MONITORING OF ENVIRONMENTAL POLLUTION WITH HEAVY METALS IN WASTE AND DRAINAGE WATER AND THEIR EFFECT ON SOIL AND PLANTS IN NILE DELTA

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ABSTRACT

This study was carried out to evaluate the quality of five wastewater sources in Nile Delta "Gharbiya main drain (sewage water), special drain of El-Mahalla El-Kobra and Kafr El-Zayat drain (industrial water) of Gharbiya Governorate, Sabal drain (sewage water) and Quessna drain (industrial water) of Minufiya Governorate". Total and available soil heavy metals (Cd, Ni, Co and Pb) as well as their content in the plants located to the studied soils{(common grower field) were under considerations}. The water samples were collected at the distances of 50,250, 500 and 1000 m from the outlet points of each source. Surface (0-15 cm) and subsurface (15-30 cm) soil samples and plant samples were collected at the above mentioned distances of water sampling.

Content of heavy metals in the selected drains was in the following order: Pb > Cd > Co > Ni, except in Kafr El-Zayat and Quessna drains. The content of heavy metals in the industrial water was higher than in the sewage water. The content of Pb and Ni was lower than the permissible limits of irrigation water. Whereas the content of Cd and Co was higher several times than the safe limits of irrigation water. Total suspended materials (TSM) range are71-1548 mg/l. Quessna drain showed higher values at all distances, while Kafr El-Zayat source recorded the lowest TSM. Chemical oxygen demand (COD) and Biological oxygen demand (BOD_5) have wide variation, reflecting source and origin of pollutants as well as dilution effect. Water samples collected from most water sources are excessive loaded with organic contaminants except of Kafr El-Zayat source.

Total and available Cd, Ni, Co and Pb contents (mg/kg) in the surface and subsurface studied soils decreased along the distance away from outlet points and drains, and it is well observed in the surface samples. Total concentrations of heavy metals are arranged in the following order: Ni (1535.15 - 48.67)> Pb (832.17- 57.24) >Co (410.60 – 20.16) > Cd (48.48 - 1.75) mg/kg .Whereas the available form are arranged in the following order: Pb (50.15 – 1.05) >Ni (5.42 – 1.08) > Cd (1.79 -0.01) >Co (0.93 – 0.70) mg/kg. Total and available Ni was higher than the permissible limits in most studied locations, and may be classified as highly polluted soils due to long use of such water sources.

The contents of Cd, Co, Pb and Ni in the collected plants were decreased with increasing the distance from outlet points and pollution sources within the same plant species. In addition, their contents have wide variations. High contents of Cd and Pb were found in the plants irrigated by sewage water compared by industrial water. The high content of Ni was monitored in the plants cultivated in El-Mahalla El-Kobra followed by Quessna. High content of Co was found in all the collected plants. Contents of Cd, Co, Pb and Ni in the shoots of lettuce, wheat, el-molokhia and rice were higher than in their roots.

Keywords: Heavy metals, wastewater, water quality, biological oxygen demand (BOD_5), chemical oxygen demand (COD), pollution, contamination, sewage water, industrial water.

INTRODUCTION

Land protection is today the most urgent problem associated with industrial progress and civilization development of societies. Since most of industrial factories in Egypt lie in and around the agricultural land, water and soil pollution would be expected along with the usual air pollution. On the other hand, the use of wastewater in agriculture is of supreme important in arid and semi-arid countries. Around 10% of water distributed in the Nile Delta is already reused drainage water (Abdel Rashid et al., 2000). It is planned on short term to double this amount after the implementation of the new extension project. The concentration of toxic elements (Zn, Co, Fe, Pb, Cd, Ni, Hg etc.) in the wastewaters is an important factor to be considered in the planning of land-based waste management. When wastewaters are discharged into water bodies (rivers, streams, sea, drains, or lakes), they can be a serious source of pollution because of their high biological oxygen demand (BOD_5), chemical oxygen demand (COD), suspended solids, high concentration of nutrients, toxic elements and pathogens. On the basis of their composition, these wastewaters have been rated as strong, medium and weak pollutants (Baddesha et al. 1986).

Salem (2002) studied water samples collected from Abu-Zaabal, Kafr El-Zayat and Talkha companies. Both EC (dSm^{-1}) and SAR values of water samples were safe on use i.e. non-saline and non-sodicity hazard are expected. Concentration of Cd, Pb, Ni, Fe, Zn and Cu were below the permissible limits. Toxic metal pollution of waters and soils is a major environmental problem, and most conventional remediation approaches do not provide acceptable solutions (Nriagu, 1991). Major among pollutant sources are agrochemicals (fertilizers and pesticides), municipal wastewater (sewage) and atmospheric fall-out (El-Sokkary 1993 and Alloway, 1995). Sahar Ahmed (2001) reported that the farming near Tinting and Silk companies, which irrigated by low quality of irrigation water have a high content of the previous heavy metals compared with the other farming. Heavy metals are non-degradable, persist in nature for long periods and are toxic to living organisms at fairly low concentration

(Alloway, 1995). Chang et al. (1984) demonstrated that more than 90 % of applied heavy metals were found in the surface 15 cm of the soil. Abd El-Aziz (1992) found that the average content of total Cd in the surface layers of El-Saff soils was 0.6 mg/kg (virgin non irrigated soils), 1.95 mg/kg (soils irrigated from non polluted water), 3.2 mg/kg (soils polluted by industrial and sewage wastes), 3.25 mg/kg (soils irrigated with sewage wastes directly) and 1.95 mg/kg (soils irrigated with industrial wastes directly). Abdel-Sabour et al. (1995) found that, the total and available contents of Co in El-Gabal El-Asfar soil increased from 9.3 to 25.8 and 1.15 to 2.53 mg Kg^{-1} as a result of increasing period of irrigation with sewage water from 16 to 52 years, respectively. Salem (2002) found that the available Pb content ranged from 3.99 to 4.91 and 2.09 to 4.22 mg/kg around chemicals and Fertilizers Company, from 0.92 to 2.18 and 0.56 to 1.94 mg/kg around Superphosphate Company and from 1.25 to 1.76 and 1.19 to 1.70 mg/kg around Urea Company in surface and subsurface layer, respectively.

Total content of Cd in the soils were high significant correlated with the Cd content in the edible portions of cabbage, carrot, lettuce and radish grown on 50 different soils polluted from various sources (Holmagren et al., 1993 and Alloway, 1995). In addition, Aboulroos et al. (1996) found a high correlation between the concentration of Ni, Pb, Zn, Cd and Co in corn leaves and its content in soil.

The object of the present study aims at the following :1) Evaluation of five wastewater sources located at Gharbia and Minufiya Governerates. 2)Impact of long use of such sources on some soil heavy metal status {Pb, Co, Cd and Ni}. 3)Monitoring heavy metals content in different crops cultivated in the two Governerates by Egypt growers , some of them are edible crops.

MATERIALS AND METHODS

Five areas located in some Delta soils (Gharbiya and Minufiya Governorates) were selected to represent the different types of pollution sources (Table 1).

1-Water samples

Water samples were collected from the drains and irrigation canals at the distance of 50, 500 and 1000 m along outlet tubes of the different types of pollution sources. The collected water samples were taken at springtide of 2003, according to APHA, (1985). EC, pH, Ca^{++}, Mg^{++}, Na^{+}, K^{+} ,CO_3^{-} , HCO_3^{-} ,Cl^{-} were measured according to Rhoades (1982). SAR and RSC as a water quality monitored parameters were calculated after Richards (1954) and Hinrich et al., (1979), respectively. Temperature (°C) is measured on site using a reversing mercury thermometer. Total suspended materials (TSM) was determined according to Jackson, (1973). Water samples were exposed to digestion using nitric acid as described in APHA, (1985) then total metals concentrations of Cd, Ni, Co and Pb; inorganically and organically bound both dissolved and particulate; were measured using Perkin Elmer atomic absorption, Spectrophotometer model 2830 (Klute, 1986). Chemical oxygen demand (COD) and Biological oxygen demand after five days (BOD_5) were measured according to ISO (1990).

Table (1): Locations of the studied areas.

Site	Governorate	Area	Pollution source	Activity type
1	Gharbiya	Seberbay	Wastewater (Gharbiya main drain)	Sewage drainage
2		El-Mahalla El-Kobra	Wastewater (Special drain)	Industrial (Tinting and Chemicals)
3		Kafr El-Zayat	Wastewater (Kafr El-Zayat drain)	Industrial (pesticide)
4	Minufiya	El-May	Wastewater (Sabal drain)	Sewage drainage
5		Quessna	Wastewater (Quessna drain)	Industrial (Mobarak Industrial City)

2-Soil samples

Surface (0–15 cm) and subsurface (15–30 cm) soil samples were collected at the distances of 50,250, 500 and 1000 m from the drains at the same distances of water sampling, illustrated in Fig. (1).

