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Environmental Quality and Vegetation Analysis of Ismalia Bank. (Abo Zabal Industrial Area).

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Abstract

The influence of Abo Zabal fertilizer factory on air quality and soil contamination were investigated. Air pollution index of different sites and soil pollution indices were calculated. The metal contamination in the soils was evaluated by calculating enrichment factor (EF), contamination factor (CF), geo-accumulation index (Igeo) and pollution load index (PLI). Soil quality for total heavy metals in the study area was evaluated. The factory was found to change the reaction of the soil to become acidic and all heavy metals were shown to be high at the factory site and decreased with increasing the distance from the factory. This pollution of the environment caused changes in the vegetation of the study area.

Key Words

air quality, fertilizer, soil contamination, vegetation

Introduction

Air pollution is a major problem arising mainly from industrialization (Odilora *et al.* 2006). The cause of the contamination is the presence of a wide range of inorganic and organic compounds (Ghosh and Singh 2005). Heavy metals are the main constituent of the inorganic contaminants.

Phosphate fertilizers industry is considered one of the most important strategic industries which enhance the social development and economic progress. Phosphate fertilizer industry is promising in Egypt due to the availability of basic raw materials needed for the manufacturing processes such as raw rock phosphate (Salam 2013). All fertilizer industries are very important, but create air, soil and water pollution as oxide of sulfur and acid mist from sulfuric acid plants, oxides of nitrogen from nitric acid and fluorides from phosphoric acid plant (Thakkar 2013).

Plants growing on heavy metal polluted soils show a reduction in growth due to changes in their physiological and biochemical activities (Chibuike and Obiora 2014). Environmental pollution due to fertilizer factories has documented by several authors (Ali, *et al.* 2011 Salam 2013 Thakkar 2013).

The aim of this work is to determine air quality and soil pollution under the influence of Abo Zabal fertilizer factory and their effect on natural vegetation near the factory.

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Material and Methods

Study Area and Sampling

The survey was conducted at Abo Zabal chemical fertilizer production company. It is installed on a site of 284,000 m^2, 30 km North East of Cairo El Maahd road at El Esmalia Canal. Six sites have been chosen (Figure 1) in this study. One site was in front of the factory (site F) at 30°16'31.45" N and 31°22'51.67" E and the other four sites were downwind direction and separated from the site at the factory with one kilo meter (site 1 at 30° 16' 18.15" N and 31° 22' 23.53" E, 2 at 30° 16' 1.05" N and 31° 21' 53.83" E, 3 at 30° 15' 40.10" N and 31° 21' 24.45" E and 4 at 30° 15' 25.56" N and 31° 21' 14.55" E) and the another site was in the other direction (upwind) from the factory as control (site C) 30° 18' 0.85" N and 31° 23' 31.55" E. This study conducted during summer and winter of 2012.

Air quality analysis (SO_2, NO_x and Suspended particulate matter SPM)

Air quality analysis (SO_2, NO_x and SPM) Sampling and measurements were based on Environmental Protection Agency (US EPA) and American Standard Test Methods (ASTM: ASTM D6216 and NOISH 0600) using Miran Gas Analyze and Thermo Dust meter. Air pollution index (API): was calculated as described by (Rao and Rao 1989).

API = 1/3 [(SPM) / (S_{SPM}) + (SO_2) / (S_{SO2}) + (NO_X) / (S_{NOx})] X 100 where SSPM, S_{SO2} and S_{NOx} represent the ambient air quality standards for SPM, SO_2 and NO_x**.** Index value Remarks (Ambient air quality standards taken for calculation of air pollution index 140 µg/m3 for SPM, 60 µg/m^3 for SO_2 and 60 µg/m^3 for NO_x); 0-25 Clean air; 26-50 Light air pollution; 51-75 Moderate air pollution 76-100 Heavy air pollution; >100 Severe air pollution.

Soil Sample Preparation and Analysis

Soil samples were air-dried, sieved, and analyzed in the laboratory using standard techniques. The soil reaction was determined in saturated soil paste, using Fisher´s pH meter according to Jackson (1967). Sulphates were estimated using the turbid metric method according to Anonymous (1980). Total nitrogen content was determined as described by Jackson (1967) and expressed as mg/100g. For the determination of phosphorus, the method reported by Kutter and Lichenstein (1932) and was described by Humphries (1965) was used. Heavy metals were determined using method 3050B EPA Standard Methods and measured by inductively coupled plasma ((ICP-MS) but fluoride ion was determined using selective ion electrode.

