10].

In literature, the heavy metal studies that focused on recreational areas and parks are rare. Kabala et al. [11] examined total concentrations of Cu, Pb and Zn from 180 small family gardens of Poland and found that up to 35% of soils are excessively contaminated and require reclamation. Rajan et al. [12] investigated the heavy metal chemical changes before and after a monsoon at the recreational park tributaries in Pahang, Malaysia. They took water samples from 5 tributaries 6 times (3 times before, and 3 after the monsoon) and monitored the temperature, pH, oxygen derivation and the quantities of 8 heavy metals (Ag, Cd, Cu, Cr, Fe, Ni, Pb, and Zn). They too, also concluded that the water supply in the investigated National Parks have acceptable quality for recreational purposes. On the other hand, the usage of multivariate statistical analysis in heavy metal studies is very common. Arslan et al. [13] used cluster analysis and principal component analysis to comprehend the relationships between salinity, sodicity, and some soil properties in irrigated areas of the Bafra Plain, Turkey. They took 86 samples from different depths of 0-30 cm and 30-60 cm and used cluster analysis to group the sampling sites. Similarly, Liu et al. [14] used principal component analysis and cluster analysis to evaluate the heavy metal concentrations in soils around two gauge hills from Zhuxiangzhuang coal mine, northern Anhui province, China. Shahbaz et al. [15] analyzed the egg contents, prey and soil samples of little egret and cattle egret from two headworks to assess the importance of prey and habitat contamination as an exposure source for heavy metals. They used Correlation Analysis and Hierarchical Agglomerative Cluster Analysis (HACA) and identified relatively similar associations of metals and their source identification. Zheng et al. [16] used multivariate statistical analysis (correlation analysis, principal-components analysis, and clustering analysis) to investigate the heavy metal content of particulate matter in the city of Guangzhou in southern China by using samples of urban foliage near 36 pedestrian bridges.

The purpose of this study is investigating the relationship between heavy metal pollution levels (Cd, Cr, Cu, Ni, Pb, Zn) and the pH and electrical conductivity (EC) of soil samples from the parks on the Asian side of Istanbul. Linear correlation analysis is used for this purpose.

2 Material and method

2.1 Sampling procedure

This study was conducted in the city of Istanbul, the most important city in Turkey in terms of its industry and economy. Beside the intensive industrial facilities and economic mobility of the city, the high population intensifies the problems of environmental pollution. Istanbul is an intercontinental city, which is between Europe and Asia. The European part of the city is called the European side and the Asian part is called the Asian Side. According to a report which is prepared by the Turkish Statistical Institute (TSI), the city has a total population of 13.6 million people and 64.7% of this population is living in the European side while the other 35.3% living in the Anatolian side [17]. Since most of the parks are isolated places when compared with general urban areas, it was intended to select the most probably contaminated parks in order to show the relationship of heavy metal concentrations. For this purpose, the most frequently visited 16 parks were selected as sampling sites. The selected sampling sites (parks) are in the vicinity of the intense urban activity. As a result of this condition, selected parks are also near intense traffic roads and industrial activities. The texture of soils which were measured in this study is generally sandy, clayey, loamy, slight alkali, saltless, and contains low amounts of lime and medium amounts of organical material [18]. In the site selection phase of the study, this situation is taken into consideration and an assumption is made that these areas should be much more exposed to heavy metal contaminations, especially sourcing from the air and flue gas exhaust emissions. For sampling areas, another default pollutant factor is annual maintenance works such as fertilization and soil regulation processing works. After determining the sample sites, the soil samples were taken from two levels of depths (0-20 cm and 20-40 cm) by considering soil color, the slope, plant diversity and the difference of activities on the ground. For each determined sampling point, a sufficient number of soil samples were taken to that rep-resents corresponding parcel. Afterwards, these soil samples were mixed to obtain homogenous composite, and at least one kilogram of the sample was taken from each homogenous composition. The sampling points and sampling numbers are given in Table 1.

Table 1. Sampling point notation and the number of sampling.