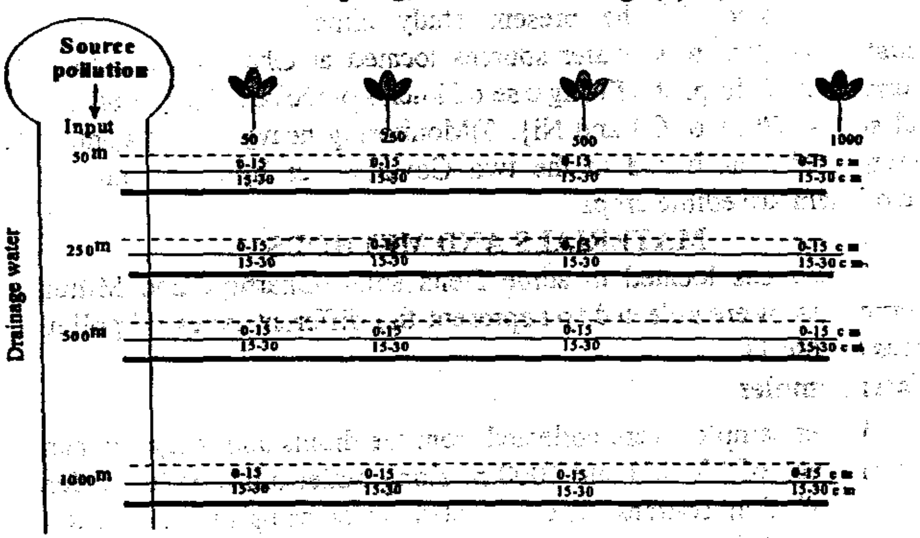

Fig. (1): Illustration of the collected soil and water

The soil samples were air-dried ground with porcelain mortar, passed through nylon sieving cloth of 2 mm, and mixed thoroughly for laboratory analyses. pH (in 1:2.5 soil water suspension) , EC, soluble cations and soluble anions were determined and expressed as meq/L(in the saturated soil paste extract), using the same methods described in water analysis. Organic matter (OM) content (%) and cation exchange capacity (CEC, using NaOAc of pH 8.2) were determined according to Cottenie *et al.*,(1982) and Klute (1986) respectively. Some characteristics of these soils presented in Table (2).

Table (2): Soil chemical properties.

L	DI	Soil depth (cm)	pH †	EC* dSm^{-1}	Soluble ions (meq/L) Cations Na^+	K^+	Ca^{2+}	Mg^{2+}	Anions Cl^-	HCO_3^-	SO_4^{2-}	OM %	CEC cmol/kg
Seberbay	50	0-15	7.21	0.34	1.35	0.32	1.01	0.76	2.39	0.29	0.75	2.27	42.4
		15-30	7.63	0.28	1.11	0.26	0.77	0.61	1.91	0.20	0.69	2.13	41.5
	250	0-15	7.50	0.60	2.69	0.70	1.39	1.25	4.20	0.43	1.39	2.16	42.3
		15-30	7.67	0.39	1.69	0.26	1.06	0.85	2.81	0.27	0.77	2.03	41.2
	500	0-15	7.25	1.11	4.86	1.33	3.03	1.85	7.73	0.88	2.45	2.10	41.3
		15-30	7.72	0.07	3.38	0.95	1.90	0.79	7.75	0.54	1.74	1.97	40.8
	1000	0-15	7.80	0.60	2.60	0.79	1.45	1.08	4.12	0.42	1.41	2.02	41.2
		15-30	7.97	0.45	2.06	0.59	1.17	0.66	3.15	0.33	1.01	1.82	40.5
EL-Mahalla EL-Kobra	50	0-15	7.44	2.97	13.16	4.71	7.46	4.34	19.92	2.63	7.13	2.02	37.2
		15-30	8.10	2.93	13.80	4.73	7.32	3.39	19.58	2.56	7.11	1.92	36.1
	250	0-15	7.78	2.78	12.12	4.18	6.81	4.09	18.71	2.48	6.61	2.00	37.0
		15-30	8.00	2.68	12.30	3.93	6.63	3.72	18.60	2.41	6.07	1.91	36.0
	500	0-15	7.61	2.7	12.40	3.77	6.99	3.85	18.99	2.57	5.44	1.97	36.9
		15-30	7.67	2.61	12.18	3.70	6.8	3.45	18.53	2.51	5.10	1.88	36.0
	1000	0-15	7.38	2.46	11.39	3.39	7.00	3.11	17.94	2.31	4.33	1.92	36.8
		15-30	7.50	2.42	10.88	3.30	6.50	3.21	17.58	2.21	4.23	1.81	36.0
Kafr EL-Zayat	50	0-15	7.57	1.58	7.08	1.76	4.89	2.10	10.33	1.40	4.20	1.97	34.2
		15-30	7.51	1.47	6.23	1.69	4.81	1.98	10.04	1.32	3.34	1.90	33.1
	250	0-15	7.54	1.35	6.00	1.65	4.26	1.38	9.26	0.93	3.31	1.96	34.1
		15-30	7.57	1.31	5.63	1.52	4.21	1.63	9.15	0.86	3.07	1.89	33.1
	500	0-15	7.60	1.32	5.68	1.68	4.26	1.56	9.18	0.84	3.16	1.93	34.0
		15-30	7.70	1.23	5.55	1.58	4.21	0.91	9.09	0.78	2.38	1.84	33.2
	1000	0-15	7.73	1.25	5.48	1.73	3.92	1.38	9.15	0.86	2.49	1.90	33.9
		15-30	7.74	1.22	5.36	1.60	3.70	1.45	8.97	0.77	2.47	1.85	33.2
EL-May	50	0-15	7.01	1.65	6.97	1.76	3.72	3.30	11.50	1.48	2.68	2.23	38.3
		15-30	7.66	0.97	4.31	1.39	3.09	2.08	6.70	1.03	1.92	2.02	35.5
	250	0-15	7.61	1.27	5.45	1.29	2.37	3.56	9.19	0.89	2.59	2.15	38.1
		15-30	7.78	0.77	3.05	1.23	2.51	0.93	6.64	0.71	1.59	1.43	35.3
	500	0-15	7.74	1.08	4.57	1.67	3.17	1.34	7.48	0.89	2.46	2.10	37.9
		15-30	7.81	0.66	2.07	0.84	2.24	0.79	4.88	0.57	1.12	1.95	35.2
	1000	0-15	7.73	0.71	2.94	0.73	1.78	1.65	4.60	0.67	1.84	2.00	37.5
		15-30	7.76	0.54	2.22	0.55	1.57	1.10	3.51	0.39	1.54	1.93	34.9
Quessna	50	0-15	7.65	1.04	4.05	1.61	2.30	2.55	6.74	0.58	3.10	1.65	28.5
		15-30	7.69	0.76	3.53	1.26	1.82	0.93	5.18	0.43	1.95	1.35	20.2
	250	0-15	7.63	0.90	3.75	1.00	2.13	2.03	5.08	0.43	2.95	1.63	28.1
		15-30	7.67	0.64	2.73	0.95	1.60	1.05	5.42	0.35	1.56	1.34	20.1
	500	0-15	7.62	0.75	3.15	0.80	2.18	1.40	4.41	0.40	2.71	1.50	27.4
		15-30	7.67	0.60	5.43	0.82	1.62	1.03	3.65	0.37	1.38	1.30	18.9
	1000	0-15	7.60	0.70	3.00	0.65	1.83	1.22	4.00	0.33	6.69	1.40	27.3
		15-30	7.72	0.55	2.10	0.65	1.50	1.13	2.80	0.25	2.34	1.25	18.5

L = Location , DI = Distance from input, † = pH in 1:2.5 soil water suspension. * = In soil paste extract
In all studied samples CO_3^{--} = 0.00 meq/l

Total content of heavy metals (Cd, Ni, Co and Pb) were extracted using the extracted solution of Aqua Regia as described by Cottenie *et al.* (1982), the available forms were extracted using dithionite triamine penta acetic acid (DTPA), calcium chloride ($CaCl_2$) and triethanol amine as reported by Lindsay and Norvell (1978). Both total and available heavy metals were determined using Perkin Elmer atomic absorption spectrophotometer model 2830.

