"EFFECT OF DIFFERENT INDUSTRIAL WASTES ON SOIL QUALITY AT DIFFERENT LOCATIONS OF EGYPT"

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Abstract

To declare the effect of pollution by industrial emissions on the agricultural land in some industrial areas of Egypt, soil and wastewater samples were collected from five locations surroundings to industrial factories. Samples of each site were taken to the windward at 0, 500, 1000, 1500 and 2000 meter away from the boundary of each factory.

The obtained results of chemical analysis can be summarized as follows:

1. The quality of water samples collected from all sites are within the permissible limits for irrigation except this from El-Nasr company of chemical and fertilizers at Talkha which had excessive loaded with organic contaminants.
2. The concentrations of some heavy metals (Fe, Mn, Zn, Cu and Pb) in the tested soil samples decreased significantly with increasing the distance away from the source of pollution. Also, dominance of such heavy metals in each site followed the decreasing order: Fe > Mn > Zn > Cu > Pb. These values were much higher than that obtained in the virgin soils (non-polluted soils).
3. The values of soil respiration (microbile activity in the soil samples) significantly increased as the distance from the source of pollution increase at all locations under investigation. An opposite trend was marked between available heavy metals content and microbile activity (r = -0.94).

Key words: Industrial wastewaters, soil pollution, heavy metals and industrial emissions.

Introduction

In Egypt, there are many industrial aggregates adjacent to different agriculture ecosystem. Health of people as well as soil quality and productivity at these areas has been dramatically reduced. Mashali *et al.* (2005) found that, the alluvial clay soils of North Nile Delta contain high amount of some heavy metals (Co, Cr, Cu, Ni and Zn) In addition, the total number of liquid discharges along the Nile river between Aswan and Cairo is 67 of which 22 are industrial discharges and 45 are agricultural drains (El–Sokkary, 1996). The total volume of liquid waste is about 3882 million m^3/year. In addition, the total volume of effluents discharges in the two branches of Nile Delta (Damietta and Rosetta) is about one milliard m^3/y. The river Nile at Helwan city receives about 12 million m^3/y effluents from iron and steel industries.

The present study aimed to: identify the impact of emissions and discharged pollution from industrial activities on the irrigation water and soil characteristics.

Materials and Methods

1. Samples of industrial wastewater:

Samples of industrial wastewater were collected from five discharge points of some factors as shown in Fig. (1) and River Nile water was taken as a reference.

Electrical conductivity (EC) and pH of the water samples were determined immediately. Suitable quantity of each water sample was filtered for chemical analysis of some pollution parameters. Among these parameters are; biological oxygen demand (BOD), chemical oxygen demand (COD), NH_4^+–N and NO_3^-–N; soluble cation and anions; and some heavy metals.

COD and BOD were determined according to American Public Health Association (APHA, 1989). NH_4^+ and NO_3^-–N were determined according to Cottenie ***et al.*** (1982). Water quality relations were calculated by some equations such as sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) as follows:

$$RSC = [HCO_3^- + CO_3^=] - (Ca^{++} + Mg^{++})$$

Where all concentrations in meq/L (Hinrich ***et al.***, 1979).

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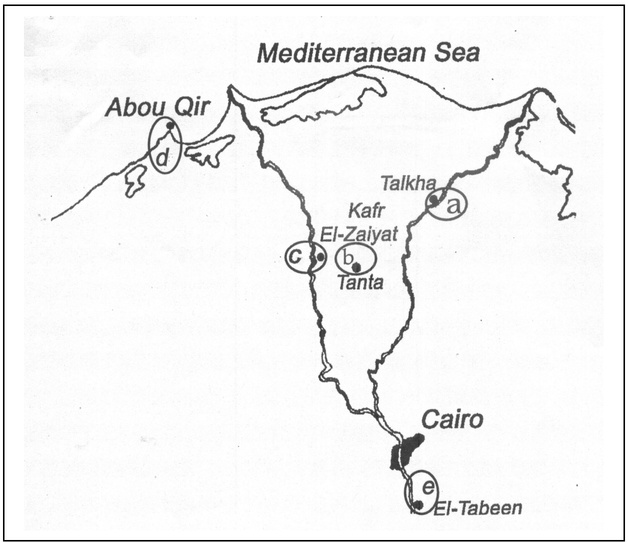

Fig. 1: Locations of soil and wastewater samples.

a = Location of soil and water samples taken near El-Nasr Company of Chem. and Fert. at Talkha city.

b = Location of soil and water samples taken near Misr Co. of Petr. refining at Tanta city.

c = Location of soil and water samples taken near super phosphate factory and salt and soda Co. at Kafr El-Zaiyat city (2 soil samples).

d = Location of soil and water samples taken near El-Nasr Co. of Chem. and Fert. at Abou Qir (Alex.).

e = Location of soil and water samples taken near the general Co. of Metals and the Iron and Steel and El-Coke factories at El-Tabeen, South Helwan city (2 soil samples).