Indices of Pollution

In order to give proper assessment of the degree of contamination, attempts were made to calculate the pollution load index PLI using the equation of Tomlinson *et al.* (1980). The PLI represents the number of times by which the metal content in the soil exceeds the average natural background concentration, and gives a summative indication of the overall level of heavy metal toxicity in a particular sample. The control samples were taken to represent natural background. According to Angula (1996), PLI is able to give an estimate the metal contamination status and the necessary action that should be taken. This parameter is expressed as:

$$CF = Cm\ sample / Cm\ control$$

Where Cm sample, is the concentration of a given metal in soil sample Cm control, is value of the metal at the control site.

$$PLI = (CF1 \cdot CF2 \cdot CF3 \cdot CFn)^{1/n}$$

Where, n is the number of metals studied and CF is the contamination factor.

The extent of soil contamination was assessed using the enrichment factor (EF) and geoaccumulation index (Igeo). The EF was calculated using the method proposed by Sinex and Helz, (1981), as follows: **EF= (Me/Fe) sample / (Me/Fe) control**

Where: Me/Fe sample, is the metal to Fe ratio in the sample of interest, Me/Fe control, is the control value of metal to Fe ratio. A reference element is often a conservative one, such as the most commonly used elements: Fe, Al, Mn, Sc, Ti etc. (Yongming *et al*, 2006). Iron was chosen as the element of normalization because natural sources (1.5 %) vastly dominate its input (Salah *et al*, 2012). Five contamination categories have been recognized on the basis of the enrichment factor (Mmolawa, 2011). Elements which are naturally derived have an EF value near unity, while elements of anthropogenic origin have EF values of several orders of magnitude (Sutherland, 2000). $EF < 2$ Deficiency to minimal enrichment; $2 \leq EF < 5$ Moderate enrichment; $5 \leq EF < 20$ Significant enrichment; $20 \leq EF < 40$ Very high enrichment; $EF > 40$ Extremely high enrichment.

I geo is the enrichment of metal concentration above baseline concentrations was calculated using the method proposed by Muller, 1969: **I geo = Log2 (Cm sample / 1.5 cm control).**

Vegetation analysis

The flora of the vegetation of a side branch of River Nile passing through Abo Zabal Region studied during summer and winter of 2012. The presence and absence of different species were recorded at different sites. Identification and nomenclature were according to Täckholm (1974) and Boulos (1999, 2000, 2002 and 2005). Life forms of the species were identified following the Raunkiaer scheme (Raunkiaer, 1934).

The agglomerative clustering techniques were applied to classify the zonal vegetation of the different sites.

Community Similarity

Sorenson's coefficient (Kruscal, 1964) gives a value between 0 and 1, the closer the value is to 1, the more the communities have in common. Complete community overlap is equal to 1; complete community dissimilarity is equal to 0. The equation is:

Sorenson's Coefficient (CC)

$$= \frac{2C}{(S1+S2)}$$

Where C is the number of species the two communities have in common, S1 is the total number of species found in community 1, and S2 is the total number of species found in community 2.

Statistical analysis and data confirmation

Data were statistically analyzed using one-way ANOVA test. The computations were done by using SPSS software Version (17.0). Values presented are means ± standard deviation (SD) of three replicates.

Results and discussion

Air pollution index

Air pollution index for the six sites (Table 1) showed that three sites (Fig, 1 and 2) were under severe air pollution and these sites the nearest to the fertilizer factory, and the other site (3) was under heavy air pollution, the control site and the 4Km downwind site (4) having light air pollution. Pollution due to fertilizer industry was found in varying degrees in air, water and soil. Virtually every fertilizer industry produces some gaseous effluents (Thakkar 2013) which was recorded in our study by the increase in air pollutants at the site in front of the factory and a decrease with increase the distance from the factory. Air pollution index for different sites showed that the factory had high effect on the air quality as the sites under the influence of the factory have sever air pollution.

Soil analysis

Soil reaction has wide range as it ranged from 8.4 to 5.4 (Table 2). The pH was alkaline in sites C, 3 and 4 and acidic in sites F, 1 and 2. Site F was the most acidic followed by site 1 and site 2 respectively and site C was the highest alkaline followed by site 4 and site 3 respectively. Sulphates determined were significantly higher in soil samples collected from sites F, 1, 2and 3 respectively if compared soils from sites C and 4 and the values was higher from soil collected during summer than soil collected during winter. The highest value of phosphorous was at site F (732 mg/100g dry wt. during summer and 692 mg/100g dry wt. during winter) while the lowest was at site C (54.2 mg/100g dry wt. during summer and 48.2 mg/100g dry wt. during winter). The highest nitrogen value has recorded at site F (54.2 mg/100g dry wt. during summer and 50.9 mg/100g dry wt. during winter) and the lowest ones were at site C (2.1 mg/100g dry wt. during summer and 1.9 mg/100g dry wt. during winter).

