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Environmental Risk Assessment for Soil and Plants Pollution Resulting of Emitted Dust from Industrial Activities

Sherif, A.E.A.[1] and Atwany, A.M[2].

[1]Enviro. Rese. Dep. Soils, Water & Envir. Res. Instit., Giza - Egypt.
[2]Egyptian Environmental Affairs Agency, El-Maadi, Cairo - Egypt.

Abstract: This research was carried out in the industrial zone of Akersha, north of Khanka, to study the extent of pollution resulting from the dust emitted from the industrial activities on soil, some plants and their environmental impact. To achieve this aim, samples were taken from the air dust emitted from the industrial activities, the soil and plants growing in the neighboring area. The most important results are as follows:- The highest content of Fe, Mn, Zn, Cu, Cd, Cr, Ni, and Pb in dust emission was found at 100 m distance from industrial zone at spring season. The lowest content for Fe, Zn, Cr and Pb were found at 850 m distance from industrial zone at autumn season; while Mn, Cu, Cd and Ni were found at 750 m distance from industrial zone at winter season. With respect to the total concentration of Cu, Cd and Pb in soil were higher than the permissible limits at all sites and seasons; but the other elements were with the safe limits allowed. High total concentrations of Fe, Zn Cd and Pb in soil were found at the sites located near the factory, and decreased with a distance far from industrial activities zone in the North-East direction. Contamination degree (Cd) was ultra-high degree of contamination. But the degree of modified contamination degree ($_{m}dC$) was low degree of contamination in all sites and different seasons. Enrichment factor was between low for Mn and very high for Zn; Cd and Pb were very high for all different sites and seasons. All plants were considered hyper-accumulator for (Fe, Mn, Cu, Cr, and Ni) in all plants grown at the soil affected by dust emitted at spring, summer, autumn and winter seasons, except Wheat plant with (Mn and Cu); Cu in Spinach and Cabbage at winter; while, Arugula, Faba bean, Mallow, Okra fruits and Molokhia considered hyper-accumulator for Cu. As well as Wheat, Spinach and Cabbage considered not hyper-accumulator for Cu. Bio-concentration (<1) for Zn, Cd and Pb in all plants under study except Arugula was considered hyper-accumulator for Zn at spring season.

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1. Introduction

Different industrial activities are degrading various environmental components like water, air, soil and plant vegetation. Cement dust contains heavy metals like nickel, cobalt, lead, chromium, pollutants hazardous to the biotic environment, with impact for vegetation, human and animal health and ecosystems **Shukla et al, (2008)**. The main air pollutants are represented by gases forms, particles in suspension, different ionizing and radiation. The gases forms are: oxidized and reduced forms of carbon (CO_2, CO, CH_4), of nitrogen (NO_2, NO, N_2O_4, NH_3, NH_4^+) also SO_2, O_3, C_6H_6 vapours, Hg, volatile phenols, Cl_2, etc. The particulate forms are: PM10 and PM2.5 particulate matter, heavy metals with toxic effect (Pb, Ni, Cd, As), polycyclic aromatic hydrocarbons PAHs, etc. Atmospheric pollutants have a negative effect on the plants; they can have direct toxic effects, or indirectly by changing soil pH followed by solubilization of toxic salts of metals like aluminum. The particulate matters have a negative mechanical effect. They cover the leaf blade reducing light penetration and blocking the opening of stomata. These impediments influence strongly the process of photosynthesis which rate declines sharply, **Iuliana and Barbu (2011)**. While **Tianxin et al, (2016)** reported that, air and soil pollution from mining activities has been considered as a critical issue to the health of living organisms. However, few efforts have been made in distinguishing the main pathway of organism genetic damage by heavy metals related to mining activities.

Rizescu et al. (2011) reported that, this dust contains hazardous, leachable elements such as zinc, lead or cadmium which require fume extraction system dust to be stored in specific landfills. **Jalees and Asim (2016)** found that Heavy metals in airborne suspended particulate matter which were collected on glass fiber filters from four different locations from urban atmosphere. The concentration for the particulate matter was analyzed for trace metals as for iron (23.08 µg m^{-3}) and zinc (15.36 µg m^{-3}), lead (6.23 µg m^{-3}), nickel (7.95 µg m^{-3}), chromium (1.23 µg m^{-3}) were higher while copper (3.14 µg m^{-3}) and arsenic (1.59 µg m^{-3}), manganese (2.0 µg m^{-3}) concentrations were low. **Kara and Bolat (2007)** reported that soils polluted with alkaline cement dust resulted in significant reductions in microbial biomass levels compared to control soils. The decrease in this ratio was an indication of soil degradation in the polluted soils.

Bhanu et al. (2014) found that, the ambient concentrations of heavy metals (in PM10) showed significant temporal and spatial variations at different sites around coal mining areas. The mean concentrations of heavy metals in PM10 were found in the order of Fe > Cu > Zn > Mn > Pb > Cr > Cd > Ni. The major sources contributing to air pollution in Jharia were coal mining related activities and active mine fires, and secondarily vehicular emissions, while wind–blown dust through unpaved roads also contributed to some extent.

The aim of this study to monitoring and environmental risks assessment the effect of the accumulation of dust emitted from industrial activities on soil and plant.