2. Field survey study:

Five soil samples (0–20 cm) were collected at 0.0, 0.5, 1.0, 1.5 and 2.0 km to the windward from the agricultural area of every factory borders as shown in Fig. (1). The soil samples were air–dried, gently ground to pass a 2 mm sieve for chemical analysis and pollution parameters as mentioned in section-1.

Available heavy metals were extracted by DTPA extraction (Cottenie ***et al.*** 1982) and measured using AAS (Page ***et al.***, 1982). Soil respiration was determined as an indicator of OM decomposition rate by CO_2 released after 24 hours incubation at laboratory temperature (Anderson, 1982).

Results and Discussion

1. Chemical analysis of wastewater samples:

The main chemical properties and pollution parameters of water samples collected from different sources are shown in Tables (1, 2) and Figure (2).

Electrical conductivity (EC) was as low as 0.36 dS/m of the water samples collected from the River Nile water, while, EC value was as high as 3.86 dS/m from site No. 4.

Water samples classified as C_2S_1 had moderate salinity hazard and low alkalinity. Whereas, the water samples which classified C_3S_1 had medium–high salinity hazard and low alkalinity. However, the wastewater of discharge point No. 4 was classified as C_4S_1 which considered high salinity hazard and low alkalinity.

Table (1): Classification of the water samples collected from outlets of factories and canals of irrigation or drainage.

	Source of water	EC[a] dS m^{-1}	SAR[b]	Water Class	RSC[c]
1	The River Nile	0.36	1.69	C_2S_1	-0.25
2	Drain No. 1 at El-Rodhah, Talkha Collecting drain of Industrial	1.27	7.65	C_3S_1	-1.13
3	Complex at El-Tabeen, Helwan	0.68	2.58	C_2S_1	-1.53
4	Ammonium discharge point of El-Nasr Company of Chem. and Fert. at Talkha. Carbon dischaerge point of El-Nasr	3.86	5.57	C_4S_1	28.48
5	Company of Chem. and Fert. at Talkha.	0.95	9.30	C_3S_1	-0.23
6	Discharge point of Misr Company Petr. Refining West Tanta	0.38	1.84	C_2S_1	0.32
7	Discharge point of Super. Factory at Kafr El-Zaiyat	2.11	4.81	C_3S_1	-7.42
8	Discharge point of Salt and Soda Company. at Kafr El-Zaiyat	0.77	3.98	C_3S_1	-0.26

[a]EC = Electrical Cond. dSm^{-1} at 25°C
C_1 = 0.10 to 0.25 = low C_2= 0.25 to 0.70 = moderate
C_3 = 0.75 to 2.25 = medium high C_4 = 2.25 to 4.00 = very high
[b]SAR = Sodium Adsorption Ratio. S_1 = 0 to 10 = low
S_2 = 10 to 18 = medium S_3 = 18 to 26 = high
S_4 >26 = very high
[c] RSC = Residual Sodium Carbonate in meq. 1^{-1}
RSC < 1.25 = suitable RSC = 1.25-2.5 = marginal
RSC > 2.5 = not suitable

Table (2): The content of soluble – P, mineral nitrogen, and oxygen demand in the water samples collected from outlets of factories and canals of irrigation or drainage.

Water sample number	Soluble-P (ppm)	Mineral-N, ppm		Oxygen demand, ppm	
		NH^+_4-N	NO^-_3-N	BOD	COD
1	0.07	0.70	1.39	2.79	3.50
2	0.01	5.95	11.20	10.50	12.40
3	0.09	5.25	3.85	23.01	51.20
4	0.30	840.00	73.60	79.12	82.40
5	0.10	9.10	7.00	9.60	11.40
6	0.10	8.40	3.50	18.14	20.00
7	0.13	2.45	24.85	3.49	5.13
8	0.10	2.80	8.05	11.20	15.80

1: The River Nile.
2: Drain No. 1 at El-Rodhah village, Talkha city.
3: Collecting drain of Iron and steel and El-Coke Factories and discharge point of Misr Company of Petroleum refining at El-Tabeen South Helwan city.
4: Ammonium discharge point of El-Nasr Company of Chem. and Fert. at Talkha city.
5: Carbopn discharge point of El-Nasr Company of Chem. and Fert. at Talkha city.
6: Discharge point of Misr Company of Petroleum Refining West Tanta city.
7: Discharge point of Super phosphate Factory at Kafr El-Zaiyat city.
8: Discharge point of Salt and Soda Company at Kafr El-Zaiyat city.