Soil pH is often found to have the largest effect on solubility and speciation of metals in the soil solution. Thus, each unit decrease in pH results in approximately two-fold increase in the concentration of the metals (Christensen 1984 Sanders *et al.* 1986 Muwanga 1997). Site F was the most acidic followed by site 1km downwind from the factory and site 2. This acidity may have contributed

Figure (1): The study area showing the different site

Figure (2): Proportional percentage of life forms of recorded species

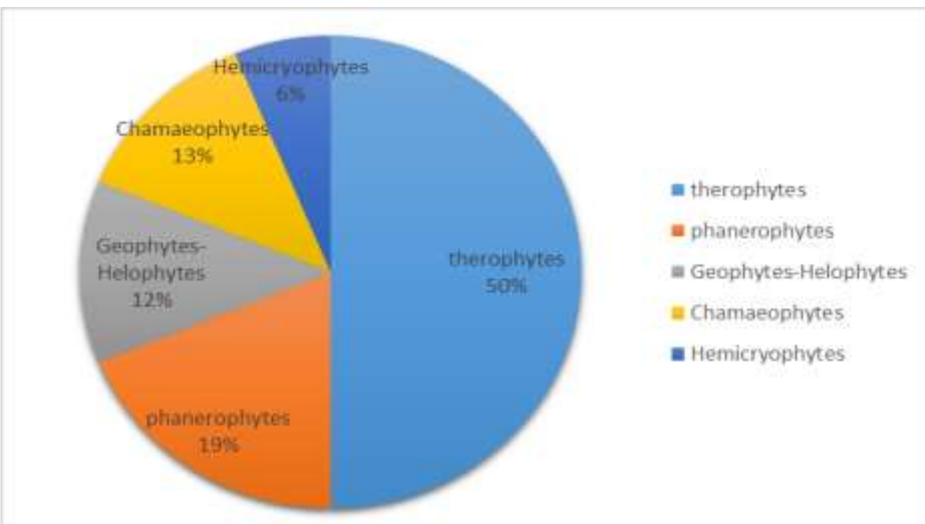


Table 1: Ambient air quality and air pollution index for different sites during summer and winter of 2012.

Sites		Season	Air pollution parameters				Air pollution index	
			CO mg/m³	SO_2 µg/m³	NO_2 µg/m³	SPM10 µg/m³		
Control	C	Summer	3	40	33	50	42.46	Light air pollution
		Winter	2.8	37	32	52	40.7	Light air pollution
In front of factory	F	Summer	5.5	166	98	170	187.14	Severe air pollution
		Winter	5.2	157	96	178	182.9	Severe air pollution
Km distance downwind from factory	1	Summer	4.2	122	95	140	153.8	Severe air pollution
		Winter	4.1	119	91	147	151.67	Severe air pollution
	2	Summer	3.8	100	89	98	128.33	Severe air pollution
		Winter	3.4	93	84	100	122.14	Severe air pollution
	3	Summer	3.4	70	64	76	92.5	Heavy air pollution
		Winter	3.2	67	56	82	87.85	Heavy air pollution
	4	Summer	3.1	44	40	55	49.76	Light air pollution
		Winter	3	42	37	56	47.22	Light air pollution

to an absorption of these contaminants, therefore increasing their adverse effect on the plants as mentioned by Commission of the European Communities (CEC) and Directive (1986) who showed that the metal limiting value may be reduced in the soil with pH value lower than six. This decrease in pH may be attributed to the concentration of sulphates at the sites near the factory.

Heavy metals (Table 3) attained the highest values in site F compared with that recorded in other sites. The prevailing elements were Cr (39.3µg/g dry wt.) then Pb (33.2µg/g dry wt.) and Ni (16.3 µg/g dry wt.) together representing the most dominant elements while the lowest elements were Mn, Cu and Fe as their values were less than 1µg/g dry wt. The values of heavy metals found to be high at the factory site and decreased with increasing the distance from the factory as contamination can be diffused or localized (Van der Perk 2006 Horta *et al.* 2015).