Sampling points	Notation	Number of soil samples	
		0-20 cm	20-40 cm
Kadıköy Moda Parkı	P1	23	23
Göztepe Parkı	P2	11	11
Osman Gazi Korusu	P3	23	23
İdealtepe Parkı	P4	14	14
Gözdağı Parkı	P5	17	17
Pendik Üst Kaynarca	P6	15	15
Tuzla Botaş Parkı	P7	18	18
Büyükçamlıca Parkı	P8	16	16
Küçükçamlıca Parkı	P9	20	20
Millet Parkı	P10	6	6
Beykoz Korusu	P11	15	15
Beykoz Çayırı	P12	10	10
Hidiv Kasrı	P13	9	9
Fethipaşa Korusu	P14	11	11
Doğancılar Parkı	P15	4	4
Üsküdar Sahil Parkı	P16	7	7
Total		**219**	**219**

2.2 Sampling analysis

When Heavy metal analysis based on the ISO 11464 [19] standards, soil samples were subjected to a drying process in an air circulated oven in which the loss of moisture or 24-hour did not exceed 5% by weight (on average 35 - 40 °C). To ensure homogeneity, soil samples have been prepared for analysis by grinding the samples with wood and porcelain mortar and hammers until the particle diameter is convenient to pass under a 12:18 mm sieve. Wood and porcelain mortars and hammers were used to prevent from metal contamination. Then, 0.2-0.3 g weighing analysis samples were taken over teflon vessels from this homogenized soil samples, and a 10 ml acidic solution (1:3 HNO_3: HCl) was added on this analysis sample. After a one hour digestion process under a Microwave power (Berghof Speed), the resulting extract was then diluted with distilled water at the desired rate and has been made ready for measurements. The heavy metal (Cd, Cr, Cu, Ni, Pb, and Zn) concentrations were measured by using the ICP-OES instrument (Perkin Elmer, Optima 2100 [20].

2.3 pH and Electrical Conductivity analysis

To measure the pH values of soil samples first, 5ml soil analysis samplings have taken and 25 ml of pure water was added on to obtain a suspension. Subsequently, this suspension was stirred vigorously and has been waited from 2 hour to 18 hour to access stabilization period of suspension. After stabilization, the pH was measured by using an appropriate instrument (WTW Multi 340i) on the filtrated suspension. The electrical conductivity of the soil was also measured with the same instrument. Before measurement 20 g of analysis samples were taken from a homogenized soil mixture. Pure water is used to suspensionized these samples, then suspensions are shaken for 30 minutes at 180 rpm agitation rate value. After agitation, the suspension was filtrated and the Electrical Conductivity (EC) values were measured with the instrument WTW Multi 340i.

3 Result and discussion

3.1 Heavy metals of soil samples

The mean values of heavy metal concentrations for each sampling point (parks) are presented in Table 2 and 3 related to the soil sample depths as 0-20 cm and 20-40 cm, respectively. In nature; cadmium and zinc are associated with one another. Cadmium is obtained as a by-product during the refination of zinc.

Table 2. The heavy metal concentrations of samples in the depth range of 0-20 cm

	pH	*EC*	*Cd*	*Cr*	*Cu*	*Ni*	*Pb*	*Zn*
		µmhos/cm	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
P1	7.830	121.130	0.310	45.810	27.780	26.810	14.150	63.400
P2	7.790	118.360	0.390	54.530	19.760	35.560	12.340	82.320
P3	7.290	123.320	1.140	47.810	38.260	30.820	35.520	68.160
P4	7.670	230.930	0.320	52.770	38.600	33.820	15.610	69.660
P5	7.640	142.000	2.670	44.890	37.180	29.500	154.420	189.690
P6	8.040	159.200	0.890	48.630	37.110	37.210	28.390	115.480
P7	7.730	188.440	0.320	49.240	21.430	38.910	19.720	53.510
P8	6.650	146.940	0.420	71.960	31.490	31.740	26.880	63.930
P9	7.420	149.400	0.270	53.050	27.880	30.250	24.560	55.770
P10	7.940	266.670	0.140	42.620	35.610	34.570	20.710	61.930
P11	7.110	127.330	2.540	66.270	50.830	64.310	33.020	118.690
P12	7.530	228.200	1.560	50.260	50.700	40.980	28.110	101.180
P13	6.550	148.330	1.760	68.040	45.640	54.130	36.950	107.110
P14	7.240	160.180	1.480	83.540	53.450	59.090	36.360	111.290
P15	7.640	204.250	1.540	51.040	54.400	44.510	112.450	129.100
P16	7.630	257.710	1.110	44.160	30.550	35.400	24.460	79.430
mean	*7.481*	*173.274*	*1.053*	*54.664*	*37.542*	*39.226*	*38.978*	*91.916*
min.	*6.550*	*118.360*	*0.140*	*42.620*	*19.760*	*26.810*	*12.340*	*53.510*
max.	*8.040*	*266.670*	*2.670*	*83.540*	*54.640*	*64.310*	*154.420*	*189.690*
SD	*0.424*	*49.636*	*0.814*	*11.625*	*10.979*	*11.003*	*38.432*	*36.047*