2. Materials and Methods

2.1. Site description:-

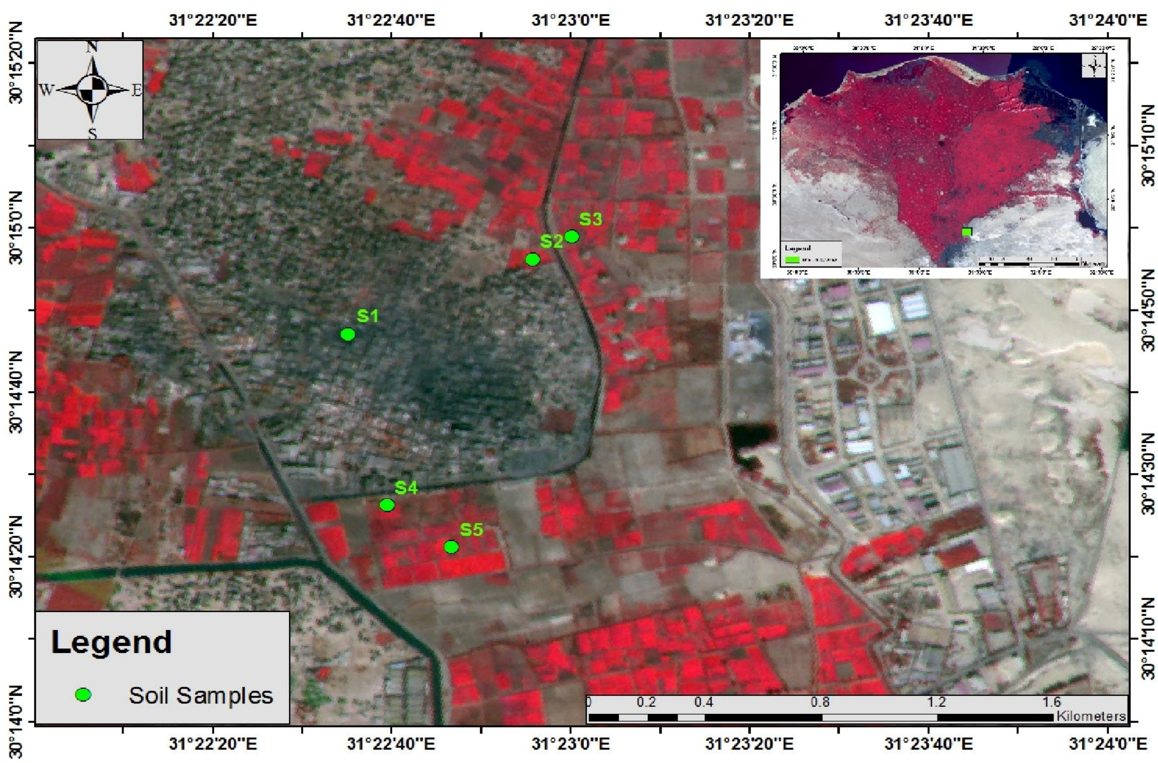

Figure 1. The locations of sites were selected using GPS.

Al-Akrasha industrial zone was in Qalyubia Governorate, away from El-Khanka city a distance of 2 kilometers and is located on an area of 250 acres of coordinates 30°14'41"N 31°22'35" E.; Fig.1. Its content on more than 1,000 foundries, led to a poor state of environmental conditions and pollution. It is a random area of the factories iron, turnings, and foundry (Cast iron, aluminum, copper, lead and drainage covers foundries). Which raises dust and smoke as a result of the factories and foundries toxic and unsafe disposal of hazardous waste of furnace slag earths generated of which. The location become extinct cultivated area with dried trees and vegetation as a resulting of emitted dust to the air from the foundries over the 24 hours, without any modern scientific techniques in production as well as the lack of filters for air purification of toxins and fumes black.

2.2. Soil and Air dust emitted Samples.

Three dust emitted samples were collected from industrial zone under study by high volume air samplers, through the special filter for pull samples at different distances. The device dust sample was placed on the roof of a building high of about 10 meters, located within the middle of the center of the dust emitted for take the first sample.

The second and third samples a distance about were 500 and 750 meters from the middle of the industrial zone, with wind direction south west throughout three times spring season; summer season and winter season. Also 100, 650 and 850 m and north-east; throughout one time autumn season. As well as different plants samples growing in the region through the four seasons of the year beginning from spring then summer seasons 2015; following autumn season 2015, then followed by winter season 2016. Surface soil samples (0-20 cm) were collected from the same sites a distance of 100, 500 and 750 m from industrial zone.

2.3. Soil Analysis.

The soil samples were air dried, passed through a 2- mm sieve, the following determinations were made based on the methods. Available (Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb) were extracted according to the method of **Soltanpour** and **Schwab (1991).** Total elements (Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb) were digested by aqua regia HCl and HNO_3 mixture (3:1) at 150 ˚C for two hours according to **Cottenie et al. (1982)** and **ICARDA (2013)**.

2.4. Plant Samples Analysis.

Each plants sample washed thoroughly with tap water to remove any attached particles, and then rinsed three times with deionized water. The samples were put in an oven and dried at 70 ^oC and then grounded. The fine ground was prepared as half gram of dry matter was wet digested by using a mixture of sulphuric and percloric acids ($HClO_4$+H_2SO_4) acids according to the procedure of **Benton (2001).**

2.5. Dust Analysis.

Filter dust samples were stored and protected from light at low temperatures until analysis in special small plastic box. Dust emission samples were put in oven drying at 65 ˚C for 2 hr, the samples were heated and digested with 1:1 (v/v) conc. HNO_3 to H_2O_2 (the process was repeated several times until complete digestion), and then diluted to a volume of 50 mL with 1% HNO_3 for analyses of total Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb **(State Environmental Protection Bureau and Editorial Group, 1995)**.

Elements in dust extraction; soil and different plant samples extraction were determined according to the procedure of **"Environmental Protection Agency" EPA. (1991)** by using inductively coupled plasma (ICP) Spectrometry (model Ultima 2 JY Plasma).