Table 2: Mean values of soil pH, Sulphates, available phosphorus and available nitrogen determined in soil collected from different sites (C: Control, F: Factory, 1, 2, 3 and 4: Km distance downwind from the factory) during summer and winter. (Values with same litter in the same row are not significant)

Paramaters	Season	Sites					
		Control	In front of Factory	Km distance downwind from the factory			
		C	F	1	2	3	4
pH	Summer	8.3	5.3	5.9	6.1	7.1	8.2
	Winter	8.4	5.4	6	6.1	7.3	8.4
SO_4^{-2}	Summer	3.5± 0.5d	98.6 ± 2a	82± 0.9 a	44.1±2.9b	12± 0.3 c	5.1 ±1d
	Winter	4.5± 0.5e	90.1 ± 1a	76± 1.2 b	40.1 ±1c	12± 0.7 d	5.3 ±2e
Avail P mg/100g dry wt.	Summer	54.2±0.9e	732±22a	532.1±15b	311±23.9c	107.3±9d	60.1±3e
	Winter	48.2±1e	692±21 a	502.1±5b	289±29c	96±5d	56.1±1e
Avail N mg/100g dry wt.	Summer	2.1±1.1e	54.2±1a	49.2±2b	24.9±1.5c	11.3±1d	3±0.4e
	Winter	1.9±1d	50.9±1a	45.2±4a	24±0.5b	11±1c	3±0.4d

Indices of Pollution

In this study, the enrichment factor (EF), contamination factor (CF) and pollution load index (PLI) was applied to assess heavy metal contamination in soil

1 Pollution Load Index (PLI)

The (PLI) provides simple but comparative means for assessing a site quality, where a value of PLI < 1 denote perfection; PLI =1 present that only baseline levels of pollutants are present and PLI >1 would indicate deterioration of site quality.

In this study the contamination factor and pollution load index are present in (Table 4). The contamination factor was found to be decreased with increasing the distance from the factory. All metals were belonging to very high contamination category at the site in front of the factory (F) except Fe and Mn were belonging to low and moderate contamination category respectively.

The pollution load index (PLI) in all sites were above 1 and the highest value was at site factory and the lowest was at site 4. Consequently, soils near the fertilizer factory can be considered to be of pollution concern.

Table 3: Mean values of trace elements (µg/g dry wt.) in soil from different sites (C: Control, F: Factory, 1, 2, 3 and 4: Km distance downwind from the factory) during summer and winter. (Values with same litter in the same row are not significant).

Trace elements µg/g soil	season	Sites					
		Control	In front of Factory	Km distance downwind from the factory			
		C	F	1	2	3	4
Cr	Summer	1.5±0.2d	39.3±0.5a	27.5±1.1a	26.5±1a	12±0.9c	2.5±0.3d
	Winter	1.3±0.1d	32.3±1.1a	20.5±1.5b	21.5±0.9b	9±0.9c	2±0.12d
Ni	Summer	1±0.12d	16.3±1.1a	10.2±0.9b	7.5±0.8b	3.5±0.1c	1.5±1d
	Winter	1.2±0.02e	15.1±1.2a	9.6±0.5b	6.6±0.32c	3.4±0.1d	1.1±0.02e
Pb	Summer	0.97±0.01c	33.2±1.1a	30.2±0.9a	28.4±1.1a	10.9±0.4b	1.1±0.1c
	Winter	0.9±0.1c	30.1±1.2a	26.1±1.3a	25.3±0.92a	11±0.9b	1.9±0.4c
Cd	Summer	0.09±0.01c	1.3±0.05a	1.31±0.1a	0.53±0.03b	0.21±0.01c	0.11±0.01c
	Winter	0.09±0.01c	1.3±0.03a	1.13±0.4a	0.44±0.01b	0.2±0.02c	0.11±0.04c
Co	Summer	0.03±0.00e	5.2±0.3a	3.1±0.2b	3±0.3b	0.9±0.06c	0.2±0.01d
	Winter	0.03±0.01e	4.9±0.2a	3±0.3b	2.6±0.2b	0.7±0.1c	0.14±0.03d
Cu	Summer	0.04±0.01c	0.3±0.02a	0.3±0.02a	0.21±0.02ab	0.19±0.01b	0.09±0.2c
	Winter	0.01±0.00c	0.23±0.03a	0.16±0.01ab	0.15±0.04ab	0.1±0.01b	0.02±0.00c
Fe	Summer	0.07±0.01b	0.19±0.03a	0.18±0.02a	0.1±0.01b	0.09±0.01b	0.09±0.02b
	Winter	0.07±0.01b	0.16±0.01a	0.1±0.02b	0.1±0.03b	0.08±0.01b	0.06±0.01b
M	Summer	0.02±0.01b	0.11±0.02a	0.12±0.01a	0.09±0.01a	0.03±0.01b	0.03±0.01b
	Winter	0.02±0.01b	0.11±0.01a	0.09±0.01a	0.04±0.01b	0.02±0.01b	0.02±0.01b
Zn	Summer	0.12±0.02c	1.91±0.1a	1.5±0.11a	0.9±0.09b	0.71±0.1b	0.18±0.06c
	Winter	012±0.03d	1.78±0.08a	1.34±0.1a	0.73±0.01b	0.24±0.03c	0.13±0.01d
F	Summer	0.07±0.01d	8.89±0.4a	7±0.32a	3.54±0.3b	0.8±0.1c	0.1±0.02d
	Winter	0.05±0.01d	8.18±032a	5.9±0.2a	3±0.24b	0.75±0.1c	0.09±0.03d