3-Plant samples

Plant samples that already have been cultivated by growers were collected from each field site under investigation in May 2003, at the defined distances. The plant samples (French beans, turnip, potato, lettuce, wheat, cotton, okra, el-molokhia, rice, cotton, corn, onion, citrus and vine) were taken as a whole intact plant (except citrus and vine to take off shoots). Plant samples were carefully washed thoroughly by dropping the plant in 10-4 N HCl solution and then dipped in a successive containers filled with redistilled water. Then, divided into shoots and roots, air-dried, dried at 70 °C, milled and digested by wet ashing according to Chapman and Pratt (1961). Heavy metals content were measured using Perkin Elmer atomic absorption, spectrophotometer model 2830.

RESULTS AND DISCUSSION

1-Water quality

Data in Table (3) showed that, the values of EC are ranged between 0.57 in Kafr El-Zayat drain and 5.11 dSm^{-1} in Quessna drain. According to Ayers and Westcot (1985), the samples of Kafr El-Zayat drain were classified as non-saline (within permissible limit) , while the samples of Quessna drain were highly saline (above permissible limit) and the samples of other drains were slight to moderate saline.

Table (3) showed that, the values of pH of all collected water samples were lied between 7.40 and 8.63, so no restriction of use such sources according to FAO (1985) and USEPA (1992), which defined the suitable pH (6-9).Data in Table (3) showed that, the dominant soluble cations of water samples are sodium and calcium. However, the dominant soluble anion is chloride. Depending on concentration of soluble cations and anions, hazard caused by both Na+ and Cl- could occur with plants irrigated by Quessna and El-Mahalla El-Kobra drains water according to Ayers and Westcot (1985). Calculated SAR values of the five irrigation sources are lied between 3.1 of kafr El- zayat and 10.5 of Quessa drain. Very slight changes in SAR values with distance far from outlet changes are detected (Table 3). This was true for all sources, except that of Quessna drain where, SAR values showed gradual decrease along distance from starting point i.e. SAR was 10.59 at 50 m, then decreased to 7.33 at 1000 m. According to Ayers and Westcot (1985), no soil permeability problems could occur when using all sources accept that of Quessna drain which lied on restriction border. Moreover, SAR values are lower than recommended permissible limits set by law 48/1982 for treated (primary and secondary treatments) wastewater in Egypt. These results are in harmony with those obtained by Sahar Ahmed (2001), Mohamed (2002) and Salem (2002). According to the values of RSC (Table 3), the different water sources under study have negative values ,which mean that such parameter may led to misunderstanding results (recommended levels have positive values) so, one may excludes this parameter in the evaluation under our study.

Table (3): The chemical analysis of water samples.

Site No.	L	DI	°C	PH	EC dSm^{-1}	Soluble ions (meq/L)						SAR	RSC meq/L
						Na^{+}	Ca^{2+}	Mg^{++}	$CO3^{-1}$	$HCO3^{-2}$	Cl^{-}		
1	Seberbay	50	28	7.94	1.53	7.90	4.21	0.84	0.00	1.81	11.20	4.97	-3.24
		250	27	7.99	1.52	8.32	4.15	0.76	0.00	1.70	11.45	5.31	-3.21
		500	25	8.02	1.51	8.45	3.98	0.70	0.00	1.50	12.50	5.52	-3.18
		1000	24	8.02	1.41	8.51	3.55	0.54	0.00	1.47	12.59	5.95	-2.62
		Mean	26	7.89	1.49	8.3	3.97	0.71	0.00	1.62	11.94	5.44	-3.06
2	El-Mahalla El-Kobra	50	30	8.25	2.15	13.31	4.25	2.04	0.00	1.81	16.50	7.51	-4.32
		250	30	8.48	2.25	14.05	4.35	2.10	0.00	1.70	17.35	7.82	-4.65
		500	28	8.55	2.40	15.25	4.54	2.15	0.00	1.50	18.05	8.34	-4.97
		1000	27	8.60	2.48	15.72	4.81	2.19	0.00	1.47	18.15	8.40	-5.32
		Mean	29	8.47	2.32	11.58	4.49	2.12	0.00	1.62	17.51	8.02	-4.82
3	Kafr El-Zayat	50	28	7.40	0.57	3.11	1.43	0.46	0.00	0.40	3.95	3.20	-1.49
		250	28	7.40	0.59	3.11	1.40	0.66	0.00	0.40	4.05	3.052	-1.66
		500	26	7.61	0.59	3.15	1.40	0.62	0.00	0.35	4.20	3.13	-1.67
		1000	25	7.68	0.62	3.25	1.35	0.84	0.00	0.32	4.52	3.11	-1.87
		Mean	27	7.52	0.59	3.16	1.40	0.65	0.00	0.37	4.18	3.12	-1.67
4	El-May	50	28	8.30	1.44	7.85	3.40	1.04	0.00	0.65	10.65	5.27	-3.79
		250	28	8.42	1.44	8.05	3.22	1.27	0.00	0.48	10.90	5.37	-4.01
		500	26	8.48	1.37	8.11	3.00	1.01	0.00	0.30	11.35	5.73	-3.71
		1000	25	8.68	1.24	7.55	2.65	1.05	0.00	0.25	10.10	5.55	-3.45
		Mean	27	8.48	1.37	7.89	3.07	1.09	0.00	0.42	10.75	5.48	-3.74
5	Quessna	50	31	8.63	5.11	30.30	10.15	6.21	0.00	2.15	38.80	10.59	-14.21
		250	29	8.60	4.43	25.50	8.65	6.18	0.00	1.90	31.50	9.37	-12.93
		500	29	8.47	4.30	24.61	8.45	6.59	0.00	1.82	30.70	8.97	-13.22
		1000	27	8.41	3.80	20.17	7.11	8.02	0.00	1.50	25.80	7.33	-13.63
		Mean	29	8.53	4.41	25.14	8.59	6.75	0.00	1.84	31.70	9.07	-13.50

L = Location , DI = Distance from input (m)

According to Table (4),total suspended materials (TSM) are ranged between 71 mg/L in the sample collected at 1000 m of Kafr El-Zayat drain and 1548 mg/L in the sample collected at 50 m of Quessna drain. As expected , TSM values decreased as distance from starting outlet increased .For instance in Seberbay main drain, TSM values decreased as follows :398,334,310and 158 mg/l when distance increased away at 50,250,500 and 1000 m, respectively. This was a general trend for all tested sources due to gradual settling out of the suspended particles along the distance. TSM of Quessna drain recorded higher values at all distances while Kafr El-zayat source recorded the lowest TSM values. These results revealed that the content of TSM for the studied waters exceeds the recommended maximum level (30mg/l) according to USEPA, (1992).

Table(4):Some heavy metals content and quality evaluation parameters of the water samples studied.

Site No.	L	DI	TSM mg/L	COD mg/L	BOD_5 Mg/L	Heavy metals content (mg/L)			
						Cd	Ni	Co	Pb
1	Seberbay	50	398	637	47.1	0.092	0.061	0.086	0.230
		250	334	425	47.5	0.090	0.060	0.080	0.210
		500	310	283	48.7	0.083	0.056	0.065	0.200
		1000	158	143	49.8	0.080	0.055	0.065	0.195
		Mean	300	372	48.28	0.086	0.058	0.074	0.209
2	El-Mhalla El-Kobra	50	211	575	40.40	0.172	0.072	0.161	0.520
		250	200	390	41.15	0.165	0.070	0.159	0.505
		500	180	265	42.20	0.154	0.064	0.150	0.505
		1000	165	162	43.65	0.130	0.062	0.140	0.480
		Mean	189	348	41.85	0.155	0.067	0.153	0.503
3	Kafr El-Zayat	50	130	315	0	0.131	0.056	0.145	0.315
		250	110	283	0	0.127	0.055	0.140	0.308
		500	81	192	2.5	0.145	0.053	0.133	0.300
		1000	71	130	3.8	0.095	0.051	0.120	0.275
		Mean	98	230	3.15	0.125	0.054	0.135	0.300
4	El-May	50	678	425	46.70	0.105	0.069	0.072	0.205
		250	664	354	47.51	0.100	0.067	0.065	0.205
		500	410	213	48.35	0.093	0.062	0.055	0.191
		1000	380	211	48.98	0.091	0.060	0.050	0.180
		Mean	533	301	47.89	0.097	0.065	0.061	0.195
5	Quessna	50	1548	566	36.6	0.200	0.095	0.255	0.888
		250	306	283	37.5	0.185	0.090	0.247	0.871
		500	208	142	40.5	0.163	0.072	0.225	0.830
		1000	142	142	42.3	0.140	0.068	0.195	0.790
		Mean	551	283	39.23	0.172	0.081	0.231	0.845

