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ASSESSING HEAVY METALS POLLUATION IN SOME SURFACE SOILS OF DELTA REGION, EGYPT.

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ABSTRACT

Heavy metals pollution of surface soils due to industrialization and urbanization has become a serious concern in many developing countries. The extent of pollution with heavy metals may vary according to the activity located in the region. For this purpose five sources were examined with four cities in east Delta-Egypt (Aga, Sandoob, Talkha and the last one is Damiatte) to evaluate contamination with heavy metals resulting from the different sources of pollution (irrigation industrial, sewage, agricultural irrigation and car smoking fumes near roads). Soil samples were randomly collected from each site on depths (0-15 cm) and (15-30 cm) by using auger and were analyzed to assess the concentration of heavy metals (Cu, Cd, Ni and Pb) in those soils to compare between different locations. The results showed wide variation in concentration of studied heavy metals in soils as affected by activates in the areas and whenever, in the region has high activity led to increase the amount of heavy metals release in the environment. These values are all down the maximum tolerable levels set by, MAFF (1992) and EC (1986) except Cd.
Keywords: Pollution - heavy metals - irrigation industrial–sewage-car smoking fumes.

INTRODUCTION

Soil pollution by heavy metals is a significant environmental problem worldwide (Alloway, 1995). Dispersion of metals in irrigated soils and plants growing there on might result in contamination of food that may be hazardous to domestic animals and humans (Jolly *et al.,* 2013). Transfer of metals from soils to plants is one of the key pathways for exposure of humans via the food chain. (Hough *et al.,* 2003).. The accumulation of heavy metals in surface soils is affected by many environmental variables, including parent material and soil properties, as well as by human activities, such as industrial production, traffic, farming and irrigation. Big areas of land can be contaminated by heavy metals released from smelters, waste incinerators, industrial wastewater, and from the application of sludge or municipal compost, pesticides, and fertilizers. Due to mobilization by activities of humans, including mining, smelting, manufacturing, use of agricultural fertilizers, pesticides, municipal wastes, traffic emissions, industrial effluents and industrial chemicals, pollution of soils by transition metals, such as cadmium (Cd), nickel (Ni), zinc (Zn), lead (Pb), copper (Cu), has increased dramatically during the last few decades (Chibuike and Obiora 2014). Fertilizer industry is considered to be source of natural radionuclides and heavy metals as a potential source. It contains a large majority of the heavy metals like Hg, Cd, As, Pb, Cu, Ni, and Cu (FAO, March, 2009). Rapid and unorganized industrialization and urbanization have contributed to the elevated levels of heavy metals in the urban environment of the developing countries (Wong *et al.*, 2003). Emission of heavy metals from the industries and vehicles may be deposited on the vegetable surfaces during their production, transport and marketing (Othman, 2001). Other anthropogenic sources of heavy metals include the addition of manures, sewage sludge, fertilizers and pesticides which may affect the uptake of heavy metals by modifying the physico-chemical properties of the soil such as pH, organic matter, bioavailability of heavy metals in the soil (Yusuf and Osibanjo, 2006). Yuanan Hu, *et al.*, (2013) studied heavy metals in the surface soils from lands of six different use types. Samples were collected and analyzed for major heavy metals (As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, and Zn). The results indicate that, Mn, Co, Fe, Cr, and Ni in the surface soils were primarily derived from lithogenic sources, while Hg and As contents in the surface soils were controlled by both natural and anthropogenic sources. The pollution level and potential ecological risk of the surface soils both decreased in the order of: urban areas > waste disposal/treatment sites industrial areas > agricultural lands forest lands > water source protection areas. These results indicate the significant need for the development of pollution prevention and reduction strategies to reduce heavy metal pollution for regions undergoing fast industrialization and urbanization.

Therefore, the main objective of this study is evaluating the effectes of the studied activities in different areas on their surface soils content of heavy metals.

MATERIALS AND METHODS

Soil samples were collected in 2014 season included five majors sources for heavy metals (industrial, sewage and agriculture and car smoking). Four sites were selected in Delta region, Egypt(Aga, Sandoob, Talkha and the last one is Damiatta).