Table 4: Contamination factor (CF) and pollution load index (PLI) of metals in the soil from different sites (F: Factory, 1, 2, 3 and 4: Km distance downwind from the factory) during summer and winter.

Contamination factors of trace elements	season	Sites				
		In front of the Factory	Km distance downwind from the factory			
		F	1	2	3	4
Cr	Summer	26.2	18.33	17.66	8	1.6
	Winter	24.84	15.76	16.53	6.92	1.53
Ni	Summer	16.3	10.2	7.5	3.5	1.5
	Winter	12.58	8	5.5	2.83	0.91
Pb	Summer	34.22	31.13	29.27	11.23	1.13
	Winter	33.44	29	28.1	12.22	2.11
Cd	Summer	14.44	14.55	5.88	2.33	1.22
	Winter	14.44	12.55	4.88	2.22	1.22
Co	Summer	173.33	103.3	100	30	6.67
	Winter	163.33	100	86.66	23.33	4.67
Cu	Summer	7.5	7.5	5.25	4.75	2.25
	Winter	23	16	15	10	2
Fe	Summer	2.71	2.57	1.42	1.28	1.28
	Winter	2.28	1.42	1.49	1.142	0.8
Mn	Summer	5.5	6	4.5	1.5	1.5
	Winter	5.5	4.5	2	1	1
Zn	Summer	15.917	12.5	7.5	5.91	1.5
	Winter	14.83	11.17	6.08	2	1.08
F	Summer	127	100	50.57	11.42	1.42
	Winter	163.6	118	60	15	1.8
PLI	Summer	19.6	16.22	11.13	5.17	1.71
	Winter	29.22	20.22	14.05	5.67	1.58

2. Enrichment Factor

Details of the enrichment factor (EF) are presented in Table (5). Cobalt and Florid have the higher enrichment at the factory belonging to extremely high enrichment category followed by Lead and Chromium with significant enrichment category.

3. Geo-accumulation Index

It is clear from (Table 6) that Co and Pb had the highest values of Geoaccumulation index (from moderate to strongly polluted) followed by F and Cr (moderate pollution) and the lowest was Ferrous.

4. Vegetation analysis

Sixteen species were recorded in the study area. Regarding the number of species within each family, the abundant one was Poaceae represented by 4 species comprising 25% of the total number of the recorded species, followed by two families Cyperaceae and Asteraceae (2 species) representing 12.5% (for each family) of the total number of the recorded species in the study area. Eight families represented by one species comprising 6.5% (for each family) of the total number of the recorded species in the study area (Table 7).

4.1 Life Form

According to life form classification scheme by Raunkaier, (1934) the recorded 16 species were grouped in the five major life-form classes namely Phanerophytes (PH), Chamaephytes (CH), Hemicryptophytes (Hemi), Therophytes (TH) and Geophytes-Helophytes (GH) these classes were illustrated in (Figure 2).

Therophytes (TH) were the abundant life-form in the study area represented by 8 species (50%) of the total number of the recorded ones; of these species were Chenopodiuum album, Ipomoea purpurea and Digitaria sanguinalis. Geophytes- Helophytes (GH) was represented by 3 species (18.75) of the total number of the recorded species; these species were Phragmites australis, Cyperus alopecuroides and Cyperus articulatus. Chamaephytes (CH) comprised of 2 species (12.5%) of the total number of the recorded species; these species were Alhagi graecorum and Reaumuria hirtella. Phanerophytes (PH) also comprised of 2 species (12.5%) of the total number of recorded species; these species were Pluchea dioscoridis, and Ricinus communis.