2.6. Data analyses

Different factors were used to identify the soil contamination and pollution. All factors used were described according to the given equations:

2.6.1. Contamination Factors (CF).

Contamination factor **(CF)** was used to determine the contamination status in the studied surface soil samples according the equation of **Liu et al. (2005)**, where the concentration of each heavy metals in soil were divided into categories as presented in Table 1 and Equation No (1):

***CF=Measured con/Background con.* Equation No. (1)**

Table 1. Categories of soil contamination factor

CF classes	Degree of contamination factors.
CF< 1	Low contamination factor.
1≤ CF< 3	Moderate contamination factor.
3≤ CF < 6	Considerable contamination factor.
CF > 6	Very high contamination.

The background concentrations of the different studied elements were illustrated in Table 2. according to **Turekian** and **Wedepohi (1961)**. The significance of contamination factor and the level of contamination values are described according to **Häkanson (1980)** as show in Table 1.

Table 2. Distribution of elements in the earth's crust (used as background)

Elements	Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb*
Background elements in the earth's crust ($mgkg^{-1}$)	47200.0	850.0	95.0	45.0	0.30	90.0	68.0	23.9*

*According to **Bradford et al. (1996)**

1.6.2. Contamination Degree (Cd).

The **(Cd)** is the sum of contamination factors of all elements examined as described by **Häkanson (1980),** equation No (2), defined the contamination categories Table 3.

$$Cd = \sum_{I=1}^{I=n} CF \qquad \textit{Equation No. (2)}$$

Table 3. Categories of soil contamination degree level

Cd classes	Contamination degree level.
Cd < 9	Low degree of contamination.
9 ≤ (Cd) < 18	Moderate degree of contamination.
18 ≤ (Cd) < 36	Considerable degree of contamination.
(Cd) ≥ 36	Very high degree of contamination, indicating serious anthropogenic pollution.

1.6.3. Modified Degree of Contamination (mCd).

The **(mCd)** was defined as the sum of all contamination factors as described by **Abrahim (2005),** then was calculated by equation No. (3) and its values were used in the classification of contamination degree Table 4.

$$mCd = \sum_{I=1}^{1=n} CF/n$$ ***Equation No. (3)***

Where: n, is number of analyzed elements, i=1, is the elements and CF, is contamination factor.

Table 4. The modified degree of soil contamination

mCd classes	Modified degree of contamination level.
mCd < 1.5	Nil to very low degree of contamination.
1.5 ≤ mCd <2	low degree of contamination.
2 ≤ mCd < 4	Moderate degree of contamination.
4 ≤ mCd < 8	High degree of contamination.
8≤ mCd < 16	Very High degree of contamination.
16 ≤ mCd < 32	Extremely High degree of contamination.
mCd ≥ 32	Ultra high degree of contamination.

1.6.4. The Pollution Load Index (PLI).

The **(PLI)** is able to give an estimate of the metals contamination status and the necessary action that should be taken. The **(PLI)** proposed by **Tomlinson et al. (1980)** was calculated following equation No. (4) and used to delineate the degree of pollution level as in Table 5.

$PLI= (CF_1 \times CF_2 \times CF_3 \times ... \times CF_n)^{½}$. **Equation No. (4)**

Table 5. Degree of pollution level for described pollution load index

PLI Classes	Degree of pollution level
PLI < 1	Perfection.
PLI = 1	Base line pollution level of pollution level index.
PLI > 1	Deterioration of site quality.

1.6.5. Enrichment Factor (EF).

The **EF** of an element is based on standardization of a measured element against a reference element. The value of the enrichment factor was calculated as expressed by **Buat-Menard** and **Chesselet (1979)** using equation No. (5) and the obtained data were compared with contamination degree illustrated in Table 6.

$EF = (C_m/C_{Background}) / (Fe_m/Fe_{Background})$ **Equation No. (5)**

Where, C_m is the concentration of the heavy metals in the study site, $C_{background}$ is the concentration of the reference heavy metals in the study site.

Fe_m is the concentration of the examined heavy metal in the control sample, $Fe_{background}$ is the concentration of the reference heavy metal in the control sample. Iron was used as a reference heavy metal and the value obtained from the control sample was used as the reference value according to **Rashed (2008)**.

Table 6. Degrees of soil Enrichment Factor (EF)

EF classes	Degree of contamination level.
EF < 2	Deficiency to mineral enrichment factor (indicates that the predominant source of element is the Earth crust).
EF = 2-5	Moderate enrichment factor (another source rather than the Earth crust such as human activities).
EF = 5-20	Significant enrichment factor.
EF= 20-40	Very high enrichment factor.
EF > 40	Extremely high enrichment factor.

* According to **(Faiz et al., 2012)**.

2.7. Bio concentration factor (BCF):

The BCF is calculated according to **Liu et al. (2006)** using the following equation **No. (5)**.

$BCF = C_{plant} / C_{soil}$ *Equation No. (5).*

where: - C_{plant} is the concentration of elements in the plant and C soil is the concentration of the same elements in the soil on dry weight basis BCF > 1 then the plants can be accumulators; BCF = 1 is no influences and BCF < 1 then the plant can be an excluder.

3. Results and Discussion

I. Assessment of micro-elements and heavy metals in dust emitted from Al-Akrasha industrial zone in different sites through four seasons.

Data in Table 7 shows the range and mean values of content for the selected micro-elements and heavy metals analyzed in dust emitted on filters to Al-Akrasha industrial zone in different sites through four seasons. Eight elements (Fe, Mn, Zn, Cu, Cd, Cr, Ni, and Pb) were measured in all sites. The highest content of Fe, Mn, Zn, Cu, Cd, Cr, Ni, and Pb in dust emitted was found at 100 m far from industrial zone at spring season. The lowest content for Fe, Zn, Cr and Pb were found at 850 m from distance industrial zone at autumn season; while Mn, Cu, Cd and Ni were found at 750 m from distance industrial zone at winter season.