Cadmium compounds are used as stabilizers or pigments in; the coating process of metals, alkali coils, several metal alloys such as copper and in plastics. Because of this, the cadmium concentration is at high levels where the places where industrial activities are intense

Table 3. The heavy metal concentrations of samples in the depth range of 20-40 cm

	pH	*EC*	*Cd*	*Cr*	*Cu*	*Ni*	*Pb*	*Zn*
		µmhos/cm	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*	*mg/kg*
P1	8.190	161.300	0.370	52.510	33.920	32.860	18.060	68.720
P2	8.000	122.270	0.350	58.190	19.170	37.130	14.760	71.500
P3	7.240	126.420	1.040	40.500	38.570	28.930	25.740	62.010
P4	7.690	203.360	0.250	46.560	33.610	30.500	11.570	61.220
P5	7.660	115.800	2.780	43.640	31.580	29.470	142.220	173.860
P6	8.130	161.270	0.890	46.340	37.090	35.030	24.710	122.360
P7	8.040	161.670	0.390	48.280	23.390	35.890	28.230	58.990
P8	6.700	153.750	0.350	68.860	31.490	43.080	23.550	57.920
P9	7.360	135.550	0.260	45.610	28.730	25.280	25.440	51.110

P1 0	7.9 90	250.5 00	0.1 20	43. 020	31. 850	29. 700	25.2 60	54.2 80
P1 1	7.1 20	129.1 30	2.4 90	59. 380	48. 670	58. 010	30.2 10	115. 540
P1 2	7.8 90	213.7 00	1.6 30	44. 930	45. 790	38. 500	23.4 00	93.7 80
P1 3	7.0 10	58.78 0	2.2 10	68. 830	48. 560	63. 680	26.9 20	94.2 50
P1 4	7.2 70	166.1 80	1.5 10	76. 430	53. 360	61. 250	33.8 00	110. 070
P1 5	7.9 10	183.0 00	1.6 60	55. 710	60. 680	45. 770	120. 690	131. 880
P1 6	7.9 90	195.7 10	1.1 80	58. 900	30. 400	37. 830	30.0 90	78.0 30
me an	*7.6 37*	*158.6 49*	*1.0 92*	*53. 606*	*37. 304*	*39. 557*	*37.7 91*	*87.8 45*
mi n.	*6.7 00*	*58.78 0*	*0.1 20*	*40. 500*	*19. 170*	*25. 280*	*11.5 70*	*51.1 10*
ma x.	*8.1 90*	*250.5 00*	*2.7 80*	*76. 430*	*60. 680*	*63. 680*	*142. 220*	*173. 860*
SD	*0.4 57*	*45.54 3*	*0.8 69*	*10. 728*	*11. 251*	*11. 917*	*37.2 04*	*34.8 09*

As shown in Table 2, for all parks and at the depth between 0-20 cm, the overall mean values of cadmium concentration were 1.050 mg/kg, whereas, the minimum and the maximum values appeared to be 0.140 mg/kg and 2.670 mg/kg at the parks P10 and P5, respectively. Similarly, the mean cadmium concentration is 1.09 mg/kg at the depth level 20-40 cm (Table 3) and the min-max Cd concentration are observed in P10 and P5 parks, respectively. The mean Zn concentration of 0-20 cm depth is 91.920 mg/kg where the maximum Zn concentrations were measured from the samples of P5 for both depth ranges. For 0-20 cm depths the minimum Zn concentration is observed at P7 and in the depth range of 20-40 cm the minimum concentration of Zn may be observed in P9 (Table 2-3).