Hemicryptophytes (Hemi) represented by only one species (6.25%) of the total number of recorded species, which was Imperata cylindrica (Table 7).

The composition of life form provides information, which may help in assessing the response of vegetation to variations in environmental factors (Ayyad and El-Ghareeb 1982). Therophytes had the highest contribution, followed by geophytes-helophytes, phanerophytes, chamaephytes and hemicryptophytes.

Table 5: Enrichment factor (EF) of metals in the soil from different sites (F: in front of factory, 1, 2, 3 and 4: Km distance downwind from the factory) during summer and winter.

Enrichment factor of trace elements	season	Sites				
		In front of the factory	Km distance downwind from the factory			
		F	1	2	3	4
Cr	Summer	11.46	7.129	12.36	6.22	1.29
	Winter	10.87	6.13	11.57	5.38	1.19
Ni	Summer	7.13	3.96	5.25	2.72	1.16
	Winter	5.50	3.11	3.85	2.2	0.71
Pb	Summer	14.97	12.10	20.49	8.73	0.88
	Winter	14.6	11.27	19.67	9.50	1.64
Cd	Summer	6.3	5.66	4.12	1.81	0.95
	Winter	6.31	4.88	3.422	1.72	0.95
Co	Summer	75.83	40.18	70	23.33	5.18
	Winter	71.45	38.88	60.66	18.14	3.62
Cu	Summer	3.28	2.91	3.67	3.69	1.75
	Winter	10.06	6.22	10.5	7.77	1.55
Mn	Summer	2.40	2.33	3.15	1.16	1.166
	Winter	2.4	1.75	1.4	0.77	0.77
Zn	Summer	6.96	4.86	5.25	4.601	1.16
	Winter	6.48	4.34	4.25	1.56	0.84
F	Summer	55.56	38.88	35.4	8.88	1.11
	Winter	71	45.88	42	11.6	1.4

Table 6: Geo-accumulation index (Igeo) values of investigated metals at different sites (F: in front of the Factory, 1, 2, 3 and 4: Km distance downwind from the factory) during summer and winter.

Geo-accumulation index of trace elements	season	Sites				
		Factory	Km distance downwind from the factory			
		F	1	2	3	4
Cr	Summer	1.54	1.38	1.37	1.03	0.34
	Winter	1.52	1.32	1.34	0.97	0.31
Ni	Summer	1.34	1.13	1	0.67	0.3
	Winter	1.22	1.03	0.87	0.58	0.087
Pb	Summer	1.66	1.62	1.59	1.18	0.17
	Winter	1.65	1.59	1.57	1.21	0.44
Cd	Summer	1.28	1.29	0.89	0.49	0.21
	Winter	1.28	1.23	0.81	0.47	0.21
Co	Summer	2.36	2.14	2.12	1.60	0.94
	Winter	2.34	2.12	2.06	1.49	0.79
Cu	Summer	1	1	0.84	0.80	0.47
	Winter	1.49	1.33	1.30	1.12	0.42
Mn	Summer	0.56	0.54	0.28	0.23	0.23
	Winter	0.48	0.27	0.28	0.18	0.057
Zn	Summer	0.87	0.9	0.78	0.30	0.3
	Winter	0.87	0.7	0.43	0.12	0.12
F	Summer	1.33	1.2	1	0.89	0.3
	Winter	1.29	1.17	0.91	0.42	0.16

Table 7: List of the recorded families with their species, life form, duration, floristic category, English name and Arabic name. Ch = Chamaephytes, COSM = Cosmopolitan, Ge = Geophytes, He = Hemicryptophytes, Ph = Phanerophytes and Th = Therophytes; ES = Euro-Siberian, IT = Irano-Turanian, MA = Malysian, ME = Mediterranean, SA = Saharo-Arabian, SU = Sudanian, SZ = Sudano-Zambezian, TR = Tropical.