Concerning the descending order for highest content for of the above mentioned at 100 meter distance from industrial zone were found in summer > spring > Autumn > winter, respectively. This may be due to wind speed did division for practical of dust from industrial zone or to more activity in this time of year. Regarding the effect of distance on content of micro-elements and heavy metals data in Table 7 showed decreasing the content with increasing the distance from industrial zone. In general, dust contents at the near from center of industrial activities zone were high for all the metals compared to those from far center of foundries.

Also data in Table 7 illustrated that, the micro-elements and heavy metals in the dust emitted mainly come from the emission of industrial activities; the dominant wind direction. The data also revealed that, the total content of micro-elements and heavy metals in dust emitted of the industrial area different during the seasons of the year, this indicates that un-stability of industrial activities throughout the year, which leads to a change in the content of dust emitted by micro-elements and heavy metals loaded into the air. These results agree with **Gharaibeh et al. (2010)** found that, all heavy metals in urban and rural sites reached maximum concentrations in June, July, and August. This is consistent with the increased activities which leading to particulate matter emission during the summer period.

Table 7. Assessment of micro-elements and heavy metals in dust emitted to Al-Akrasha industrial zone in different sites through four seasons.

Seasons	Distance from industrial activities (m)	mg kg^{-1}							
		Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb
Spring	100	9199.2	56.25	2873.4	186.45	1.49	31.28	66.97	66.39
	500	4522.5	25.38	1353.8	92.85	1.04	20.83	40.01	36.48
	750	1524.4	19.84	183.4	14.81	0.50	6.41	14.25	8.24
Average summer		5082.03	33.82	1470.20	98.04	1.01	19.51	40.41	37.04
Summer	100	9247.4	83.28	2931.7	212.38	1.56	41.87	68.08	69.02
	500	5206.2	26.62	1600.1	102.16	1.24	19.76	40.63	34.32
	750	1881.8	18.28	286.3	24.12	0.50	6.47	16.25	9.22
Average spring		5445.13	42.73	1606.03	112.89	1.10	22.70	41.65	37.52
Autumn	100	5506.5	87.29	2530.1	146.74	1.47	39.97	50.14	57.57
	650	2544.0	20.48	1754.9	46.70	0.99	11.05	34.09	35.65
	850	1253.2	18.51	95.7	18.35	0.50	6.28	13.27	7.25
Average autumn		3101.23	42.09	1460.23	70.60	0.99	19.10	32.50	33.49
Winter	100	5142.3	65.48	2304.8	142.77	1.39	29.72	49.54	46.35
	500	2592.9	20.43	1424	49.98	1.26	11.52	31.48	33.98
	750	1524.4	15.7	163.5	11.62	0.46	7.26	9.15	7.86
Average winter		3086.53	33.87	1297.43	68.12	1.04	16.17	30.06	29.40
Minimum for all seasons		1253.20	18.28	95.70	14.81	0.50	6.28	13.27	7.25
Maximum for all seasons		9247.40	87.29	2931.70	212.38	1.56	41.87	68.08	69.02
Average for all seasons		4178.73	38.13	1458.48	87.41	1.03	19.37	36.16	34.36

The minimum content of micro-elements and heavy metals in dust emitted of air were 1253.20, 18.28, 95.70, 14.81, 0.50, 6.28, 13.27 and 7.25 mg kg^{-1}; as well as the maximum content were 9247.40, 87.3, 2931.70, 212.38, 1.56, 41.87, 68.08 and 69.02 mg kg^{-1}, for Fe, Mn, Zn, Cu, Cd, Cr, Ni, and Pb respectively.

The average of micro-elements and heavy metals was reached their maximum content during the summer season; this is consistent with the increased activities leading to particulate matter emission. Because the soil is dry for high temperature, while was damp in winter for rain, then larger amounts of soil particulate transferred to aerosol in the summer. High concentration was in the spring season compared to winter could be attributed to the particulate transferred loaded with heavy metals excitation by wind.

II. Available micro-elements and heavy metals in soils affected by dust emitted from industrial activity at different sites through four seasons.

Data in Tables 8 showed that available Fe, Mn, Zn, Cu and Cd, in spring, summer, autumn and winter seasons were very high content and more highly limits allowed according to **Soltanpour** and **Schwab (1991)**, but Cr, Ni and Pb are within the safe limits allowed according to **Soltanpour** and **Schwab (1991)**; **Horneck et al., (2011)** and **Michael et al., (2007)** The average values of available content of micro-elements and heavy metals in soils at spring season was (106.0,16.35,119.14, 25.65, 0.28, 0.53, 1.76 and 14.05 mgkg^{-1}); summer season (120.04, 25.25, 178.23, 17.91, 0.23, 0.46, 0.79 and 12.35 mgkg^{-1}); autumn season (118.07, 17.22, 115.48, 46.00, 0.33, 0.20, 1.71 and 13.93 mgkg^{-1}) and winter season (135.53, 22.16, 79.53, 40.84, 0.62, 0.21, 0.079 and 15.59 mg kg^{-1}) for Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb, respectively.

Finally data obtained reveled that, the lowest values in soil content of Fe, Mn were found in spring season; Zn and Ni were found in winter season, Cu, Cd and Pb were found in and Cr was found autumn season. This emphasizes the role of winds in carrying factory and foundries dust and fumes west east and north-east, resulting in metal concentration of the agricultural soils.

III. Total micro-nutrients and heavy metal contents in soils affected by dust emitted from industrial activities at different sites through four seasons.