L = Location , DI = Distance from input (m)

Chemical oxygen demand (COD) and Biological oxygen demand (BOD_5) values of seberby water recorded the highest levels as compared with rest of water sources, while Kafr El-Zayat sources recorded the lowest level, at all distances(Table,4). Actually, the wide variation exhibited between water sources reflecting source and origin of pollutants as well as dilution effect. It is of interest to note that BOD_5 values increased as distance from input increased, this trend is opposed to that of COD trend. Moreover, values of (BOD_5) recorded zero level at 50 and 250 of Kafr El-Zayat source. Kafr El-Zayat source has that lowest values of TSM, COD and BOD_5. The obtained values of BOD_5 were lied above the limits of primary and secondary treated water irrigation standards set by law 48/1982. On the other hand, concentration values of COD exceeded the maximum permissible limits. Bouwer and Chaney (1974) classified the irrigation water according to its concentration of BOD_5 and COD where they reported that, the normal wastewater might have BOD_5 between 10 and 20 mg/L and COD of 30-60 mg/L.

According to obtained data in (Table, 4) it can be noticed that, the water samples collected from Kafr El-Zayat drain at different sites are within the permissible limits. Other water samples, which collected from the different sites, are excessive loaded with organic contaminants, which exposed to degradation process of water quality and impose hazard effects on the water-biosystem, as well as initiate and / or sustain eutrophication and the conditions follow. Increasing of both BOD_5 and COD of water eutrophication. Increasing of both BOD_5 and COD of water systems led to increase cost effectiveness of treating water for drinking (Chapman and Riess, 1995).

Heavy metals concentration in Table (4) showed that Pb had high concentration magnitude and Ni had the lowest one. This trend was true for all water sources. On the other hand, Cd and Co concentrations are lied to in between .In general, heavy metals concentrations followed the sequence Pb>Cd >Co> Ni. Very slight changes in heavy metals concentrations as the distance from charging outlet increased, reflecting steady state of concentration. Obtained data showed that, the highest concentration of Cd, Ni, Co and Pb were found in Quessna drain followed by El-Mahalla El-Kobra drain. These results are in agreement with those found by Sahar Ahmed (2001), Mohamed (2002) and Salem (2002).

Regarding to the presented data (Table ,4), it can be recognized that, level of Pb and Ni in all water samples collected from different sources were less than permissible levels in irrigation water (5 and 0.2 mg/L for Pb and Ni respectively) which reported by law 48/1982 in Egypt, FAO (1985) and US EPA (1992).Since concentration of both Pb and Ni are ranged between 0.180 - 0.888 mg/L and 0.051 - 0.095 mg/l respectively. On the other hand, Cd and Co concentrations in the all water samples under study were higher several times than the permissible limits (0.01 and 0.05 mg/L for Cd and Co respectively) i.e. Cd and Co concentrations are ranged between 0.08 – 0.20 mg/l and 0.05 – 0.255 mg/l, respectively.

2-Status of Cd, Ni, Co and Pb in soils irrigated by such sources

Data in Tables 5,6,7and 8 showed the contents of total and available Cd, Ni, Co, and Pb as mg/kg in surface (0-15 cm) and subsurface (15-30 cm) layers in the soils irrigated by the studied water sources in Gharbiya and Minufiya Governorates.

Table (5): Total and available Cd content (mg/kg) in the studied soils irrigated by wastewater.

S	L	DI	Soil depth (cm)	Distance from drain (m)							
				50		250		500		1000	
				Av.	Total	Av.	Total	Av.	Total	Av.	Total
1	Seberbay	50	0-15	0.08	48.48	0.08	23.50	0.06	22.65	0.05	21.15
			15-30	0.04	9.35	0.03	8.50	0.03	8.50	0.02	8.15
		250	0-15	0.08	24.05	0.07	23.50	0.05	22.50	0.05	21.00
			15-30	0.03	9.15	0.03	8.25	0.03	7.43	0.02	7.15
		500	0-15	0.06	23.15	0.05	23.00	0.05	21.70	0.04	20.25
			15-30	0.03	7.50	0.03	7.05	0.02	6.90	0.02	6.75
		1000	0-15	0.05	21.62	0.05	19.95	0.04	18.50	0.04	18.11
			15-30	0.03	7.50	0.02	6.65	0.02	6.50	0.01	6.50
2	El-Mahalla El-Kobra	50	0-15	0.06	11.35	0.06	10.35	0.04	9.50	0.04	8.15
			15-30	0.03	4.50	0.03	4.32	0.03	3.25	0.02	3.25
		250	0-15	0.06	11.05	0.05	10.35	0.04	9.35	0.04	7.98
			15-30	0.03	4.15	0.02	3.75	0.02	3.25	0.02	3.00
		500	0-15	0.05	9.90	0.04	9.42	0.03	8.50	0.03	7.42
			15-30	0.02	3.84	0.02	3.60	0.02	2.95	0.01	2.90
		1000	0-15	0.04	9.50	0.04	9.25	0.03	8.05	0.02	7.11
			15-30	0.02	3.84	0.02	3.50	0.01	2.80	0.01	2.80
3	Kafr El-Zayat	50	0-15	0.06	7.42	0.06	7.25	0.05	6.50	0.05	5.85
			15-30	0.04	2.67	0.03	2.65	0.03	2.50	0.03	2.25
		250	0-15	0.05	7.25	0.05	6.75	0.05	6.30	0.04	5.75
			15-30	0.03	2.60	0.03	2.50	0.02	2.50	0.02	2.15
		500	0-15	0.05	6.50	0.04	6.15	0.04	6.00	0.03	5.60
			15-30	0.03	2.35	0.02	2.15	0.02	1.98	0.01	1.98
		1000	0-15	0.04	5.45	0.04	5.00	0.03	4.92	0.02	4.75
			15-30	0.02	2.35	0.01	2.05	0.01	1.89	0.01	1.75
4	El-May	50	0-15	0.08	17.35	0.08	16.50	0.06	16.35	0.05	15.60
			15-30	0.03	6.82	0.03	6.50	0.03	5.65	0.02	5.15
		250	0-15	0.07	16.25	0.06	16.10	0.05	15.70	0.04	14.82
			15-30	0.03	6.42	0.02	5.95	0.02	5.50	0.01	5.05
		500	0-15	0.07	15.00	0.04	14.65	0.04	14.50	0.03	14.10
			15-30	0.02	5.72	0.02	5.35	0.01	5.10	0.01	4.60
		1000	0-15	0.05	13.22	0.04	11.90	-	-	-	-
			15-30	0.02	5.55	0.02	4.64	-	-	-	-
5	Quessna	50	0-15	1.79	32.50	1.50	31.80	-	-	-	-
			15-30	0.72	11.40	0.64	8.50	-	-	-	-
		250	0-15	1.70	32.00	1.15	30.15	-	-	-	-
			15-30	0.50	10.35	0.35	8.24	-	-	-	-
		500	0-15	1.32	25.52	0.92	20.50	-	-	-	-
			15-30	0.40	8.45	0.35	7.30	-	-	-	-
		1000	0-15	1.15	21.87	0.55	20.05	-	-	-	-
			15-30	0.34	7.15	0.27	6.50	-	-	-	-

S= site No., L = Location, DI = Distance from input (m), Av = available.

- The samples is not taken due to the change of the sources of irrigation water.

The tabulated data showed that, both available and total contents of Cd, Ni, Co, and Pb have wide variation, reflecting nature and chemical composition of irrigation water sources and the distance from discharge point and drain as well as soil depth. In all studied locations, the contents of Cd, Ni, Co, and Pb (total and available) in the surface layer were higher than in the subsurface layers. Accumulation of these metals in the soil surface is of great ecological significance due to their great influence on soil biological activity. These results may be due to contentious irrigation by such wastewater, cycling through vegetation, atmospheric deposition and adsorption by the organic matter. These results are in agreement with the results of Abou Hussien and El-Koumey (1997) and Salem (2002).

Contents of heavy metals are gradually decreased with increasing the distance from discharge point and drain, whereas the highest value was recorded at 50 m away from discharge point and drain. Content of Cd, Ni, Co, and Pb in the studied locations at different distances was in harmony with that found in the water samples collected from the drains at the same distance (Table, 4). Total concentrations of the studied heavy metals are arranged in the following order: Ni (1535.15 - 48.67)> Pb (832.17- 57.24) >Co (410.60 – 20.16) > Cd (48.48 - 1.75) mg/kg. These results are in agreement with those found by Abou Hussien and El-Koumey (1997) and Abdou *et al.* (2001).