Mostly, the chromium exists in the form of insoluble chromic acid $Cr_2O_3H_20$ in soil and this form is not mobile in soil structure. The washing process of soil via irrigation and precipitation increases the mobility of chromium depending on whether the chromium has formed soluble compounds or not. As seen in Table 2, the overall mean value of Cr is 54.664 mg/kg. The minimum and maximum concentrations of Cr are observed in P10 and P14, respectively. For the depth level 20-40 cm, the overall mean value is calculated as 53.606 mg/kg, whilst the minimum and maximum concentrations are found in P3 and P14, respectively. The overall mean concentrations of Cu are 37.542 mg/kg and 37.304 mg/kg for the level depths of 0-20 cm and 20-40 cm, respectively. For both levels, the minimum and the maximum concentrations are measured in the parks P2 and P15. The Ni concentrations mean values vary from 39.226 mg/kg to 39.557 mg/kg with changing depth levels from 0-20 cm to 20-40 cm. In near surface levels, the minimum and maximum Ni concentrations are observed in P1 and P11, and for deep level samples minimum and maximum levels are measured in the samples of the P9 and P13, respectively.

In this study; another investigated heavy metal compound was Pb. The majority of the atmospheric Pb is revealed as a result of the combustion of alkyl-lead that has been used as an additive in fuels. Pb emissions released into the atmosphere is condensed in the soil thanks to precipitation, and then subsequently becomes party to the entire food chain via plants and animals. The Pb mean concentrations of the parks are 38.978 mg/kg and 37.791 mg/kg for shallow and deep levels, respectively. The minimum and maximum Pb concentrations are observed in P2 and P5 for 0-20 cm depths, whereas these values are observed in the parks P4 and P5 for the depth level of 20-40 cm (Table 2-3). Limit values for related heavy metals in national soil pollution control regulation were given in Table 4.

Table 4. Sampling point notation and the number of sampling.

Pollutant	*Limit value for skin exposure (mg/kg dry soil)*	*Limit value for pollutant transportation to ground water (mg/kg dry soil)*
Pb	400	135
Cd	70	27
Cr	235	10
Cu	3129	514
Ni	1564	13
Zn	23464	6811

As seen in Table 4, Pb, Cd, Cr, Cu, Zn concentrations of measured samples are lower than national soil pollution regulations. But Ni concentrations of samples are higher than limit value for pollutant transportation to groundwater contamination. Heavy metal concentrations some different regions were adopted from Elmaslar et.al, [21] and given in Table 5. When we compare the average heavy metal values determined in soil samples of this study with the obtained results in the literature, it can be noted that heavy metal concentrations are similar with results obtained from the other studies.

Table 5. Heavy metal concentrations of soil samples in different studies

Location	**Cu** *(mg/kg)*	**Ni** *(mg/kg)*	**Zn** *(mg/kg)*	**Pb** *(mg/kg)*	**Cd** *(mg/kg)*
Industrial area [22]	21.520	-	42.710	0.380	0.121
Agricultiral soil (0-30 cm), polluted area, Bulgaria [23]	58.300	-	338.00 0	217.00	3.590
Industrial area, Hong Kong [24]	26.100	-	62.80	87.700	1.310
Agricultiral soil, Manisa, Turkey [25]	14.300	22.300	6.750	27.300	2.800
Agricultiral soil, Menemen,	14.400	42.700	5.620	41.000	2.700

Turkey [25] Top soil, Istanbul City [21]	30.500	44.500	207.600	17.700	0.460

3.2 pH and electrical conductivity analyses

The results of pH concentrations and EC values are presented in Table 2 and 3 for the 16 parks on the Asian side of Istanbul, with regard to different sampling depths. For the activities of soil organisms and plant-availability of nutrients, the optimum pH level should be between 6-7 values. While plant growth is possible both below and above these pH values, there could be some disadvantages, therefore the soil nutrient deficiencies or potential toxicity could be predicted by observing the pH levels. As shown in Table 2 and Table 3, the pH values of soil samples vary within the scale of neutral (6.5-7.5) and slightly alkaline (7.5-8.5).