Sampling:

Soil samples were randomly collected from each site during study on depths (0-15 cm) and (15-30 cm) by using auger appliance contaminated with four sources of pollution (irrigation industrial, sewage, agricultural irrigation and Car smoking fumes near roads) In order to estimate the soil content of heavy elements (Pb and Cd). Soil samples were air dried, crushed, passed through 2 mm sieve and kept for analysis.

Studied soil locations: Map 1 show the locations of the studied soils where:

Location (**L**) A: Talkha B: Sandoob . C: Aga D: Damiatta

Pollution source : T1: Agriculture drainage T2: Industrial drainage T3: Sewage drainage T4: Car smoking T5: Control (Agriculture area)

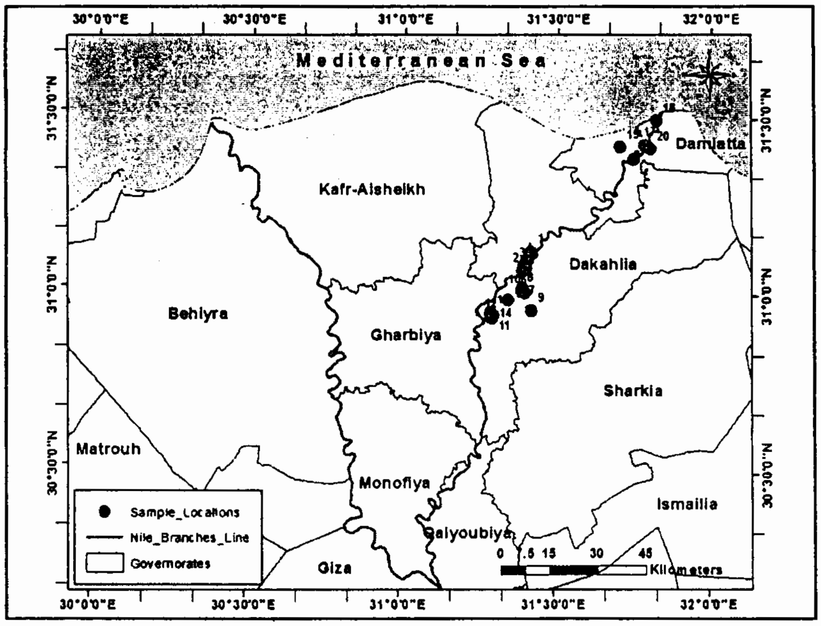
Soil sampling depths (D), D1: 0-15 cm D2: 15-30 cm.

Soil analyses:

Mechanical analysis was determined using the international pipette method (Piper, 1950). Soil reaction pH in soil paste was determined by using Bechman pH meter (Page *et al* 1982). Electrical conductivity (EC_e) dS m^{-1}, at

25° C in soil paste (Page, 1982). Available Cu, Pb, Ni and Cd were extracted by ammonium acetate–EDTA according to (Cottenie *et al.,* 1982) and determined with Atomic Absorption technique (GBC Avanta).
Some physical and chemical properties if the experimental soils are presented in Tables (1, 2, 3 and 4).

Variance analysis of obtained data was performed using the SAS Statistical software (SAS Institute, 2004) .



Figr 1: map of the studied soil locations.

RESULTS AND DISSCUSSION

Data presented in Table 1 show the particle size distribution for the studied soils. Meanwhile Table 2 data show Means of SP % as affected by the interaction between four location and five pollution resources at two soils depths.

As general, the textural classes for the investigated soils vary from sandy and sandy-loam. While The values of saturation percentage ranged between 27.50 to 58.90 %.

Table 1: The particle size distribution for the studied soils.