The values of total micro-nutrient and heavy metal contents in soil affected by emitted are presented in Table 9 the sequence of heavy metals according to their total content in soil during spring season was Fe > Cu > Zn > Pb > Mn > Cr > Ni > Cd. The sequence of micro elements and heavy metals according to their total content in soil during summer season was Fe > Cu > Mn > Zn > Pb > Cr > Ni > Cd. As well as the sequence for total content in soil during autumn season was Fe > Cu > Zn > Pb > Mn > Cr > Ni > Cd, while in winter season was Fe > Cu > Zn > Mn > Pb > Cr > Ni > Cd. The results also showed that, total Fe, Mn, Zn Cu, Cd, Cr, Ni and Pb concentrations were higher in the soil samples collected from site near from industrial activities zone 100 meter that was located very close to the factory and foundries than those in other sites. These results agree with **Qi-Li et al. (2015) who** found that, at sampling sites, Fe was as the dominated metal in the total detected metals in both particle sizes, followed by Zn and Pb. They were regarded as the marker elements of iron and steel production emission along with Cr and Mn. The concentrations of all measured heavy metals were 1–3.53 times higher. The concentrations of steel related elements (Fe, Zn, and Mn) in this work were significantly high. Additionally, Cd was found as the most enriched heavy metal by the enrichment factor analysis, followed by Zn, Pb, and Cu. The main sources contributing to heavy metals site were denitrified by principle component analysis: steel dust (including coal combustion of coal-fired power plant, coke making and steel making emission), vehicle emission and road re-suspension dust and soil dust. The result suggested the steel dust has influence on the whole study area.

Table 8. Some available micro-elements and heavy metals in soils affected by dust emitted from industrial activities at different sites through four seasons.

Seasons	Distance from industrial activities (m)	Available content mgkg^{-1}							
		Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb
Spring	100 m	121.99	32.59	132.50	34.65	0.26	0.67	1.42	13.69
	500 m	102.85	8.91	129.78	24.09	0.30	0.47	2.26	17.46
	750 m	93.17	7.54	95.14	18.20	0.26	0.44	1.61	10.99
Average for spring season		106.00	16.35	119.14	25.65	0.28	0.53	1.76	14.05
Summer	100 m	118.81	14.67	177.95	27.36	0.26	0.60	0.65	10.04
	500 m	124.89	47.14	188.22	16.57	0.25	0.45	0.78	13.15
	750 m	116.43	13.93	168.51	9.81	0.19	0.31	0.93	13.87
Average for summer season		120.04	25.25	178.23	17.91	0.23	0.46	0.79	12.35
Autumn	100 m	95.16	20.70	108.70	57.84	0.56	0.26	1.52	14.78
	650 m	124.94	11.13	148.19	40.44	0.24	0.16	1.89	12.87
	850 m	134.11	19.83	89.56	39.71	0.19	0.18	1.72	14.13
Average for autumn season		118.07	17.22	115.48	46.00	0.33	0.20	1.71	13.93
Winter	100 m	182.72	48.15	122.12	70.19	0.95	0.33	0.95	18.84
	500 m	126.71	15.48	65.80	27.45	0.56	0.20	0.50	15.17
	750 m	97.15	2.84	50.66	24.89	0.34	0.11	0.92	12.76
Average for winter season		135.53	22.16	79.53	40.84	0.62	0.21	0.79	15.59
Minimum for all seasons		93.17	7.54	65.80	9.81	0.19	0.16	0.50	10.04
Maximum for all seasons		182.72	48.15	188.22	70.19	0.95	0.67	2.26	18.84
Average for all seasons		119.91	20.24	123.10	32.60	0.36	0.35	1.26	13.98
Guidelines	Low	0 – 3.0	0 – 0.5	0 – 0.9	0 – 0.2	< 0.1	---	< 0.10	< 13.0**
	Medium	3.1 – 5.0	0.6 – 1.0	1.0 – 1.5	0.3 - 0.5	0.10-0.5*	8.0*	0.10-5	13.0**
	High	> 5.0	> 1.0	> 1.5	> 0.5	> 0.1	---	> 5.0	20 -100

Guidelines for limits according to Soltanpour and **Schwab (1991); Horneek et al., (2011)*and Michael et al., (2007)**.**

Total micro elements and heavy metals in soil are toxic with respect to the total concentration of Cu, Cd and Pb in all sites and four seasons; but the other elements were non-toxic and within the safe limits allowed; according to **Kabata-Pendias** and **Pendias (1992)** and **European Union Standards (EUS, 2002)**. The results found suggest that the foundries and some still factory had some marked effect on the total soil content of most studied elements. In addition, the total concentrations of these elements in the soil vary greatly according to the direction of winds. The highest total Mn and Ni content of most were found in the soil collected at summer located very close to factory in the West East. Cu and Cr in soil collected at winter season showed almost as similar trends. The averages of total concentration in soils were 13773.1, 387.1, 366.2, 461.0, 15.8, 138.3, 42.8 and 309.5 mgkg^{-1} for Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb respectively. Table 9. Showed that, high total concentrations of Fe, Zn Cd and Pb in soil were found at the sites located near the factory, and decreased with a distance far from the factory and foundries in the North-East direction.

Table 9. Total micro nutrients and heavy metals in soils affected by dust emitted from of industrial activities at different sites through four seasons.