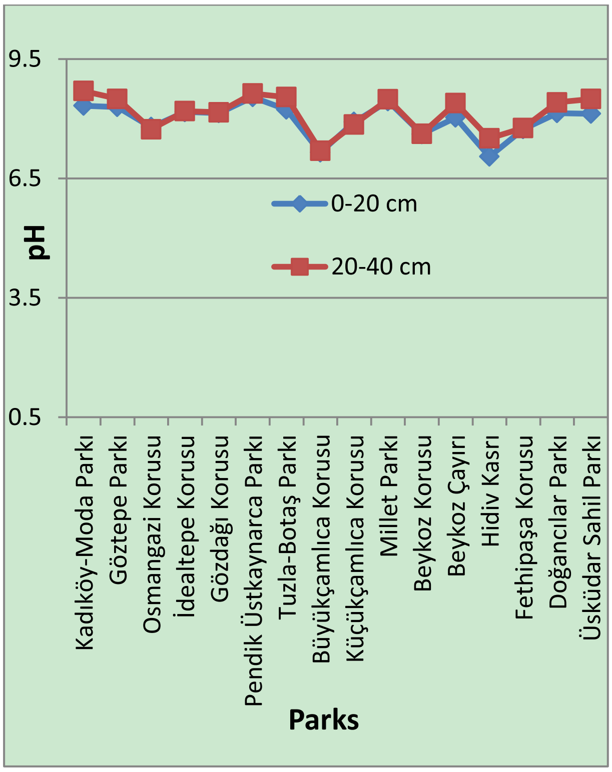

Figure 1. Variation of the pH values according to their locations and depths.

While the soil depths change between two levels, the pH levels appear to be stable regardless, i.e. there are no serious differences between pH values (Fig. 1). As is well known, organic and chemical fertilizers that are used as manure usually cause the increase of salt concentrations in soil, since they consist of dissolved materials. While the increase in concentration levels affects the osmotic pressure, this situation leads a dehydrational media where even if there is adequate water, the plants can not benefit. Additionally, a negative consequence of this situation is that the water within the plant can filtrate through the ground. As shown in Table 2 and 3 the investigated soil samples have a mean EC value of 173.274 µmhos/cm and 158. 649 µmhos/cm for shallow and deep data set, respectively. As shown in Fig. 2, EC values do not show significant differences except Hidiv Kasri. By these results it can be asserted that all soil samples belong to the salt-free soil class (0-4000 µmhos/cm) by the sense of the EC.

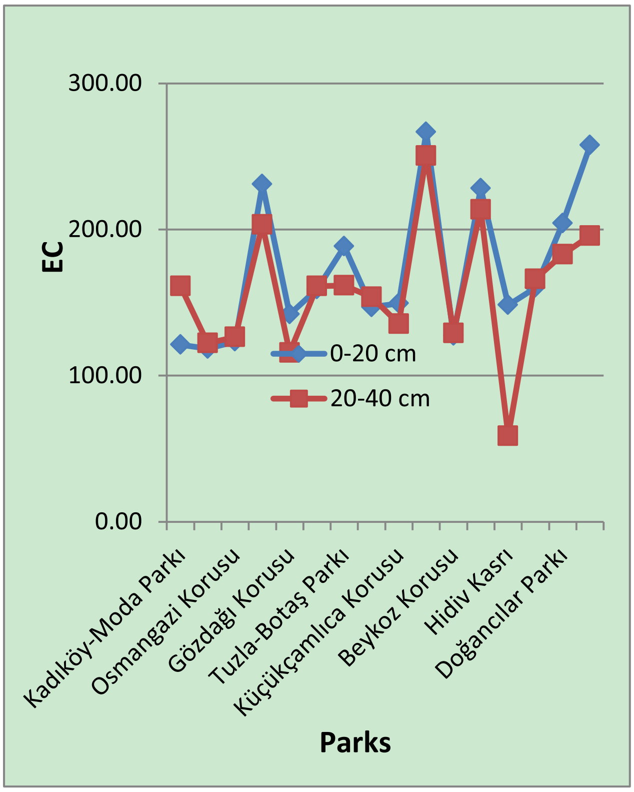

Figure 2. Variation of the EC results (µmhos/cm) according to their locations and depths.

3.3 Determination of correlation between heavy metals, pH and EC

Correlation analysis method has been applied to the data set that is obtained from the experimental results of soil samples. The existence of a linear relationship between heavy metal concentrations, pH and EC values, were investigated. At this stage of statistical analysis, it was assumed that there would not be a mutual interaction between variables and there existed only a linear relationship. For this purpose, the widely used parametrical Pearson Correlation Analysis was employed to investigate the way of interaction, whilst the determinant coefficients were used to examine the strength of the relationship.