The quality of water samples were classified according to COD and BOD values (Bouwer and Chaney, 1974). They reported that the normal wastewater might have BOD between 10 and 20 mg/L and COD of 30–60 mg/L. Accordingly, Table 2 indicate that the water samples collected from all sites are within the permissible limits except site No. 4 which had excessive loaded with organic contaminants which led to degradation of water quality and impose hazard effects on the water–biosystem as well as initiate and/or sustain eutrophication and the condition follow. Also, increasing BOD and COD of water systems increases cost effectiveness of treating water for drinking when this water goes to water streams..

The values of heavy metals (Fe, Mn, Zn, Cu and Pb) in Fig. 2 were among recommended limits either for long or short term use. These results may be due to the short half lives of trace elements in the dissolved form because of their rapid transport of the sediments (El–Sokkary, 1996).

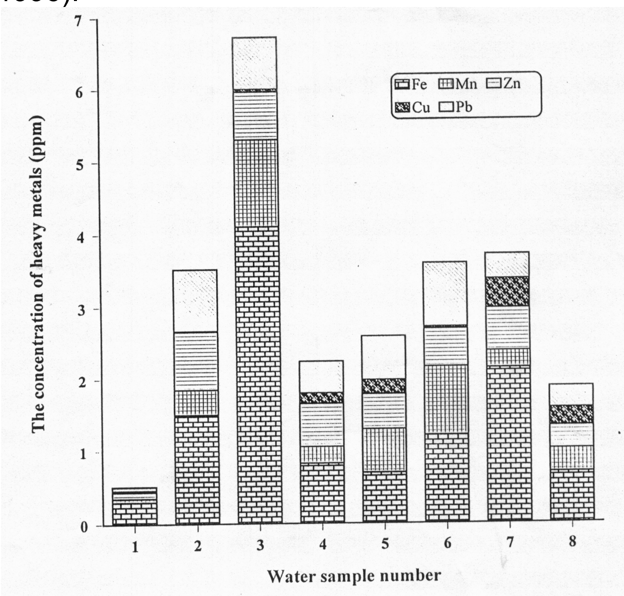

Fig. (2): The concentration of heavy metals (ppm) in the water samples collected from outlets of factories and canals of irrigation or drainage.

2. Soil properties as affected by pollutant type and distance from the source of pollution:

2.1. Soil salinity:

Figure (3) shows that the EC values in the tested soil samples were decreased significantly with increasing the distance away from the source of pollution. One exception was observed for the soil samples collected near El–Nasr company of Chemicals and Fertilizers at Talkha city, where the EC values increased with increasing the distance from company border. This may be due to the emission of gaseous ammonia (NH_3) which forms salts with acidic gases (such as SO_x and NO_x) and can be transported long distances especially in the absence of clouds (Ferm, 1998).

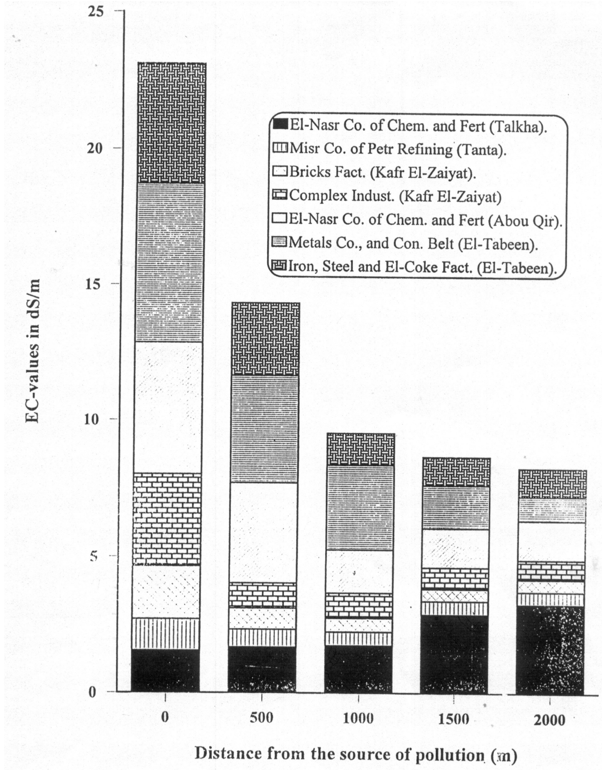

Fig. (3): The electrical conductivity (EC) values in the studied soil samples as affected by pollutant types and various distances from the different pollution sources.