Family	Species name	Life form	Duration	Floristic category	English name	Arabic name
Amaranthaceae	*Amaranthus hybridus*	TH	Annual	COSM	Green amaranth, prince´s father	رؤيف
Asteraceae	*Pluchea dioscoridis* (L.) Desf	PH	Perennial	SA +SZ	Ploughmans spikenard, Marsh fleabane	برنوف
	Erigeron crispus Pour	TH	Annual	ME+MA	Flax-leaved Fleabane, Hairy Fleabane, Asthmaweed,	حشيش الجبل هلوك بلدى عين الكتكوت
Brassicaceae	*Rorippa palustris* (L.) Besser	TH	Biannual	ES+IT+ME	bog marshcress, bog yellowcress	
Chenopodiaceae	*Chenopodiuum album* L.	TH	Annual	COSM	Lamb's quarters-white goosefoot	السرمق الأبيض - الزربيح الأبيض
Convolvulaceae	*Ipomoea purpurea* (L.) Roth	TH	Annual	PAL	tall morning-glory, common morning glory	أثمان أرجوانى
Cyperaceae	*Cyperus alopecroides* Rottb	GH	Perennial	PAN	Fostail sedge, foxtail flatsedge, Matsedge	بردي السلطان سراقون اصلا
	Cyperus articulates L	GH	Perennial	PAN	jointed flatsedge	ديس مدور بوط سعد
Euphorbiaceae	*Ricinus communis*	PH	Perennial	PAN	Castor-Oil Plant	خروع

Fabaceae	*Alhagi graecorum* Boiss.	CH	Perennial	ME+IT-SA+ SU	Manna Tree-Persian	عاقول- العاقول الإغريقي
Poaceae	*Digitaria sanguinalis*	TH	Annual	PAL	Crabgrass	دَفرا- دفيره
	Phragmites australis (Cav.) Trin.ex	GH	Perennial	COSM	Common Reed	القيصوب الأسترالي - الغاب - البردي – البوص
	Echinochloa colonum (L.) Link	TH	Annual	ME+IT +Trop	Jungle rice-Awnless Barnyard Grass	حشيش انارب-ديفره أبوركبة
	Imperata cylinderica (L.) Raeusch	Hemi	Perennial	ME+PAL	blady grass, cogon grass, Cottonwool grass	حلف, ذيل القط, بودويس
Convolvulaceae	*Ipomoea purpurea* (L.) Roth	TH	Annual	PAL	tall morning-glory, common morning glory	أثمان أرجوانى
Tamaricaceae	*Reaumuria hirtella* Jaub.& Spach	CH	Perennial	SA+IT	Common Reaumuria	مليحه

The main advantage of being annual or geophyte is to have high degree of plasticity in growth rate, size and phenology and to remain dormant in years of climatic extremes (Khedr, 1999) which can explain the absence of many species (Therophytes) from the sites under the effect factory dust. The high percentage of therophytes in the present study may be related to the seasonal rainfall. This trend can be similar to that of the whole Egyptian flora (Hassib 1951). Heneidy and Bidak (2001) pointed out that the dominance of therophytes over the other life forms seems to be a response to the hot-dry climate, topographic variation and biotic influences.

4.2 Classification

The study area was divided into different well-identified vegetation groups based upon the similarity of the six sampling stands in the studied area. For this purpose, TWINSPAN numerical classification program was applied to facilitate the understanding of possible vegetational group relationships (Hill 1979).

Data of 6 sites of vegetation growing in Abo Zabal was analyzed using TWINSPAN to classify the sites at the second level into three groups labeled (1-3) in (Figure 3) each sample group comprises a set of sites with greater with-set homogeneity of vegetation, than when compared with other sample groups. Each group was characterized by indicator species, identified by

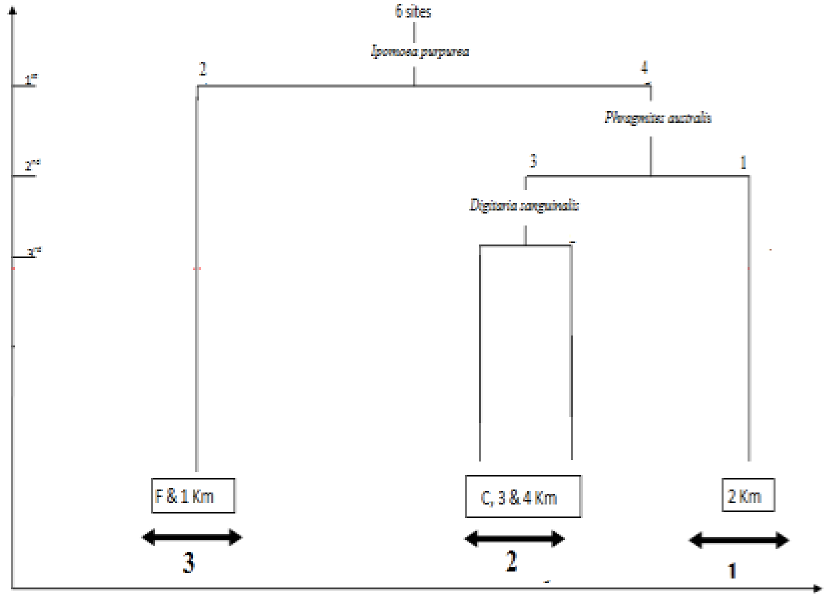
Table 8: Means of importance value (I.V.) and presence (%) of selected species inthree vegetation groups derived after application of TWINSPAN