Seasons	Distance from industrial activities (m)	Total content mgkg^{-1}							
		Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb
Spring	100	21811.2	346.7	449.0	596.8	22.0	213.5	57.2	433.7
	500	15616.4	313.4	366.1	298.6	13.5	109.0	23.2	287.4
	750	7588.6	218.7	113.8	241.9	12.5	53.2	22.5	255.1
Average for spring season		15005.4	292.9	309.6	379.1	16.0	125.2	34.3	325.4
Summer	100	18473.0	1044.3	558.9	545.5	23.2	252.5	84.9	423.2
	500	13138.3	643.2	365.0	459.2	12.5	119.4	41.4	389.8
	750	13906.8	252.8	101.1	375.4	10.5	54.1	20.6	150.3
Average for summer season		15172.7	646.8	341.7	460.0	15.4	142.0	49.0	321.1
Autumn	100	22822.0	628.6	669.4	598.0	20.1	169.8	88.5	579.4
	650	17975.1	120.5	349.7	423.3	19.4	193.0	24.7	318.5
	850	10424.9	205.3	346.0	485.1	13.2	55.6	21.8	241.0
Average for autumn season		17074.0	318.1	455.0	502.1	17.6	139.5	45.0	379.6
Winter	100	7308.3	354.7	456.1	647.4	23.3	265.6	83.0	229.4
	500	9620.7	344.3	445.5	508.8	10.3	108.0	24.2	276.5
	750	6592.2	172.4	174.0	352.5	9.3	66.3	21.3	129.6
Average for winter season		7840.4	290.5	358.5	502.9	14.3	146.6	42.8	211.8
Minimum for all seasons		7308.3	120.5	101.1	241.9	10.3	53.2	20.6	150.3
Maximum for all seasons		22822.0	1044.3	669.4	647.4	23.3	265.6	88.5	579.4
Average for all seasons		13773.1	387.1	366.2	461.0	15.8	138.3	42.8	309.5
Critical Limit		200-50000 [a]	20-10000 [a]	300-600 [a]	2-250 [a]	3 [b]	150 [b]	75 [b]	300 [b]

a= Kabata-Pendias and Pendias (1992) and b= European Union Standards (EUS, 2002).

IV. Some indicator of environmental pollution factors.

Soils polluted from dust emission at Al-Akrasha industrial zone was assessed for contamination factors (CF), degree of contamination (Cd), modified degree of contamination (mCd) and the pollution load index (PLI), results are shown in Table 10. Data obvious indicated that soils contamination factor for Fe and Mn was low in all seasons and distance from industrial activities zone. Contamination factor for Zn was moderate and low in spring; summer at 500, 750 m and autumn at 650 and 850 m distance from of industrial activities zone. While in winter season the CF was moderate at 500 and 750 m distance from the foundries, as well as CF was considerable at 100 meter distance from industrial activities for all seasons.

Concerning (CF) of Cu, Cd and Pb were very high in all sites and seasons except Pb was considerable at 850 m distance from industrial activities in autumn season. Regarding (CF) for Cr and Ni were low at 500 and 750 m in spring; summer and winter, respectively and at 850 m in autumn, but Ni was only low CF in some season at 650 m. But Cr in autumn season was moderate at 650 m distance from industrial activities with all seasons. As well as of for Cr and Ni were moderate in all seasons at 100 m distance from the foundries. The contamination factor for the different elements generally followed the sequence Cd > Cu > Pb > Zn > Cr > Ni > Cr > Mn > Fe. On the other hand, data could be concluded form these results that the highest contamination for Fe, Mn, Zn, Cr, Ni and Pb in winter season, but were highest contamination for Cu and Cd in summer season. In case of contamination degree (Cd), ultra-high degree of contamination was found in all sites and different seasons. But the degree of modified contamination degree ($_{m}$dC) was low, in all sites and different seasons.

Pollution severity and its variation along the sites were determined with the use of pollution load index. This index is used to compare pollution status of different places **(Tomlinson et al. 1980)**. Regard to the pollution load index (PLI) data showed that low values was at 750 m in spring, summer and winter, while was moderate at 100 and 500 m in spring and in autumn season at 100 and 650 m distance, also was moderate at 500 m in summer and winter seasons respectively. (PLI) was nil degree of contamination in autumn season at 850 m. But was high degree of contamination in summer and winter season at 100 m distance from industrial activities area.

The values of pollution load index in summer and winter seasons, was generally high (> 1) at 100 m distance from industrial zon activities. Consequently, the pollution load index confirms the degredation of soil in this sites. These results confirmed that long term of polluted from dust emission might increase the accumulation of heavy metals in soil. The values of (PLI) in summer and winter seasons were high (> 1) compared with spring and autumn seasons.

Table 10. Some indicator of environmental pollution factors for dust emitted effect on soils.

Seasons	Distance from industrial activities (m)	Contamination factor (CF)								Contamination degree	Modified degree of contamination	Pollution load index
		Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb	(Cd)	mCd	PLI
Spring	100	0.50	0.54	3.01	20.79	61.11	1.75	1.46	18.15	107.31	13.41	3.84
	500	0.36	0.49	2.46	14.75	34.72	0.89	0.41	12.03	66.09	8.26	2.36
	750	0.21	0.32	0.74	12.28	29.17	0.44	0.39	10.08	53.63	6.70	1.53
Summer	100	0.59	0.56	3.75	19.01	64.44	2.07	1.49	17.71	109.62	13.70	4.12
	500	0.42	0.53	2.45	16.00	37.50	0.98	0.43	13.33	71.64	8.96	2.56
	750	0.23	0.34	0.97	13.08	30.28	0.44	0.36	7.96	53.66	6.71	1.57
Autumn	100	0.20	0.55	3.06	22.56	64.72	1.58	1.00	11.57	105.24	13.15	3.12
	650	0.26	0.53	2.99	10.40	28.61	1.39	0.42	9.60	54.21	6.78	2.27
	850	0.18	0.27	0.76	8.43	23.06	0.28	0.27	5.42	38.67	4.83	1.14
Winter	100	0.62	0.63	4.49	20.84	55.83	2.18	1.55	24.24	110.38	13.80	4.50
	500	0.49	0.50	2.35	17.73	53.89	0.89	0.73	16.31	92.87	11.61	2.95
	750	0.27	0.39	1.05	16.90	31.11	0.54	0.38	10.67	61.32	7.66	1.83

V. Enrichment factor (EF) for elements in soils affected by dust emitted from industrial activities at different sites through four seasons.