Location	Poll.souce	Depth cm.	C.sand %	F.Sand %	Silt %	Clay %	T.class
A	T1	D1	12.83	52.07	29.49	5.61	S.L
A	T2	D1	16.32	57.16	23.69	2.83	S
A	T3	D1	14.24	54.91	26.71	4.14	S.L
A	T4	D1	17.46	61.25	19.13	2.16	S
A	T5	D1	11.32	49.81	31.78	7.09	S.L
B	T1	D1	9.84	43.45	40.84	5.87	S.L
B	T2	D1	18.1	53.33	24.16	4.41	S
B	T3	D1	14.05	41.73	37.28	6.94	S.L
B	T4	D1	15.56	58.19	22.66	3.59	S
B	T5	D1	12.82	46.9	35.15	5.13	S.L
C	T1	D1	11.75	44.18	38.3	5.77	S.L
C	T2	D1	9.47	40.12	43.36	7.05	S.L
C	T3	D1	15.36	18.19	31.86	4.59	S.L
C	T4	D1	16.05	55.92	24.56	3.47	S.L
C	T5	D1	9.71	37.63	44.1	8.56	S.L
D	T1	D1	14.47	72.1	8.45	4.98	S
D	T2	D1	13.35	70.06	11.47	5.12	S
D	T3	D1	15.73	71.94	5.78	3.55	S
D	T4	D1	15.92	73.84	5.98	4.26	S
D	T5	D1	12.16	68.25	12.56	7.03	S
A	T1	D2	12.09	51.84	30.34	5.73	S.L
A	T2	D2	15.47	56.32	25.19	3.02	S
A	T3	D2	13.7	53.55	28.46	4.29	S.L
A	T4	D2	16.68	60.79	20.24	2.29	S
A	T5	D2	10.66	48.92	33.21	7.21	S.L
B	T1	D2	8.93	42.61	42.48	5.98	S.L
B	T2	D2	16.95	51.48	27	4.57	S
B	T3	D2	14.21	40.52	38.18	7.09	S.L
B	T4	D2	14.47	57.76	24.05	3.72	S
B	T5	D2	11.90	45.36	35.45	5.29	S.L
C	T1	D2	10.98	43.10	40	5.92	S.L
C	T2	D2	8.51	39.27	48.77	7.32	S.L
C	T3	D2	14.21	47.52	33.54	4.73	S.L
C	T4	D2	15.30	53.43	27.66	3.61	S
C	T5	D2	8.82	35.96	46.42	8.80	S.L
D	T1	D2	13.70	71.63	9.18	5.49	S
D	T2	D2	12.41	69.32	12.86	5.41	S
D	T3	D2	15.43	74.23	6.28	4.06	S
D	T4	D2	15.08	72.47	7.67	4.78	S
D	T5	D2	11.39	67.97	13.07	7.57	S

Table 2: Means of SP % as affected by the interaction between four location and five pollution resources at two soils depths.

L	Poll. source	SP for D1		SP for D2	
		Mean	Std dev	Mean	Std dev
A	T1	43.90	0.05	45.10	0.02
A	T2	29.70	0.02	30.80	0.07
A	T3	39.40	0.05	41.20	0.07
A	T4	27.50	0.03	28.30	0.01
A	T5	53.77	0.02	54.90	0.03
B	T1	51.90	0.01	53.20	0.02
B	T2	40.60	0.03	41.90	0.08
B	T3	55.30	0.01	56.10	0.01
B	T4	37.50	0.10	38.50	0.03
B	T5	50.20	0.03	51.31	0.05
C	T1	37.80	0.05	38.60	0.07
C	T2	39.31	0.05	40.50	0.01
C	T3	33.40	0.01	34.07	0.02
C	T4	31.60	0.02	32.80	0.020
C	T5	58.90	0.08	59.70	0.07
D	T1	42.50	0.07	44.30	0.05
D	T2	44.00	0.04	45.50	0.09
D	T3	34.20	0.06	36.10	0.02
D	T4	49.90	0.01	51.20	0.02
D	T5	57.80	0.03	59.40	0.10
LSD			0.0338		0.0383

Data in Table 3 show means of some chemical properties which reveal that the values of soil pH ranged from 7.68 to 8.20. in general, the investigated soils are moderately alkaline (pH less 8.5 and above 7). The values of EC ranged from 4.95 to 10.26 dSm^{-1}. In general, the investigated soils are saline (EC > 4 dSm^{-1}) .