	1	2	3	Presence%
Species / Stands		3	2	
Phragmites australis	0	21	0	33.33%
Echinochloa colonum	0	29.2	0	33.33%
Imperata cylinderica	0	29.2	0	33.33%
Amaranthus hybridus	18	8.233	0	66.67%
Rorippa palustris	0	6.3	0	33.33%
Ipomoea purpurea	28.1	12.78	0	66.67%
Polygonum lapathifolia.	29.55	20.21	0	66.67%
Cyperus alopecroides	97.8	55.7	106.65	100%
Chenopodiuum album	0	0	13.05	33.33%
Digitaria sanguinalis	0	8	29.55	33.33%
Cyperus articulates	0	14.21	11.775	66.67%
Alhagi graecorum	16.05	2.48	14.875	100%
Erigeron crispus Pour	0	2.56	4.575	66.67%
Reaumuria hirtella	2	0	5.6	66.77%
Ricinus communis	87.9	40.61	61.025	100%
Pluchea dioscoridis	20.6	41.75	17.625	100%

Table 9: Similarity and dissimilarity index of the vegetation comparing between different sites (F: in front of the Factory, 1, 2, 3 and 4: Km downwind from the factory) and control site during summer and winter.

Site number	Season	Similarity	Dissimilarity
F	Summer	0.608	0.392
	Winter	0.666	0.334
1	Summer	0.666	0.334
	Winter	0.7	0.3
2	Summer	0.666	0.334
	Winter	0.7	0.3
3	Summer	0.666	0.334
	Winter	0.7	0.3
4	Summer	0.78	0.22
	Winter	0.82	0.18

Figure (3): Classification of stands along the studied area, dendogram obtained by application of TWINSPAN classification technique.



TWINSPAN for each group at each level of hierarchical classification.

Group (1): Contained only one site (2 Km distance downwind from the factory). The indicator species for this group was *Phragmites australis*, whereas, the dominant species was *Cyperus alopecuroides* (IV = 97.8).

Group (2): This group consisted of three sites (Control, 3, and 4 Km distance downwind from the factory) with 7 species. The indicator species for this group was *Phragmites australis*, whereas, the dominant species was *Cyperus alopecuroides* (IV = 55.7).

Group (3): This group has two sites (Factory and 1 km distance downwind from the factory) with 4 species. The indicator species for this group was *Ipomoea purpurea*, whereas, the dominant species was *Cyperus alopecuroides* (IV = 106.65), Table (8).

The efficiency of classification technique can be evaluated in terms of structure of the clusters (vegetation groups) dendrograms, discrimination between these vegetation groups at one particular level, separation of groups of stands, the phytosociological and environmental interpretation of the results and the agreement of the results with already established knowledge about the study area (Van der Maarel 1979).

4.3 Similarity and dissimilarity

Similarity and dissimilarity index of the vegetation comparing between different sites and control site during summer and winter are recorded in (Table 9). The highest similarity index and the lowest dissimilarity in both summer and winter were in site 4 (4 Km distance downwind from the factory). The values of similarity were higher in winter than summer. The values of similarity increased with the increased the distance downwind from the factory which indicates heterogeneity of the vegetation at the factory as mentioned by Singh (2012), since uniform environmental conditions are revealed by higher value of similarity index, in contrast lower value indicates distinct heterogeneity. According to Babar *et al.* (2011) Similarity in plant species composition decreases continuously with distance and the opposite was recorded in our study as the nearest point to the control is the factory site which have the lowest similarity index with the control.

In our study the values of similarity were higher in winter than summer which explained by Singh (2012) as ″in rainy season the value of similarity index was maximum, due to high moisture content in soil, comparatively low temperature, bright light″.

Conclusion

In industrialized and heavy populated region of Abo Zabal, air pollution has an influence on vegetation. The direct effect of pollutants on plants is strongly influenced by the extent of their uptakeinto the plant tissues. Pollution also affect soils through increasing soil acidity and altering the balance of soil nutrients affecting roots and plant nutrition. Understanding the ecophysiological responses of plants against air and soil pollution helps policymakers to set guidelines to protect vegetation and ecosystem.

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