A common approach to estimate the anthropogenic impact on soils was to calculate a normalized enrichment factor (EF) for elements concentrations above the uncontaminated background levels. (EF) values of micronutrient elements and heavy metals in the studied area were illustrated in Table 11. Eventually they revealed that (EF) values ranged from 0.1 to 2 and could be considered in the range of natural variability, whereas ratios greater than 2 indicated some enrichment factors corresponding mainly to anthropogenic inputs.

Table 11. Enrichment factors of heavy metals in soils affected by dust emitted from industrial activity at different sites through four seasons.

Seasons	Distance from industrial activities (m)	Enrichment factor (EF)						
		Mn	Zn	Cu	Cd	Cr	Ni	Pb
Spring	100	1.04	12.08	33.89	187.37	6.06	3.13	55.41
	500	1.32	13.84	33.79	149.69	4.35	1.23	51.63
	750	1.50	7.21	48.72	217.68	3.68	2.06	74.95
Summer	100	0.93	12.73	26.23	167.35	6.07	2.70	45.79
	500	1.22	11.61	30.84	136.01	4.01	1.10	48.13
	750	1.44	8.50	46.74	203.55	3.37	1.70	53.31
Autumn	100	2.70	31.01	92.92	501.62	13.85	5.41	89.29
	650	1.99	23.01	32.55	168.44	9.21	1.75	56.27
	850	1.45	8.58	38.49	198.10	2.75	1.61	46.40
Winter	100	0.99	14.57	27.48	138.57	6.10	2.69	59.92
	500	0.99	9.67	29.69	169.81	3.15	1.60	51.18
	750	1.42	7.82	51.36	177.87	3.51	1.53	60.77

The average of trace elements and heavy metals concentrations given in Table 2 by **Turekian** and **Wedepohl (1961)**. Data in Table 11. Showed that, enrichment factor was between low for Mn and very high for Zn in all seasons and distance from industrial zone exception Mn at 100 m, and Zn at 100 and 650 m in autumn season. EF for Cu was very high to very-very high at 750 m distance from industrial activities in spring, summer and winter seasons, but was very-very high at 100 m distance from industrial activities in autumn season; Cd and Pb were very high for all different sites and seasons. Concerning Cr was high (EF) at 100 m distance from industrial activities in spring, summer and winter; while in autumn season was high at 100 and 650 m distance from the foundries.

As well as (EF) for Cr was moderate at 100 and 500 meter for spring, summer and winter; autumn at 850 m from the foundries. Regarding (EF) for Ni was low in summer at (500 and 750 m) and winter at (650 and 850 m) from foundries. Ni was moderate (EF) for spring, summer and winter at 100 m distance, also at 750 m in spring season. While (EF) for Ni was high in autumn at 100 m. This trend indicates that the urban centers contribute to increase elements inputs into the agricultural soils. The remaining metals negligibly influenced the soil contamination, not exceeding 4% and decreased in the following order: Cr > Zn > Cu > Ni **(Krzysztof et al. 2004)**. The significance of EFs values which were outlined by **Faiz et al. (2012)** indicated generally that Mn, Zn and Cr were deficient to normal enrichment factor (indicates that the predominant source of elements is the earth crust. Moderate enriched most probably from another source rather than the earth crust such as human activities.

Finally and based on the contamination factor, the studied soils were classified as low and slightly contaminated with Mn and Ni, moderately to high contaminated with Cr and "heavily contaminated" with Cu, Cd and Pb. The maximum values of contamination degree denoted high contamination. It was found that Cu, Cd and Pb contributed mostly to the degree of contamination index of the soil.

VI. Micro-nutrient and heavy metal contents in different plants grown in soils affected by dust emitted from industrial activity at different sites through four seasons.

Data showed in Table 12 that soils affected by dust emitted from industrial activity generally leads to change in chemical properties of soil and consequently micro-nutrient and heavy metal contents in growing plants at sites under study. The different values of Fe, Mn, Zn, Cu, Cd, Cr, Ni and Pb in plants grown was affected by dust emitted from industrial activity at different sites during spring, summer, autumn and winter seasons was obtained.

Regarding Fe content in different plants grown behind industrial zone was very-very high with all different plants; while content of Mn was low. Zn content was high in Arugula, Mallow and Wheat and low in Faba bean, Okra fruits, Melokhia, Spinach and Cabbage; as well as Cu content in different plants was high in Arugula, Faba bean, Okra fruits and Melokhia, and was low in Mallow, Wheat, Spinach and Cabbage.

Regard to heavy metals Cr and Pb were safe and below the permissible level but Ni was toxic and higher than the permissible limits according to **Bennett (1993)**, **Adriano (1986)** and **Misra** and **Mani (1991)** and Indian Standard **(Awashthi 2000).**

Generally, the highest content values in different plants were as follows: Okra fruits for Fe, Mn Cu and Pb; Arugula for Zn and Faba bean for Cr and Ni.