Data also showed that EC values were affected significantly by the source of pollution. The highest values were in the soil samples collected near the metals and conveyor Belt of El–Coke company (Helwan city). These results may be due to the geographical site and the type of emitted pollutants from pollution source.

2.2. Available heavy metals:

Data in Figures (4) showed that the values of available heavy metals (e.g. Fe element) decreased significantly with the increase of the distance from the pollution source for all locations under investigation. The other heavy metals took the same trend but with different concentrations. The average concentration of heavy metals varied as a function of the pollution source. Dominance of such heavy metals in each area followed the decreasing order: Fe>Mn>Cu>Pb. The difference in heavy metals values for one element from site to other may be due to the variation of: 1) the aim and manner of production (2) used raw materials and (3) used fuel for generating power

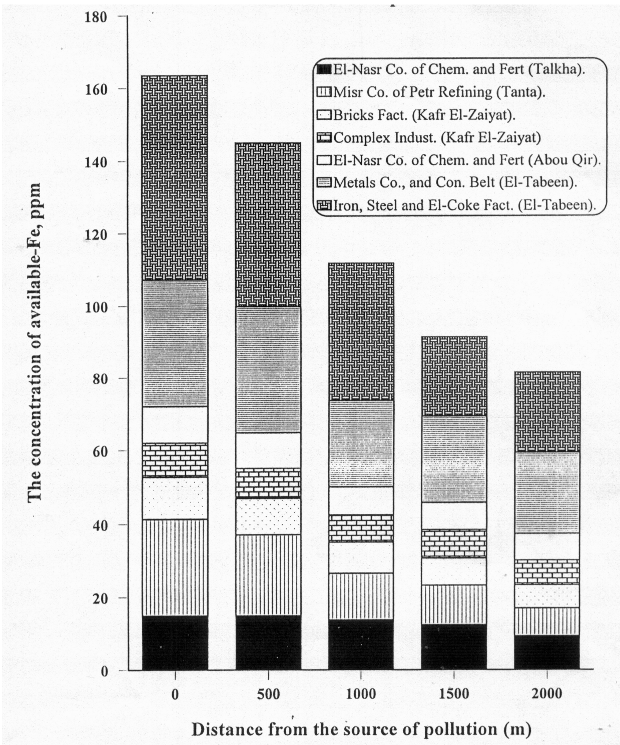

Fig. (4): The concentration of available-Fe in the studied soil samples as affected by pollutant types and various distances from the different pollution sources.

2.3. Sol respiration:

Soil respiration parameter is usually used in the ecotoxicological studies as an indicative index. Table (3) indicated that the values of soil respiration increased significantly as the distance from the source of pollution increased. On the other side, the values of respiration were affected by the type of pollution source.

Table (3): Soil respiraton value (mg CO_2.100 g^{-1} soil day^{-1}) in soil samples for different locations under investigation.

Dsit. from source of poll. (m)	El-Nasr Co. of Chem & Fer. (Talkha)	Mist. co. of Petr. refining (Tanta)	Bricks Fact. (Kafr El-Zayat)	Indust Complex. Kafr El-Zayat	El-Nasr Co. of Chem. & Fert., Abou Qir	Metals of Coke con. Belt, Helwan	Indust. Fe complex , , Hewlan
0	9.49	14.70	14.33	27.63	34.61	13.56	12.49
50	13.31	15.67	21.22	32.07	39.17	14.79	12.49
1000	22.50	15.67	21.22	35.49	41.38	16.38	16.22
1500	24.54	15.67	21.22	39.26	42.49	17.01	16.22
2000	27.48	19.40	27.99	39.53	42.49	17.01	18.43
Average	19.46	16.22	21.20	34.80	40.03	15.79	15.17
L.S.D. 5%	0.60	0.43	1.04	0.92	0.74	0.83	0.87

The results indicated that the microbial activity (respiration) may be affected by heavy metals content of the studied soils. The stress of high concentrations of available heavy metals on biological activities in soils is a matter of fact. Statistical analysis showed a highly significant negative correlation between available heavy metals content and microbial activity of the studied soil (r=–0.94 for various distances from the source of pollution and –0.72 for the type of pollution source). The specific toxic effects of heavy metals on microorganisms are caused by the binding of the metal to cellular ligands such as proteins or nucleic acids.

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