The mean values of concentrations of heavy metals in the soils of the study areas were listed in Table 4 . The highest value for the Ni was recorded in Sandoob location soil at depth 0-15 cm but the lowest one was recorded in Aga. while at depth 15-30 cm the highest value for the Ni was recoded in Talkha location soil but the lowest one was recorded in Damiatta. The highest values for the Pb and Cd were recoded in Sandoob location soils at depth 0-15 cm but the lowest one recorded in Talkha and the highest value recoded in Sandoob location also for the Pb and Cd concentration at depth 15-30 cm but the lowest one recorded in Damiatta for the Pb and Aga at depth 15-30 cm. The highest value for the Cu recoded in Damiatta location soil at depth 0-15 cm but the lowest one recorded in Talkha and the highest value for the Cu recoded in Sandoob location soil at depth 15-30 cm but the lowest one also, recorded in Talkha.

Table 3: Means of pH and EC ($dS\ m^{-1}$) in soil past extraction as affected by four studied locations and five pollution sources at two soil depths.

Locations	D Cm	pH		EC dS m^{-1}	
		In soil past extraction			
		Mean	Std Dev	Mean	Std Dev
A	D1	7.88c	0.15	7.19^{b}	1.33
B	D1	7.94^{b}	0.23	6.78^{c}	1.95
C	D1	7.77^{d}	0.28	6.04^{d}	1.90
D	D1	8.09^{a}	0.15	10.11^{a}	2.45
A	D2	7.82b	0.16	7.34^{b}	1.32
B	D2	7.89^{bb}	0.30	6.89^{c}	1.96
C	D2	7.68^{c}	0.24	6.37^{d}	1.82
D	D2	8.03^{a}	0.16	10.26^{a}	2.47
T1	D1	8.07^{b}	0.11	6.19^{d}	1.45
T2	D1	7.76^{dd}	0.24	8.95^{b}	0.76
T3	D1	7.84^{c}	0.18	8.28^{c}	2.11
T4	D1	7.75^{d}	0.09	9.27^{a}	2.86
T5	D1	8.20^{a}	0.09	4.95^{e}	1.32
T1	D2	7.99b	0.13	6.38d	1.38
T2	D2	7.68d	0.26	9.10b	0.76
T3	D2	7.76cc	0.19	8.43c	2.12
T4	D2	7.70cd	0.09	9.49a	2.78
T5	D2	8.15a	0.20	5.15e	1.27

Table 4: Means of Ni and Pb and Cd and Cu ($mg\ kg^{-1}$) as affected by four studied locations at two soil depths.

L		Ni mg kg^{-1}		Pb mg kg^{-1}		Cd mg kg^{-1}		Cu mg kg^{-1}	
		Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev
A	D1	19.93^{bb}	11.14	26.43^{d}	14.27	5.01^{d}	3.79	11.37^{d}	7.19
B	D1	22.33^{aa}	11.56	31.06^{a}	15.33	7.24^{a}	5.34	14.85^{b}	7.81
C	D1	19.45^{b}	11.52	26.81^{c}	13.17	5.82^{c}	3.6	11.83^{c}	4.91
D	D1	22.17^{a}	11.851	29.52^{b}	15.90	5.90^{b}	3.671	15.19^{a}	7.91
A	D2	3.95^{b}	1.42	4.59^{b}	1.86	1.59^{c}	1.23	5.92^{d}	3.57
B	D2	4.55^{a}	1.43	5.76^{a}	1.46	2.39^{a}	1.83	8.56^{a}	4.68
C	D2	3.81^{c}	1.36	4.42^{c}	1.49	1.48^{d}	0.791	6.83^{c}	2.85
D	D2	3.58^{d}	1.39	3.59^{d}	0.44	1.63^{b}	0.50	8.14^{b}	4.81

Data cited in Table 5 show that, the means values of concentration of studied heavy metals as affected by actives in investigated regions. In general, the Data indicated that, at depth 0-15 cm and 15-30 cm the highest value for the Ni, Pb, Cd and Cu found in T2:, T4, T3 and also, respectively but the lowest value found in T5 for all studied heavy metals.

Table 5: Means of Ni and Pb and Cd and Cu (*mg kg⁻¹*) as affected by five treatments at two soil depths.