The natural concentration of Ni, Pb, Co and Cd in the soil, according to Kabata–Pendias and Pendias (1992) were ranged from 100, 100 to 400, 25 to 50 and 3 to 8 mg Kg^{-1} respectively . Generally, total Ni were higher than the natural concentration in all studied soils except subsurface layers of El-Mahalla El-Kobra, Kafr El-Zayat and Quessna, such results may be related to heavy metal concentrations of irrigation water. Concentration of total Pb, Co and Cd are relatively lower than maximum concentration recorded by Alloway (1995).Who stated that the maximum concentrations of these elements in soil are :16338 ,1508 and 41 mg Kg^{-1}, respectively. Except the Cd concentration in the surface layer at 50 m of pollution source outlet point and drain of site No.1 (where the Cd concentration was 48.48 mg/kg) . On the other hand, the available forms of the studied heavy metals are arranged in the following order: Pb (50.15 – 1.05) >Ni (5.42 – 1.08) > Cd (1.79 - 0.01) >Co (0.93 – 0.7) mg/kg. These results are agreed with the data of Sahar Ahmed (2001), Mohamed (2002) and Salem (2002).

In general, comparing these findings with those reported by El-Sokkary and Lag (1980), they found that the uncontaminated Egyptian soil have total Cd content, 2 mg/kg and DTPA-Cd extractable was about 0.01 mg/kg. Moreover, Aboulroos *et al.* (1996) reported that the normal values of available Cd, Co,Pb and Ni in cultivated alluvial soils of Egypt are 0.03-0.06; 0.13 - 0.28; 0.78 -2.46 and 0.30 -1.02 mg/kg with an average of 0.043; 0.19; 1.39 and 0.64 mg/kg ,respectively. It means that, soil samples under consideration may considered as highly contaminated.

Table (6): Total and available Ni content (mg/kg) in the studied soils irrigated by wastewater.

S	L	DI	Soil depth (cm)	Distance from drain (m) 50 Av.	50 Total	250 Av.	250 Total	500 Av.	500 Total	1000 Av.	1000 Total
1	Seberbay	50	0-15	5.42	1535.15	5.25	1415.20	4.82	1405.39	4.15	1225.65
			15-30	3.15	400.30	3.10	380.25	3.02	370.75	2.85	335.55
		250	0-15	5.05	1500.50	4.70	1365.54	4.50	1325.40	4.10	1215.85
			15-30	2.60	355.15	2.47	380.25	2.30	350.60	2.40	325.25
		500	0-15	4.82	1300.15	4.63	1270.35	4.25	1250.50	3.98	1200.95
			15-30	2.54	340.22	2.35	305.25	2.15	300.45	2.04	302.65
		1000	0-15	4.45	1250.75	4.40	1230.65	4.05	1205.15	3.65	1117.00
			15-30	2.42	325.15	2.31	300.70	2.10	295.58	1.98	280.35
2	El-Mahalla El-Kobra	50	0-15	2.85	310.95	2.75	300.70	2.65	280.50	2.50	275.87
			15-30	1.52	90.65	1.47	85.75	1.35	83.22	1.32	80.25
		250	0-15	2.80	303.15	2.70	278.45	2.58	260.17	2.47	200.17
			15-30	1.45	87.52	1.43	80.50	1.33	78.40	1.25	70.50
		500	0-15	2.55	250.47	2.50	270.65	2.42	256.25	2.38	245.15
			15-30	1.35	80.15	1.30	70.64	1.22	70.64	1.20	60.80
		1000	0-15	2.40	245.90	2.33	225.28	2.20	215.67	2.20	210.50
			15-30	1.33	75.45	1.25	68.65	1.22	65.28	1.15	64.75
3	Kafr El-Zayat	50	0-15	2.45	250.40	2.38	240.67	2.35	225.50	2.26	223.84
			15-30	1.46	80.43	1.40	70.62	1.30	65.17	1.26	63.40
		250	0-15	2.38	235.40	2.30	288.48	2.28	224.65	2.20	218.32
			15-30	1.42	78.35	1.38	65.42	1.30	64.50	1.20	61.48
		500	0-15	2.35	233.55	2.25	224.65	2.20	219.70	2.18	210.10
			15-30	1.35	75.22	1.32	63.67	1.22	58.95	1.14	55.55
		1000	0-15	2.26	220.65	2.22	212.85	2.14	212.25	2.10	195.35
			15-30	1.35	68.30	1.20	60.15	1.18	55.25	1.10	48.67
4	El-May	50	0-15	3.90	1105.35	3.62	1020.25	3.50	1000.90	3.25	975.40
			15-30	1.85	380.15	1.72	365.52	1.65	352.58	1.52	320.35
		250	0-15	3.75	1075.65	3.48	990.82	3.35	940.25	3.17	905.15
			15-30	1.82	350.50	1.66	335.35	1.60	310.42	1.50	302.65
		500	0-15	3.72	1000.35	3.15	955.70	3.05	900.75	2.86	875.40
			15-30	1.71	332.35	1.60	308.32	1.57	297.85	1.42	282.85
		1000	0-15	3.25	915.42	3.10	885.63	-	-	-	-
			15-30	1.65	307.99	1.60	286.92	-	-	-	-
5	Quessna	50	0-15	3.25	400.95	3.05	365.45	-	-	-	-
			15-30	1.65	99.25	1.57	97.35	-	-	-	-
		250	0-15	3.10	355.60	2.82	350.45	-	-	-	-
			15-30	1.50	95.14	1.38	83.40	-	-	-	-
		500	0-15	2.65	340.25	2.54	320.15	-	-	-	-
			15-30	1.35	87.65	1.20	70.70	-	-	-	-
		1000	0-15	2.44	310.35	2.18	302.27	-	-	-	-
			15-30	1.28	75.60	1.08	68.75	-	-	-	-

S= site No., L = Location, DI = Distance from input (m), Av = available.
-The samples is not taken due to the change of the sources of irrigation water

Table (7): Total and available Co content (mg/kg) in the studied soils irrigated by wastewater.

S	L	DI	Soil depth (cm)	Distance from drain (m)							
				50		250		500		1000	
				Av.	Total	Av.	Total	Av.	Total	Av.	Total
1	Seberbay	50	0-15	0.52	130.60	0.49	127.50	0.43	127.00	0.42	126.45
			15-30	0.35	40.25	0.35	35.17	0.33	34.50	0.30	33.15
		250	0-15	0.51	125.40	0.46	123.85	0.43	120.15	0.40	119.50
			15-30	0.33	34.50	0.32	33.15	0.29	32.75	0.28	32.05
		500	0-15	0.48	118.50	0.45	117.65	0.40	111.75	0.37	111.75
			15-30	0.32	35.27	0.28	32.50	0.27	32.50	0.24	31.25
		1000	0-15	0.46	105.40	0.41	103.54	0.38	98.23	0.36	97.25
			15-30	0.32	33.42	0.27	31.00	0.25	27.65	0.20	25.84
2	El-Mahalla El-Kobra	50	0-15	0.83	240.3	0.80	230.25	0.74	215.17	0.70	207.4
			15-30	0.35	80.85	0.34	70.14	0.31	65.50	0.31	60.50
		250	0-15	0.79	225.60	0.77	210.38	0.72	205.78	0.70	203.90
			15-30	0.35	75.11	0.33	68.22	0.30	64.80	0.29	60.70
		500	0-15	0.77	220.15	0.73	200.58	0.71	198.80	0.65	190.74
			15-30	0.33	73.80	0.32	65.10	0.29	64.35	0.27	60.00
		1000	0-15	0.76	202.65	0.70	195.41	0.68	192.44	0.57	185.40
			15-30	0.30	73.80	0.30	64.50	0.28	62.15	0.26	58.17
3	Kafr El-Zayat	50	0-15	0.62	100.50	0.60	91.70	0.57	96.90	0.57	88.15
			15-30	0.25	35.40	0.25	32.18	0.23	31.50	0.22	28.17
		250	0-15	0.55	99.50	0.54	97.15	0.50	92.50	0.48	86.90
			15-30	0.23	33.28	0.20	31.25	0.19	30.00	0.16	27.50
		500	0-15	0.53	92.17	0.51	89.90	0.50	85.47	0.46	80.70
			15-30	0.20	30.42	0.18	30.42	0.17	28.25	0.15	26.15
		1000	0-15	0.50	90.65	0.49	84.30	0.46	83.20	0.43	80.05
			15-30	0.20	29.50	0.17	28.20	0.15	26.75	0.15	25.38
4	El-May	50	0-15	0.45	105.60	0.45	95.17	0.41	88.40	0.39	85.30
			15-30	0.28	35.40	0.25	33.80	0.23	32.50	0.23	29.35
		250	0-15	0.43	98.50	0.40	93.90	0.39	87.50	0.36	83.85
			15-30	0.26	32.75	0.24	30.15	0.21	25.25	0.20	23.50
		500	0-15	0.42	94.16	0.38	89.75	0.34	80.15	0.30	73.50
			15-30	0.25	28.87	0.22	23.45	0.20	22.15	0.17	20.25
		1000	0-15	0.35	83.65	0.35	85.11	-	-	-	-
			15-30	0.23	25.65	0.19	20.16	-	-	-	-
5	Quessna	50	0-15	0.93	410.60	0.85	350.85	-	-	-	-
			15-30	0.42	120.75	0.35	107.95	-	-	-	-
		250	0-15	0.90	390.75	0.83	305.47	-	-	-	-
			15-30	0.40	105.16	0.34	100.30	-	-	-	-
		500	0-15	0.82	280.60	0.81	220.84	-	-	-	-
			15-30	0.36	70.70	0.33	63.55	-	-	-	-
		1000	0-15	0.78	245.30	0.75	205.25	-	-	-	-
			15-30	0.32	65.80	0.31	58.40	-	-	-	-