The existence of a relationship between two variables, and the direction of the relationship, can be examined by correlation and determination analysis. In this analysis, it is not taken into consideration whether the variables are dependent or independent variables. In scientific literature, correlation coefficients are usually grouped into parametric and non-parametric correlation coefficients. The most well-known non parametric correlation coefficients are Spearmen and Kendall coefficients. On the other hand, the most known and widely used parametric methods are the Pearson correlation coefficient [26]. The values of the Pearson correlation coefficient vary between -1 and +1, the coefficient is about the values of zero when there is no linear relationship, and the close values to absolute one indicate that there is a strength relationship between two variables. Pearson's correlation coefficient between two variables is defined as the covariance of the two variables divided by the product of their standard deviations [27]. It must be pointed out that the Pearson correlation coefficient does not determine causalities, nor ascertain the presence of nonlinear relations, however, only linear relationship [28]. The Pearson correlation coefficient matrix of the dataset and the significance values of the correlations are presented in Table 6. Different depth observations have been merged into a dataset since there is not a significant difference between the results of different depth values.

Table 6. Correlation coefficients of pH, EC and Heavy metal concentrations [29]

	pH	*EC*	*Cd*	*Cr*	*Cu*	*Ni*	*Pb*	*Zn*
pH	*1*	*0,377*	*-0,295*	*-0,611*	*-0,298*	*-0,451*	*0,037*	*-0,003*
Sig. (2-tailed)		*0,033*	*0,102*	*0*	*0,098*	*0,01*	*0,841*	*0,987*
EC	*0,377*	*1*	*-0,315*	*-0,319*	*0,06*	*-0,215*	*-0,098*	*-0,192*
Sig. (2-tailed)	*0,033*		*0,079*	*0,075*	*0,743*	*0,238*	*0,593*	*0,292*
Cd	*-0,295*	*-0,315*	*1*	*0,218*	*0,632*	*0,552*	*0,623*	*0,839*
Sig. (2-tailed)	*0,102*	*0,079*		*0,231*	*0*	*0,001*	*0*	*0*
Cr	*-0,611*	*-0,319*	*0,218*	*1*	*0,383*	*0,755*	*-0,12*	*0,087*
Sig. (2-tailed)	*0*	*0,075*	*0,231*		*0,03*	*0*	*0,513*	*0,638*
Cu	*-0,298*	*0,06*	*0,632*	*0,383*	*1*	*0,67*	*0,335*	*0,514*
Sig. (2-tailed)	*0,098*	*0,743*	*0*	*0,03*		*0*	*0,061*	*0,003*
Ni	*-0,451*	*-0,215*	*0,552*	*0,755*	*0,67*	*1*	*-0,011*	*0,317*
Sig. (2-tailed)	*0,01*	*0,238*	*0,001*	*0*	*0*		*0,953*	*0,077*
Pb	*0,037*	*-0,098*	*0,623*	*-0,12*	*0,335*	*-0,011*	*1*	*0,807*
Sig. (2-tailed)	*0,841*	*0,593*	*0*	*0,513*	*0,061*	*0,953*		*0*
Zn	*-0,003*	*-0,192*	*0,839*	*0,087*	*0,514*	*0,317*	*0,807*	*1*
Sig. (2-tailed)	*0,987*	*0,292*	*0*	*0,638*	*0,003*	*0,077*	*0*	

As seen in Table 6, the correlation coefficient between pH-Cd and pH-Cu is r= -0.295 and r=-0.298, respectively indicating that there is an inverse low correlation. Furthermore, there are inverse relationships between the pH and all investigated heavy metals with the exception of Pb. The lowest correlated parameters with pH are between Zn and Pb, with a correlation coefficient r=-0.003 and r=0.037, respectively. These values are close to zero and negligible, thus for this dataset it can be concluded that the pH level is not influenced by Zn and Pb accumulation in park soils. On the other hand, the highest correlated parameter is Cr. The correlation coefficient between pH and Cr is r= -0.611. This value is between the range of $0.5<|r|<0.9$ so it can be asserted that the power to influence the concentration of Cr by soil pH is at a moderate level. The correlation between pH and Ni is r=-0.451, which is in low correlation zone ($0.0<|r|<0.5$).

The correlation coefficients between EC and heavy metal concentrations vary between a very low range $0.06<|r|<0.319$, therefore it can be asserted that there is no significant relationships between EC values and heavy metal concentrations. From the perspective of heavy metal cross correlations Cd and Zn (r= 0.839), Cr and Ni (r= 0.755), Pb and Zn (r= 0.807) have significant correlations.