Poll.source		Ni mg kg^{-1}		Pb mg kg^{-1}		Cd mg kg^{-1}		Cu mg kg^{-1}	
		Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev
T1	D1	22.05^{c}	2.62	18.06^{d}	3.15	7.11^{b}	2.75	12.93^{c}	2.70
T2	D1	36.45^{a}	1.35	30.44^{c}	1.42	6.81^{c}	0.20	14.56^{b}	1.77
T3	D1	28.49^{b}	2.69	38.77^{b}	4.15	12.17^{a}	2.07	24.33^{a}	3.90
T4	D1	11.76^{d}	3.25	47.17^{a}	2.66	2.36^{d}	0.42	10.98^{d}	2.05
T5	D1	6.09^{e}	0.35	7.84^{e}	0.70	1.52^{e}	0.11	3.75^{e}	0.16
T1	D2	3.70^{c}	0.95	3.96^{d}	1.16	2.40^{b}	1.13	7.33^{c}	2.04
T2	D2	6.22^{a}	0.21	4.26^{c}	0.61	1.31^{c}	0.34	8.48^{b}	0.82
T3	D2	4.28^{b}	1.04	5.11^{b}	1.16	3.26^{a}	1.39	13.25^{a}	2.91
T4	D2	2.96^{d}	0.20	6.49^{a}	1.75	1.11^{d}	0.28	5.90^{d}	1.43
T5	D2	2.71^{e}	0.29	3.14^{e}	0.45	0.78^{e}	0.11	1.86^{e}	0.16

Copper

The highest mean of Cu in the studied soils was 24. 33 at 0-15cm.depths and 13.25 *mg kg*$^{-1}$ at 15-30 cm, these values were higher compared to the control (3.75 and 1.86 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm respectively), but are still lower than the critical permissible level which is 60-125 *mg kg*$^{-1}$for soil recommended according to Alloway, 1995.

Lead

The highest mean of Pb in the studied soils 47.17 to 6.49 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm respectively, and 7.84 to 3.14 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm in the control. These values were lower than the maximum tolerable levels proposed for soil, 100-400 *mg kg*$^{-1}$set by Alloway, 1995.

Cadmium

Cadmium top concentrations of Cd in all the soil samples were 12.17 to 3.26 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm which was higher, as compared to the control (1.52 and 0.78 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm), and some of these values are higher than the critical limits (3.8 *mg kg*$^{-1}$) in soil as given by Alloway, 1995.

Nickel

The top concentrations of Ni in the studied soils varied between 36.45 and 6.22 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm, which was higher, as compared to the control (6.09 and 2.71 *mg kg*$^{-1}$at 0-15 cm and 15-30 cm), but are still lower than the critical permissible level which is 100 *mg kg*$^{-1}$for soil recommended by Alloway, 1995.

That all values of the metals concentrations obtained for all sites are below the maximum tolerable levels proposed for agricultural soils, according to, MAFF (1992) and EC (1986) except Cd in some sites.

Finally, these results are harmony with those obtained by, Al Naggar, *el al.*, (2014) assessed copper (Cu), zinc (Zn), cadmium (Cd), lead (Pb), and iron (Fe) in soil and associated plants were measured to assess contamination of a geographic area. Samples were collected from four different Egyptian regions (El-mehala El-kobra, Kafr El-Sheikh, Kafr El-zayat, and Al-fayoum). Concentrations of the selected metals in agricultural soils were significantly different among locations and seasons. Accumulation was different for clover and cotton (Al Naggar, *el al.*, 2014). Also, Hu, *et al.*, (2013).

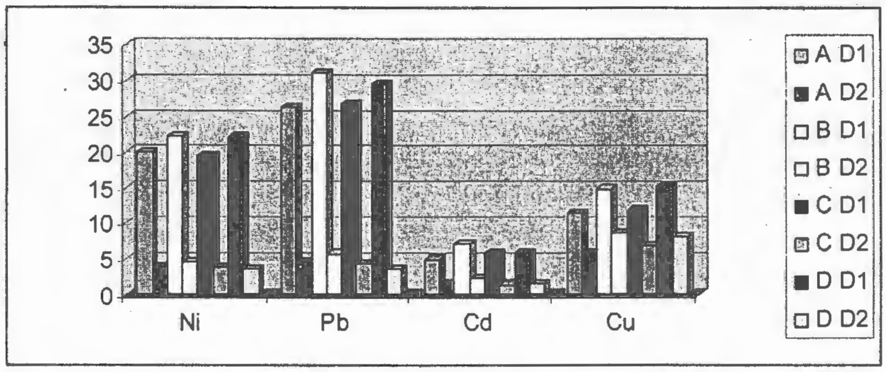


Fig. 1: The concentration of studied heavy metals in investigated soil locations (Talkha, Sandoob, Aga and Domiatte, respectively). at two depths (D1 and D2.