S= site No., L = Location, DI = Distance from input (m), Av = available.

-The samples is not taken due to the change of the sources of irrigation water

One may conclude from the present findings, that soils have been polluted due to irrigation by such water for long uses. Moreover, it is difficult to obtain identical sequence arranging the contaminated soils by heavy metals .This may be attributed in part to variation of pollutant discharged (sewage and industrials activities) into irrigation water.

Table (8): Total and available Pb content (mg/kg) in the studied soils irrigated by wastewater.

S	L	DI	Soil depth (cm)	Distance from drain (m) 50 Av.	50 Total	250 Av.	250 Total	500 Av.	500 Total	1000 Av.	1000 Total
1	Seberbay	50	0-15	5015	490.15	4517	480.70	4370	465.34	3540	410.85
			15-30	7.22	250.17	5.14	230.28	4.82	228.25	4.50	218.62
		250	0-15	3540	470.32	3322	450.87	3250	420.95	3200	410.85
			15-30	5.50	250.17	4.55	220.28	4.35	215.32	4.05	215.32
		500	0-15	3015	420.50	3015	385.44	2675	380.88	2515	370.65
			15-30	4.36	225.40	3.55	218.35	3.15	205.88	2.90	210.40
		1000	0-15	2240	335.65	2150	335.65	2005	320.05	1922	305.22
			15-30	3.22	215.32	3.10	215.32	2.85	200.17	2.64	200.17
2	El-Mahalla El-Kobra	50	0-15	2.35	650.25	2.30	620.15	2.15	625.58	2.08	600.41
			15-30	2.00	370.30	1.98	360.52	1.95	330.65	1.87	330.65
		250	0-15	2.25	640.40	2.23	600.15	2.09	590.65	2.05	570.65
			15-30	1.97	350.32	1.90	335.87	1.90	327.65	1.80	315.84
		500	0-15	2.25	635.70	2.17	565.42	2.05	565.42	2.03	540.78
			15-30	1.90	300.47	1.82	295.90	1.82	287.44	1.77	275.32
		1000	0-15	2.21	560.30	2.15	500.82	2.05	532.18	2.00	520.25
			15-30	1.90	300.47	1.80	280.74	1.75	278.94	1.66	260.84
3	Kafr El-Zayat	50	0-15	1.85	185.44	1.80	174.96	1.77	170.50	1.75	150.48
			15-30	1.60	70.85	1.42	65.44	1.35	65.44	1.32	63.05
		250	0-15	1.85	183.10	1.79	166.44	1.70	155.65	1.70	150.00
			15-30	1.57	68.97	1.35	63.57	1.20	60.700	1.18	59.50
		500	0-15	1.83	170.84	1.76	165.05	1.70	150.27	1.65	135.70
			15-30	1.52	65.65	1.30	63.05	1.18	59.50	1.18	59.50
		1000	0-15	1.75	160.75	1.70	158.75	1.62	145.30	1.60	132.27
			15-30	1.50	61.82	1.30	60.50	1.15	58.15	1.05	57.24
4	El-May	50	0-15	4280	360.85	3850	355.27	3015	340.68	2825	338.05
			15-30	6.42	150.15	5.87	121.40	3.22	120.80	3.25	120.80
		250	0-15	4150	357.28	3715	354.35	2950	340.68	2402	322.15
			15-30	5.95	145.18	5.10	121.40	3.05	119.50	2.99	118.93
		500	0-15	4125	348.15	3540	348.15	2950	335.94	2284	315.91
			15-30	5.00	144.14	4.65	120.25	3.05	119.00	2.71	114.55
		1000	0-15	4000	348.15	3436	345.11	-	-	-	-
			15-30	4.92	138.65	4.25	119.50	-	-	-	-
5	Quessna	50	0-15	4550	832.17	4315	825.40	-	-	-	-
			15-30	7.32	428.70	5.82	410.70	-	-	-	-
		250	0-15	4415	820.50	4170	800.50	-	-	-	-
			15-30	6.50	425.13	5.05	400.80	-	-	-	-
		500	0-15	4070	730.50	3850	630.15	-	-	-	-
			15-30	5.22	315.40	4.82	300.00	-	-	-	-
		1000	0-15	3850	700.90	3692	605.05	-	-	-	-
			15-30	5.22	300.00	4.40	295.17	-	-	-	-

S= site No., L = Location, DI = Distance from input (m), Av = available.

- The samples is not taken due to the change of the sources of irrigation water

3-Impact of pollution sources on some heavy metals content in the tested plants

Plant samples were collected from different cultivated crops by the ordinary growers at the defined distances to explore heavy metals status after long use of the available irrigation water. Heavy metals (Cd, Co, Ni and Pb) are expressed in mg/kg unit in both shoots and roots, are presented in Tables 9,10,11 and 12.

Table (9): Cadmium concentration (mg/kg) in shoots and roots of the plants cultivated in the tested soils irrigated by wastewater.

L	DI	Distance from drain (m)											
		50			250			500			1000		
		Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots
Seberbay	50	French Beans	80.85	110.10	Citrus	522.85	-	Vine	292.58	-	Citrus	485.67	-
	250	Turnip	315.47	405.37	Clover	45.45	40.18	Corn	33.87	40.15	Onion	170.65	205.94
		Wheat	31.25	20.45	Wheat	30.15	19.15						
	500	Potato	150.17	95.30	Clover	39.80	38.75	Citrus	425.62	-	Citrus	392.87	-
	1000	Onion	182.67	224.34	Onion	180.70	225.28	Clover	43.93	36.35	Lettuce	205.87	165.40
El-Mahalla El-Kobra	50	Corn	30.15	38.55	El-M.	65.80	62.55	Citrus	370.55	-	Cotton	25.21	23.12
	250	Citrus	400.12	-	Cotton	28.32	21.55	BM	64.66	58.31	Corn	87.32	125.35
	500	El-M.	68.70	63.70	Lettuce	150.30	131.77	Okra	25.30	18.17	Corn	25.50	30.75
	1000	Corn	28.50	30.30	Corn	28.50	29.22	Corn	25.95	28.72	Rice	42.85	35.18
Kafr El-Zayat	50	Onion	75.40	112.13	Okra	15.55	14.72	Clover	20.18	15.50	Onion	60.11	78.54
	250	Onion	71.40	90.95	Cotton	25.50	20.44	Potato	110.13	85.70	Potato	100.17	82.50
	500	Cotton	30.07	27.15	Cotton	25.50	20.80	Cotton	22.92	20.11	Okra	15.15	13.11
	1000	Onion	55.40	70.18	Corn	20.25	24.16	Corn	19.11	22.88	Cotton	20.34	17.35
El-May	50	Clover	50.15	43.50	-	-	-	-	-	-	-	-	-
	250	Clover	49.50	40.20	-	-	-	-	-	-	-	-	-
	500	Clover	45.70	38.50	Clover	38.50	37.80	-	-	-	-	-	-
	1000	Clover	30.15	25.50	Clover	20.25	19.11	-	-	-	-	-	-
Quessna	50	Corn	40.80	46.90	Citrus	413.00		-	-	-	-	-	-
	250	Corn	38.50	44.15	Corn	30.50	36.14	-	-	-	-	-	-
	500	Corn	35.11	40.40	-	-		-	-	-	-	-	-
	1000	Citrus	375.40	-	Okra	25.40	20.13	-	-	-	-	-	-

Toxic limits in plant according to Kabata Pendias and Pendias (1992): Cd (5-30 ppm).