4 Conclusion

By the results of this study the pH values of 0-20 cm samples vary between to 6.5-8.1 ranges, indicating that the soils belong to neutral and slightly alkaline soil types. As is known, in plant cultivation studies the preferred soil pH values range from 6.5 - 7.5 since because of this range the plants could retrieve the needed nutrients easier. Since the pH values are over the edge value (>7.5) in most parks (P1, P2, P4, P5, P6, P7, P10, P12, P15 and P16) it would be useful to include acidic fertilizers or sulfur the applications into the seasonal maintenance programs by terms of plant nutrition.

By examining the relationships with using correlation analysis between the heavy metal levels and EC and pH values it can be concluded that there lies a relationship between pH, Cr and Ni levels. Similarly, there is a relationship between Cd, Pd and Zn levels. For this data set the EC is found unrelated to each of the examined element levels.

Having tested the various sites, heavy metal concentrations of the samples were found below the limit values that are set by the National Soil Pollution Control Regulation [30]. However, within such areas, heavy metals could accumulate in the soil surface or (and) could filtrate the soil over time and cause threatening levels of contamination. In order to prevent this situation, uncontrolled and excessive use of pesticides and chemical fertilizers, especially in seasonal maintenance programs, should be avoided.

Acknowledgments

This study, a part of master thesis entitled “The soil quality and heavy metal content analysis in some specified playing grounds of Istanbul Anatolian side” which conducted at Bahcesehir University Natural Science Institute.

References

1. G. Uyar, E. Avcil, M. Ören, F. Karaca, M.S. Öncel, Determination of Heavy Metal Pollution in Zonguldak (Turkey) by Moss Analysis (Hypnumcupressiforme) Environ Eng Sci **26**(1):183-194. doi: 10.1089/ees.2007.0253 (2009)
2. A. Sahmurova, H. Turkmenler, E.E. Özbas, Biosorption Kinetics and Isotherm Studies of Cd(II) by Dried Enteromorphacompressa Macroalgae Cells from Aqueous Solutions. Clean – Soil, Air, Water, 38(10):936–941. doi 10.1002/clen.201000108 (2010)
3. T.T.T. Duong, B.Y. Lee, Determining contamination level of heavy metals in road dust from busy traffic areas with different characteristics. J Environ Manage 92:554-562 (2011)
4. H. Zhu, X. Yuan, G. Zeng, M. Jiang, J. Liang, C. Zhang, J. Yin, H. Huang, Z. Liu, H. Jiang, Ecological risk assessment of heavy metals in sediments of Xia-wan Port based on modified potential ecological risk index. Trans Nonferrous Met Soc China 22:1470-1477. doi. 10.1016/S1003-6326(11)61343-5 (2012)
5. N. Çağlarırmak, Gıda güvenliğinin çevre kirliliği yönünden incelenmesi (in Turkish). 7th National Environmental Engineering Congress, 24-27 October 2007, İzmir, Turkey (2007)
6. S. Khan, Q. Cao, Y.M. Zheng, Y.Z. Huang, Y.G. Zhu, Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. *Environ Pollut* 152:686-692 (2008)
7. F. Zeng, A. Shafaqat, H. Zhang, Y. Ouyang, B. Qiua, F. Wua, G. Zhang, The influence of pH and organic matter content in paddy soil on heavy metal availability and their uptake by rice plants. Environ Pollut **159**:84-91 (2011)
8. A.I. Amouei, Z. Yousefi, A.H. Mahvi, K. Naddafi, M. Tahmasbizadeh, Heavy metal concentrations in industrial, agricultural, and highway soils in northern Iran. Environmental Justice **5**(3):153-157. doi:10.1089/env.2011.0038 (2012)
9. O. Mikanova, Effects of heavy metals on some soil biological parameters, J Geochem Explor **88**:220-223 (2006)
10. O. Morton-Bermea, M.B. Alvarez, E.H. Gaso, N. Segovia, Heavy metal concentrations in surface soils from Mexico City. Bull Environ Contam Toxicol **68**(3): 383– 388. doi 10.1007/s001280265 (2002)
11. C. Kabala, C. Tadeusz, S. Leszek, Factors influencing the concentration of heavy metals in soils of allotment gardens in the city of Wroclaw, Poland. Fresenius Environ Bull **18**(7):1118-1124 (2009)
12. S. Rajan, N.N.M. Firdaus, M. Appukutty, K. Ramasamy, Effects of climate changes on dissolved heavy metal concentrations among recreational park tributaries in Pahang, Malaysia. *Biomed Res-India* 23(1):23-30 (2012)
13. H. Arslan, H. Gunal, M. Guler, Assessment the soil properties affecting salinity and sodicity of Bafra plain using multivariate statistical techniques. Carpat J Earth Env **8**(1):81-90 (2013)
14. X. Liu, L. Sun, S. Chen, Heavy metal pollution of soil around the gangue hill: a case study from Zhuxiangzhuang coal mine, northern Anhui Province, China. International Conference on Energy, Environment and Sustainable Development October 21-23, 2011, Shangai, China (2012)
15. M. Shahbaz, M.Z. Hashmi, R.N. Malik, A. Yasmin, Relationship between heavy metals concentrations in egret species, their environment and food chain differences from two Headworks of Pakistan. Chemosphere **93**:274–282 doi: 10.1016/j.chemosphere.2013.04.078 (2013)
16. Y. Zheng, Q. Gao, X. Wen, Multivariate statistical analysis of heavy metals in foliage dust near pedestrian bridges in Guangzhou, South China in 2009. Environ Earth Sci **70**(1):107-113. doi 10.1007/s12665-012-2107-z (2013)
17. TUIK, Turkish Statistical Institute, Official newsletter. No: 16. January (2012)
18. M. Buyukyildiz, The Soil Quality and Heavy Metal Content Analysis in Some Specified Playing Grounds of Istanbul Anatolian Side. Master Thesis, Bahcesehir University, Urban Systems and Transport Management Program (2013)
19. TS ISO 11464. Soil quality; pretreatment of samples for physicochemical analyses.
20. EPA, Test Methods for Evaluating Soil Waste. Microwave Assisted Acid Digestion of sediments, sludges, soils and oils, January.3051A-1 (1998)
21. E.E. Ozbas, H.K. Ozcan, N. Balkaya, G. Demir, C. Bayat, Heavy Metal Amounts in Soil and Sediments of Surface Water Sources in the Industrial Regions of Istanbul. J Residuals Sci Tech **4**(2):89-94 (2007)
22. B. Skrbic, and S. Cupic, Trace Metal Distribution in Surface Soils of Novi Sad and Bank Sediment of the Danube River. J. Environ. Sci. Health Part A. A39 (6)1547–1558 (2004)
23. P. Bojinova, B. Georgiev, I. Kabakchiev, V. Krasteva, L. Stanislavova, H. Tchuldjian, G. Welp, and G. Brummer, Harmonization of the Methods for the Investigation of Heavy Metal Pollution of Soils and the Standardization of the Assessment Criteria