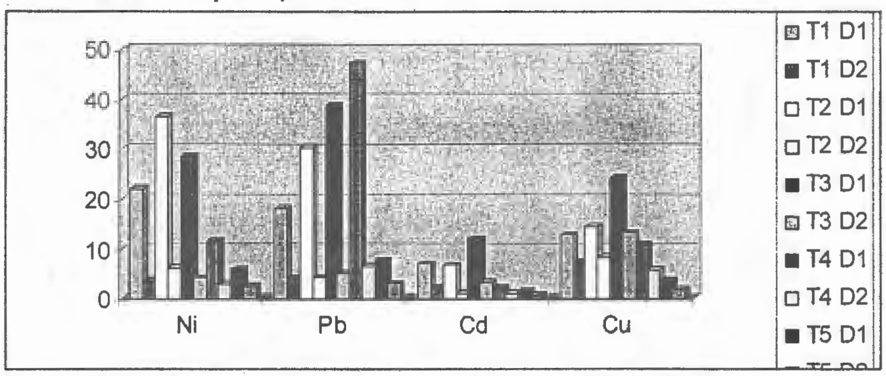


Fig. 2: The concentration of studied heavy in the soil as affected by the locations activity at two depths.

Data cited in Table 6 indicated that, there were significant differences in heavy metals contents in all studied soils due to interaction between the locations and its activity.

Table 6:Means of Heavy metals concentration as affected by the interaction between four location and five pollution resources at two soil depths.

L	T	N	Ni meg kg^{-1}		Pb meg kg^{-1}		Cd meg kg^{-1}		Cu meg kg^{-1}		Depth cm
			Mean	Std dev	Mean	Std dev	Mean	Std dev	Mean	Std dev	
A	T1	3	18.12	0.05	13.54	0.01	3.27	0.02	8.85	0.02	D1
A	T2	3	34.58	0.10	28.95	0.03	6.67	0.01	12.17	0.10	D1
A	T3	3	29.57	0.02	37.68	0.10	11.42	0.01	24.17	0.02	D1
A	T4	3	11.43	0.10	44.03	0.02	2.25	0.04	7.95	0.02	D1
A	T5	3	5.94	0.04	7.95	0.04	1.44	0.10	3.72	0.10	D1
B	T1	3	25.10	0.02	21.84	0.05	10.07	0.04	15.06	0.02	D1
B	T2	3	37.08	0.01	32.58	0.10	6.95	0.01	15.86	0.05	D1
B	T3	3	30.06	0.04	43.55	0.03	15.44	0.10	27.37	0.10	D1
B	T4	3	12.85	0.10	49.18	0.10	2.06	0.03	12.03	0.02	D1
B	T5	3	6.55	0.10	8.15	0.03	1.67	0.02	3.95	0.01	D1
C	T1	3	22.26	0.10	17.59	0.01	8.94	0.02	12.55	0.03	D1
C	T2	3	36.08	0.03	29.69	0.10	6.59	0.10	13.79	0.01	D1
C	T3	3	24.04	0.03	32.91	0.02	10.05	0.03	18.29	0.10	D1
C	T4	3	8.62	5.74	45.35	0.03	2.08	0.03	10.73	0.04	D1
C	T5	3	6.23	0.10	8.52	0.01	1.45	0.10	3.77	0.01	D1
D	T1	3	22.72	0.01	19.25	0.10	6.16	0.10	15.26	0.10	D1
D	T2	3	38.06	0.04	30.54	0.03	7.03	0.02	16.43	0.04	D1
D	T3	3	30.27	0.02	40.94	0.03	11.75	0.04	27.49	0.10	D1
D	T4	3	14.14	0.03	50.12	0.06	3.05	0.01	13.22	0.03	D1
D	T5	3	5.66	0.06	6.74	0.03	1.52	0.02	3.55	0.02	D1
LSD D1			0.9481		0.0421		0.0404		0.0437		D1
A	T1	3	2.94	0.03	2.86	0.05	0.98	0.01	4.16	0.03	D2
A	T2	3	5.94	0.02	4.40	0.61	1.19	0.03	8.72	0.10	D2
A	T3	3	5.28	0.03	6.15	0.10	3.96	0.03	11.16	0.10	D2
A	T4	3	2.72	0.10	7.06	0.04	0.94	0.10	3.57	0.02	D2
A	T5	3	2.88	0.10	2.50	0.02	0.86	0.03	1.97	0.02	D2
B	T1	3	5.14	0.10	5.63	0.05	3.92	0.04	8.93	0.02	D2
B	T2	3	5.94	0.02	4.40	0.61	1.19	0.03	8.72	0.10	D2
B	T3	3	5.28	0.03	6.15	0.10	3.96	0.03	11.16	0.10	D2
B	T4	3	2.72	0.10	7.06	0.04	0.86	0.10	3.57	0.02	D2
B	T5	3	2.88	0.10	2.86	0.02	0.94	0.03	1.97	0.02	D2
C	T1	3	3.80	0.04	3.86	0.03	2.76	0.03	7.26	0.05	D2
C	T2	3	6.36	0.10	4.27	0.02	1.04	0.04	8.86	0.10	D2
C	T3	3	3.08	0.03	3.88	0.01	1.94	0.03	9.85	0.10	D2
C	T4	3	2.86	0.03	7.16	0.10	0.98	0.01	6.25	0.10	D2
C	T5	3	2.97	0.01	2.94	0.03	0.69	0.03	1.93	0.03	D2
D	T1	3	2.91	0.03	3.84	0.10	1.94	0.03	8.97	0.01	D2
D	T2	3	6.15	0.03	3.46	0.03	1.87	0.01	7.16	0.10	D2
D	T3	3	3.53	0.02	4.12	0.10	2.06	0.04	16.02	0.02	D2
D	T4	3	3.07	0.07	3.67	0.02	1.56	0.03	6.94	0.05	D2
D	T5	3	2.25	0.04	2.87	0.01	0.72	0.05	1.61	0.04	D2
LSD D2			0.0432		0.1092		0.0356		0.0505		D2