Table 12. Assessment of micro nutrients and heavy metals for different plants affected by dust emission; grow in soils affected by dust emitted from industrial activity at different sites through four seasons at Al-Akrasha industrial zone Abu Zaabal; Governorate Qalyubia

Seasons	Nome of plant	Concentration ($mgkg^{-1}$)							
		Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb
Spring	Arugula	1199.45	34.20	108.80	59.00	0.00	2.15	6.10	1.30
	Faba bean	1216.65	53.30	42.70	23.20	0.00	2.98	10.04	0.00
Summer	Mallow	511.82	20.30	89.40	19.00	0.00	1.58	7.91	0.00
	Okra fruits	5889.24	121.00	48.20	119.80	0.00	2.26	7.19	3.30
Autumn	Wheat	311.35	10.70	59.20	11.00	0.00	2.30	5.30	0.00
	Molokhia	4497.25	83.20	36.80	96.52	0.00	2.27	4.84	0.60
Winter	Spinach	259.23	77.10	2.70	6.30	0.00	2.26	6.60	0.00
	Cabbage	526.95	35.80	26.29	9.35	0.00	0.54	1.33	0.35
Minimum		259.23	10.70	2.70	6.30	0.00	0.54	1.33	0.00
Maximum		5889.24	121.00	108.80	119.80	0.00	2.98	10.04	3.30
Average		1801.49	54.45	51.76	43.02	0.00	2.04	6.16	0.69
Standard limit for Bennett (1993), Adriano (1986) and Misra and Mani (1991).		250 - 50	20 - 200	20 - 50	5 - 20	--	20	0 - 4	0.10 – 30.0
Indian Standard (Awashthi, 2000).		--	--	--	--	1.5	--	1.5	--

VII. Bio concentration factor (BCF) of micro nutrients and heavy metals for different plants affected by dust emitted grown in soils affected by dust emitted from industrial activity at different sites through four seasons.

Plants may represent an important source of elements for humans as it is well known that metals in soil may be taken up by plants and enter the food chain. The BCF of different plants tissues grown in soil affected by dust emission and affected by dust emitted from industrial activity at different sites through four seasons are presented in Table 13. Data showed that, each plant has specified capability to accumulate elements in their tissue *i.e.* generally all plants were considered hyper-accumulator for (Fe, Mn, Cu, Cr, and Ni) at spring, summer, autumn and winter seasons, except wheat plant with Mn and Cu; as well as Arugula was considered hyper-accumulator for Zn at spring season.

Arugula, Faba bean, Mallow, Okra fruits and Molokhia considered hyper-accumulator for Cu. While Wheat, Spinach and Cabbage considered not hyper-accumulator for Cu.

The order of bio-accumulation for elements within different plants was as follows:-

1. Okra fruits > Molokhia > Faba bean > Arugula > Cabbage > Mallow > Spinach > Wheat for Fe;
2. Spinach > Cabbage > Okra fruits > Faba bean > Arugula > Molokhia > Mallow > for Mn;
3. Arugula > Wheat > Mallow > Cabbage > Faba bean > Molokhia > Okra fruits > Spinach for Zn;
4. Okra fruits > Arugula > Molokhia > Mallow > Faba bean > Cabbage > Wheat > Spinach for Cu;
5. Spinach > Wheat > Molokhia > Okra fruits > Faba bean > Cabbage > Mallow > Arugula for Cr, and
6. Mallow > Okra fruits > Spinach > Faba bean > Arugula > Wheat > Molokhia > Cabbage for Ni.

Table 13. Bio-concentration factor for micro nutrients and heavy metals for different plants affected by dust emitted and grown in soils affected by dust emission from foundries.

Seasons	Nome of plant	Bio-concentration factor (BCF)							
		Fe	Mn	Zn	Cu	Cd	Cr	Ni	Pb
Spring	Arugula	12.87	4.53	1.14	3.24	0.00	4.84	3.79	0.12
	Faba bean	13.06	7.07	0.45	1.28	0.00	6.71	6.24	0.00
Summer	Mallow	4.40	1.46	0.53	1.94	0.00	5.04	8.49	0.00
	Okra fruits	50.58	8.69	0.29	12.22	0.00	7.18	7.71	0.24
Autumn	Wheat	2.32	0.54	0.66	0.28	0.00	12.50	3.09	0.00
	Molokhia	33.53	4.19	0.41	2.43	0.00	12.35	2.82	0.04
Winter	Spinach	2.67	27.19	0.05	0.25	0.00	21.32	7.19	0.00
	Cabbage	5.42	12.62	0.52	0.38	0.00	5.08	1.45	0.03

Data showed in Table 13 that, the bio-concentration was very high (>1) for all plants grown at area and soil affected by dust emitted were considered hyper-accumulator for (Fe, Mn, Cu, Cr, and Ni) at spring, summer, autumn and winter seasons, except wheat plant with (Mn and Cu); Cu in Spinach and Cabbage at winter; while Arugula was considered hyper-accumulator for Zn at spring season. Arugula, Faba bean, Mallow, Okra fruits and Molokhia considered hyper-accumulator for Cu. As well as Wheat, Spinach and Cabbage considered not hyper-accumulator for Cu. Bio-concentration (<1) for Zn, Cd and Pb in all plants under study except Arugula was considered hyper-accumulator for Zn at spring season

Regard to Cu in Arugula, Faba bean, Mallow and Okra fruits were more than 1 that means bio accumulation plants the advers plants was Wheat, Molokhia, Spinach and Cabbage not bioaccumulation plant less than 1.

This behavior could be attributed to one or more of the following processes: (1) plant adsorb heavy metals, translocate them through tonoplast and accumulate in vacuoles, thereby, protecting cell metabolism from metal toxicity; (2) binding of the cationic element form to the anionic sites in the cell wall; (3) binding to non-proteinaceous polypeptides (Phyto 12 chelati and ons) and accumulate in the vacuole. **Sekar et al. (2004)** and **Zhu et al. (1999)**. The advantage of high biomass productive for plants most useful to remediate heavy metals on site.

Conclusion and Recommendation

It could be concluded that, the dust emitted in air was the most effect factor on the area near the industrial activities specially the agricultural soil and plants grown on that area, and the important to know the type of plants and season of grown at which distains far from industrial activities area. Based on knowledge of the heavy metal accumulation in plants, it is possible to select those species of crops and pasturage herbs, which accumulate fewer heavy metals, for food cultivation and fodder for animals, and to select those hyper accumulation species for extracting heavy metals from soil and water.

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