- The samples is not taken due to the change of the sources of irrigation water.

L = Location, DI = Distance from input, El-M. = El-Molokhia

Actually, heavy metals contents have a wide variation level among the varied cultivated crops (some of them are edible), reflecting pollution source, distance from inputs and drains, plant species, plant part and its content in the soil i.e. total and available concentrations. Taking toxic limits in plants according to Kabata Pendias and Pendias (1992) for Cd as 5-30 mg/kg, one finds all collected crop samples at 50 m distance for all studied sites have exceeded such level especially at Seberbay and El-Mahalla El-Kobra in both shoot and roots (Table,9). On the other hand the content of Cd for the same crop decreased as the distance increased from source of pollution. But such level still above the recommend level of Cd. Similar trend is exhibited with Ni (Table,10) ,since all collected samples at

50 m either from source of pollution or from drain have exceeded the recommended level of Ni (10-100mg/kg) except that of El-May crops (at all distances).

Table (10): Nickel concentration (mg/kg) in shoots and roots of the plants cultivated in the tested soils irrigated by wastewater.

L	DI	Distance from drain (m)											
		50			250			500			1000		
		Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots
Seberbay	50	French beans	205.13	285.25	Citrus	340.15	-	Vine	305.11	-	Citrus	322.70	-
	250	Turnip	270.50	410.11	Clover	50.13	47.82	Corn	190.22	21525	Onion	178.90	41450
		Wheat	68.50	54.18	Wheat	65.65	54.05	-	-	-	-	-	-
	500	Potato	211.33	167.20	Clover	50.50	42.50	Citrus	315.25	-	Citrus	315.25	-
	1000	Onion	325.05	342.17	Onion	325.15	330.70	Clover	45.40	4227	Lettuce	205.17	15067
El-Mahalla El-Kobra	50	Corn	311.11	340.22	El-olokhia	128.77	111.83	Citrus	210.05	-	Cotton	60.65	5550
	250	Citrus	270.30	-	Cotton	71.82	60.15	El-M	85.70	7070	Corn	160.30	18075
	500	El-M.	115.98	102.05	Lettuce	131.17	107.22	Okra	40.40	3574	Corn	200.17	24030
	1000	Corn	210.25	260.70	Corn	170.80	183.15	Corn	120.13	15073	Rice	140.70	11530
Kafr El-Zayat	50	Onion	130.30	138.70	Okra	33.17	32.50	Clover	40.80	3617	Onion	90.88	101.17
	250	Onion	110.25	118.70	Cotton	40.40	35.70	Potato	150.70	11115	Potato	130.25	110.11
	500	Cotton	42.50	29.60	Cotton	30.44	28.70	Cotton	29.80	2850	Okra	30.65	2725
	1000	Onion	70.65	90.50	Corn	60.60	81.43	Corn	65.60	7213	Cotton	20.50	2017
El-May	50	Clover	60.72	45.13	-	-	-	-	-	-	-	-	-
	250	Clover	55.17	45.13	-	-	-	-	-	-	-	-	-
	500	Clover	53.72	41.41	Clover	50.28	40.50	-	-	-	-	-	-
	1000	Clover	45.81	40.50	Clover	43.28	39.82	-	-	-	-	-	-
Quessna	50	Corn	270.15	335.35	Citrus	288.40	-	-	-	-	-	-	-
	250	Corn	255.70	315.90	Corn	190190	211.82	-	-	-	-	-	-
	500	Corn	215.18	250.75	.	-	-	-	-	-	-	-	-
	1000	Citrus	240.91	-	Okra	40.18	35.50	-	-	-	-	-	-

Toxic limits in plant according to Kabata Pendias and Pendias (1992): Ni (10-100 ppm).

- The samples is not taken due to the change of the sources of irrigation water.

L = Location, DI = Distance from input, El-M. = El-Molokhia

Cobalt concentration in all tested plants (Table,11), which collected from studied soil have exceeded the maximum limit concentration, recorded in contaminated plants by Kabata Pendias and Pendias (1992). Except that of clover at 1000 m distance from input and 500 m distance from drain in Seberbay site and clover at 50 m from input and 500 m from drain in Kafr El-Zayat region.

Data in Table (11) show that the high and low values of Co content for each plant species (shoots and roots) and their cultivation sites. The portions of Co content in lettuce shoots and roots are ranged from 165.18 to

100.40 and 144.50 to 98.17 mg/kg respectively. This wide range may be attributed to its range in the soil. Manal Tantawy (1996) found good and significant relationships between Co content in barley and fenugreek plants and its available content in the soil. Cobalt content in shoots of lettuce, wheat, potato, clover, okra, cotton, rice and el-molokhia was higher than roots, whereas this trend was contract for other collected plants. This variation may be attributed to translocation rate of Co from roots to shoots (Alloway, 1995 and Abdel Sabur *et al.,* 1995). Lead content (Table,12) in shoots of corn plants cultivated at 50 m from either of input and drain was 2206.44 and 2000.80 mg/kg in Seberbay and Quessna regions, respectively. Sahar Ahmed (2001) and Salem (2002) reported this fact also.

Table (11): Cobalt concentration (mg/kg) in shoots and roots of the plants cultivated in the tested soils irrigated by wastewater.

L	DI	Distance from drain (m)											
		50			250			500			1000		
		Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots
Seberbay	50	French Beans	142.15	171.80	Citrus	430.11	-	Vine	365.62	-	Citrus	405.22	-
	250	Turnip	270.83	305.94	Clover	50.67	47.18	Corn	110.55	125.13	Onion	170.15	191.44
		Wheat	60.94	53.28	Wheat	50.77	47.83						
	500	Potato	122.50	107.33	Clover	45.84	43.17	Citrus	300.30	-	Citrus	294.50	-
	1000	Onion	210.50	234.72	Onion	210.50	220.18	Clover	30.28	22.15	Lettuce	135.47	130.28
El-Mahalla El-Kobra	50	Corn	190.15	211.70	El-M	182.14	160.44	Citrus	255.65	-	Cotton	70.82	64.17
	250	Citrus	311.62	-	Cotton	82.55	75.23	El-M	150.70	122.17	Corn	160.30	194.54
	500	El-M	168.70	150.13	Lettuce	100.40	98.17	Okra	73.14	60.83	Corn	150.30	180.17
	1000	Corn	175.80	211.11	Corn	150.44	175.18	Corn	145.33	160.77	Rice	160.30	120.15
Kafr El-Zayat	50	Onion	110.15	125.17	Okra	40.50	32.17	Clover	28.30	25.14	Onion	90.95	120.15
	250	Onion	107.80	120.45	Cotton	80.75	72.17	Potato	80.60	72.30	Potato	75.17	70.94
	500	Cotton	110.70	100.84	Cotton	110.70	95.40	Cotton	90.72	80.18	Okra	35.17	30.32
	1000	Onion	92.30	105.30	Corn	80.64	102.17	Corn	68.17	84.20	Cotton	76.15	75.50
El-May	50	Clover	60.15	55.44	-	-	-	-	-	-	-	-	-
	250	Clover	60.15	52.17	-	-	-	-	-	-	-	-	-
	500	Clover	50.50	46.74	Clover	48.55	45.50	-	-	-	-	-	-
	1000	Clover	47.32	39.50	Clover	42.71	38.54	-	-	-	-	-	-
Quessna	50	Corn	170.90	201.13	Citrus	230.33	-	-	-	-	-	-	-
	250	Corn	150.65	184.22	Corn	120.60	170.14	-	-	-	-	-	-
	500	Corn	140.70	160.83	-	-	-	-	-	-	-	-	-
	1000	Citrus	250.14	-	Okra	65.80	57.42	-	-	-	-	-	-

Toxic limits in plant according to Kabata Pendias and Pendias (1992): Co (1-32 ppm)

- The samples is not taken due to the change of the sources of irrigation water.

L = Location, DI = Distance from input, El-M. = El-Molokhia

Table (12): Lead concentration (mg/kg) in shoots and roots of the plants cultivated in the tested soils irrigated by wastewater.