for Soil Protection. Report No. UBA-FB 96-071. Terytze, K.N. ed., Poushkarov Institute of Soil Science and Agroecology, Sofia and Institut fur Bodenkunde: Bonn, (1996)
24. T.B. Chen, J.W.C. Wong, H.Y. Zhou, and M.H. Wong, Assessment of Trace Metal Distribution and Contamination in Surface Soils of Hong Kong. Environ. Pollut. **96**, 61–68, (1997)
25. O.L. Elmaci, S. Delibacak, M. Secer, and A. Bodur, Fertility Status, Trace Elements and Heavy Metal Pollution of Agricultural Land Irrigated from the Gediz River. , Int. J. Water. 2, Nos.2/3, (2002)
26. J.L. Myers, A.D. Well, Research Design and Statistical Analysis (2nd ed.), Lawrence Erlbaum, p. 508, ISBN 0-8058-4037-0 (2003)
27. C.L. Joseph, K.W. Kevin, L.Y. Wan, Solar radiation modeling using ANNs for different climates in China. Energy Convers Manage **49**:1080–1090. doi 0.1016/j.enconman.2007.09.021 (2008)
28. J. Duricic, T. Erdik, A.O. Pektaş, P.H.A.J.M. Van Gelder, Mean normalized force computation for different types of obstacles due to dam break using statistical techniques. Water **5**:560-577. doi:10.3390/w5020560 (2013)
29. SPSS Algorithm, IBM SPSS Statistics 20 Algorithms, Copyright IBM Corporation, 1989, USA (2011)
30. TKKY, National Regulations of soil pollution control Turkish Official Gazette, No 27605, Turkey (2010)