CONCLUSION

The results showed that, wide variation in concentration of studied heavy metals in soils as affected by activates in the areas and whenever, in the region has high activity led to increase the amount of heavy metals release in the environment. The concentrations of studied metals in the soil lower than its critical limits except Cd. Even though these heavy metal concentrations are below the critical permissible concentration level, it seems that their persistence in the soils may lead to increased there accumulation in soil and increased uptake of these heavy metals by plants

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تقييم التلوث بالعناصر الثقيلة في بعض التربة السطحية بمنطقة الدلتا.مصر

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أصبح تلوث الطبقة السطحية للتربة بالمعادن الثقيلة بسبب المدنية امر خطير في العديد من البلدان النامية حيث وجد ان مدى التلوث بهذه العناصر قد يختلف حسب النشاط الموجود في المنطقة لهذا الغرض تم فحص خمس أماكن لاربع مدن بشرق الدلتا (اجا وسندوب وطلخا واخيرا دمياط) عرضة للتلوث بالمعادن الثقيلة الناتجة من قبل مصادر مختلفة حيث لوثت بأربعة مصادر التلوث (الري الصناعي ومياه الصرف الصحي والري الزراعي وعادم السيارات بالقرب من الطرق) وتم جمع عينات من التربة بطريقة عشوائية من كل موقع على أعماق (٠-١٥ سم) و(١٥-٣٠ سم) باستخدام البريمة ثم حللت لتقييم تركيز المعادن الثقيلة مثل (النحاس والكادميوم والنيكل والرصاص) في اراضيها للمقارنة بين المواقع المختلفة وقد أظهرت النتائج تباين واسع في تركيز المعادن الثقيلة المدروسة حيث تأثر بحجم النشاط القائم في المنطقة وقد أدى ارتفاع النشاط إلى زيادة الكمية المنطلقة من المعادن الثقيلة في البيئة. وكانت هذه القيم كلها أسفل الحد الأقصى للمستويات المقبولة التي وضعت بواسطة MAFF (1992) and EC (1986) فيما عدا عنصر الكادميوم.