L	DI	Distance from drain (m)											
		50			250			500			1000		
		Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots	Plant species	Shoots	Roots
Seberbay	50	F. beans	23455	314430	Citrus	43703	-	Vine	4555.1	-	Citrus	42064	-
	250	Turnip	3805.1	320074	Clover	15482	115566	Corn	2048.5	25567	Onion	32504	3589.4
		Wheat	12113	105548	Wheat	11752	100082						
	500	Potato	10009	137052	Clover	13386	106781	Citrus	4200.5	-	Citrus	41072	-
	1000	Onion	35062	390217	Onion	33338	367218	Clover	1300.7	10228	Lettuce	25084	2000.1
El-Mahalla El-Kobra	50	Corn	14008	1775.18	El-Molkhia	28201	263461	Citrus	3105.7	-	Cotton	7221	770.3
	250	Citrus	33333	-	Cotton	905.1	82245	El-M.	23007	20702	Corn	28052	30705
	500	El-M.	3006.1	2625.14	Lettuce	18007	1555.55	Okra	890.2	80534	Corn	10006	12184
	1000	Corn	12852	148632	Corn	12004	142050	Corn	10095	11607	Rice	20503	17184
Kafr El-Zayat	50	Onion	17882	190012	Okra	11502	104080	Clover	900.8	80514	Onion	15542	17115
	250	Onion	17005	190012	Cotton	6002	57582	Potato	420.4	50017	Potato	4064	450.7
	500	Cotton	61730	58020	Cotton	6006	52464	Cotton	556.2	5246	Okra	10002	922.8
	1000	Onion	15143	168890	Corn	11113	1225.14	Corn	10052	1184.1	Cotton	6007	505.6
El-May	50	Clover	1480.1	1350.14	-	-	-	-	-	-	-	-	-
	250	Clover	14003	1215.25	-	-	-	-	-	-	-	-	-
	500	Clover	13002	1180.14	Clover	1250.4	1111.18	-	-	-	-	-	-
	1000	Clover	11072	100040	Clover	1100.7	100040	-	-	-	-	-	-
Quessna	50	Corn	20008	2405.1	Citrus	28700	-	-	-	-	-	-	-
	250	Corn	18002	20003	Corn	1665.1	187090	-	-	-	-	-	-
	500	Corn	17800	19154	-	-	-	-	-	-	-	-	-
	1000	Citrus	25004	-	Okra	511.4	490.18	-	-	-	-	-	-

Toxic limits in plant according to Kabata Pendias and Pendias (1992): Pb (30-300 ppm).

- The samples is not taken due to the change of the sources of irrigation water.

L = Location, DI = Distance from input, El-M. = El-Molokhia

In general, the concentration of Pb in all tested plants grown in all studied soils have exceeded the maximum limits concentration recorded in contaminated plants by Kabata Pendias and Pendias (1992) they stated that the maximum Pb concentrations in contaminated plants was ranged between 30-300 mg/kg dry weight. On the other hand, Gray (1992) noted that the safe levels of Pb in mg/kg dry weight in plants ranged from 0.2 to 20 mg/kg.

Finally, these findings showed that the distribution of Pb uptake within shoots and roots are varied according to plant species. The content of Pb in the shoots of lettuce, turnip, wheat, el-molokhia, cotton, okra and rice plants was higher than roots, whereas this trend was adverse other plants. This difference in Pb distribution depends on Pb transfer rate from roots to shoots (Alloway, 1995).

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الرصد البيئي للتلوث بالعناصر الثقيلة في مياه صرف ملوثة وتأثيرها علي الأرض والنباتات بدلتا النيل

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هــذه الدراسة استهدفت تقييم خمس مصادر لمياه الري العادمة في دلتا النيل وهي مصــرف الغربية الرئيسي (ماء صرف صحي) ومصرف خاص بالمحلة الكبرى ومصرف كفر الــزيات (ماء صرف صناعي) بمحافظة الغربية ومصرف سبل (ماء صرف صحي) ومصرف قويسنا (ماء صرف صناعي) بمحافظة المنوفية وكذلك تاثيرها على محتوى الأرض من بعض العناصــر الثقيلة(الكادميوم والنيكل والكوبلت والرصاص) سواء الكلى منها أو الميسر. وقد

درس كذلك محتوى النباتات القائمة في الأراضي المدروسة من تلك العناصر الثقيلة.ولقد أخذت عينات الماء من هذه المصارف من على أبعاد ٥٠ ، ٢٥٠،٥٠٠ و ١٠٠٠متر من نقط التدفق. تم أخذ عينات أرض سطحية (٠-١٥سم) وأخرى تحت سطحيه (١٥-٣٠سم) من المناطق الخمس تحت الدراسة عند نفس المسافات من مصادر التلوث.واهم النتائج ما يلي:

١- كان ترتيب العناصر الثقيلة في عينات الماء من المصارف تحت الدراسة (ملليجرام/لتر) هو رصاص > كادميوم > كوبلت > نيكل وذلك باستثناء عينات ماء مصرف كفر الزيات وقويسنا. و كان محتوى العناصر الثقيلة في عينات ماء الصرف الصناعي أعلى من تلك الموجودة في عينات ماء الصرف الصحي وكان المحتوى من الرصاص والنيكل أقل من الحدود المسموح بها في ماء الري بينما زاد المحتوى من الكادميوم والكوبلت عن الحدود المسموح بها لماء الري.وتراوح المحتوي من المواد العالقة الكلية بين ٧١ الي ١٥٤٨ ملليجرام / لتر وكانت القيم المسجلة منها بمصرف قويسنا عالية بينما سجلت اقل القيم بمصرف كفر الزيات وذلك عند كل المسافات من نقطة التدفق. لختلفت كثيرا قيم المحتوي من الأوكسجين الكيميائي والحيوي وهذا يعكس إختلاف مصدر واصل الملوثات بالإضافة لتأثير التخفيف وسجلت كل العينات المدروسة زيادة من الملوثات العضوية ما عدا مصرف كفر الزيات.

٢- تناقص محتوى من العناصر الثقيلة "الكادميوم والنيكل والكوبلت والرصاص "(ملليجرام / كجم) سواء الكلى منه أو الميسر في عينات الأرض السطحية و تحت السطحية بزيادة المسافة عن نقط التدفق أو مصادر التلوث (المصارف) وكان المحتوى في الطبقات السطحية أعلى من تحت السطحية. ويمكن ترتيب العناصر الثقيلة تحت الدراسة حسب تركيزها الكلي في العينات المدروسة كالتالي:النيكل(١٥٣٥,١٥ – ٤٨,٦٧) > الرصاص (٨٣٢,١٧ – ٥٧,٢٤) > الكوبلت (٤١٠,٦٠ – ١٠,٥٠) > الكادميوم (٤٨,٤٨ – ١,٧٥) ملليجرام / كجم. وفي الجانب الآخر أخذ ترتيب الميسر من تلك العناصر الترتيب التالي: الرصاص (٥٠,١٥– ١,٠٥) > النيكل(٥,٤٢– ١,٠٨) > الكادميوم (١,٧٩– ٠,٠١) > الكوبلت (٣,٩٣– ٠,٧٠) ملليجرام / كجم.وكان المحتوي الكلي أو الميسر من النيكل أعلي من الحدود المسموح بها في معظم مناطق الدراسة وبذلك يمكن وصفها بأنها أراضى عالية التلوث ويرجع ذلك لطول استخدام مصادر المياه موضع الدراسة.

٣- لقد إختلف محتوى النباتات القائمة في جميع مناطق الدراسة (ملليجرام / كجم) من عناصر الكادميوم والنيكل والكوبلت والرصاص إختلافاً كبيراً. ولقد تناقص هذا المحتوى بزيادة المسافة عن نقط التدفق ومصدر التلوث داخل نفس النوع النباتي. وكان أعلى محتوى للكادميوم والرصاص موجوداً فى النباتات المتأثرة بمياه الصرف الصحي مقارنة بتلك المتأثرة بمياه الصرف الصناعي.و في الجانب الآخر كان أعلى محتوى من النيكل موجودا في النباتات المنزرعة في المحلة الكبرى يليها المنزرعة في قويسنا. ووجد أن المحتوى من الكوبلت كان عاليا في كل النباتات تحت الدراسة. كان المحتوى من تلك العناصر الثقيلة تحت الدراسة فى المجموع الخضرى لنباتات الخس والقمح والبرسيم والملوخية والبامية والأرز أعلى من محتوى الجذور.