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GROUND WATER HEAVY METALS CONTENT IN MID NILE DELTA REGION

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ABSTRACT

The current study has been carried out to investigate the concentration of heavy metals; Pb, Cd, Ni, Zn, Cu and Mn in ground water of the area located between longitudes 30º/30' and 31º/43' E and latitudes 30º/57' and 31º/30' N covering a total area of 37974 km^2. The studied area included four governorates; El-Gharbia, Kafr El-Sheikh, El-Dakahlia and Damietta up to the Mediterranean sea/or Burullus lake in the north.

Fifteen ground water samples were taken from soil profiles, twelve of them were irrigated with water drains which extended to the pump stations which rise the wastewater to the Mediterranean sea and /or Burullus lake. These area which suffering from the water shortage and obligate to reuse drainage water again in planting. The rest of studied soil profiles were irrigated with canal waters.

Results revealed that the heavy metals content in the studied ground water samples can be arranged according to their contents in this order: Zn > Cu > Mn > Ni > Pb > Cd and also showed that the concentration of Cd, Ni, Cu, Zn and Mn were higher than the permissible concentration limits for irrigation water, according to FAO , 1985, while the concentration of Pb was lower than the permissible limit.

Statistical analysis revealed that Pb, Cd, Zn and Ni were slightly increased with the depth of ground water while Cu and Mn have an opposite trend. Other relations of significant positive correlation were found between Mn and each of Cu (0.601*), Zn (0.576*), Ni (0.591*) and highly significant positive correlation between Ni and each of Pb & Zn (0.733** & 0.660**) due to the isomorphous substitution in soils. Heavy metals are not normally included in routine analysis of regular irrigation water but more attention should be paid to them and printing it harmful effect to public health.

Keywords:Heavy metals, pollution, groundwater, pump stations

INTRODUCTION

In Egypt most of the industrial factories lies in and around the agricultural land and the occurrence of water pollution would be expected. As industrial activities require large amount of water and consequently large amount of liquid besides solid wastes are produced. These polluted water, which mainly laden with heavy metals i.e., Cd, Pb, Cu, Co, Cr, Zn and Mn are pumped either into the Nile canals or drains. These metals adversely affected the quality of drinking, domestic use and irrigation water. On the other hand, Zn represents the most serious hazard on water pollution when the amount discharged into the Nile and canal water reaches about 27 ton/year followed by Pb and Mn which reaches 4.08 and 3.40 ton/year, respectively (El-Falaky *et al.,* 1988). The most potentially responsible metals for water quality impairment were Pb, Cd and Ni for domestic water supply, Pb and Cd for aquatic life uses and Mn for irrigation use (El-Sanafawy, 1997).

In Egypt data are available on the levels of trace elements in agricultural soils (El-Sokkary and Lag, 1980; Warshel, 1992, Rashed *et al.,* 1995 and Zein *et al.,* 1998). While no or little attention has been given to study the occurrence of these metals in groundwater.

The depth and salinity of ground water in north Nile Delta soils has been discussed in previous studies. The present research is mainly carried out the throw light on the levels of some heavy metals and their occurrence (i.e. from irrigation processes from pump station water or parent material, or due to atmospheric deposition, and/or from seepage from adjacent highly polluted drains) in the ground water of the Mid Nile Delta soils. Ground water could be considered as a potential irrigation water supply on condition that their contents of dissolved salts and trace elements are permissible. The present study also, deals with groundwater quality concerning the level of some heavy meals; copper (Cu), zinc (Zn) and manganese (Mn), cadmium (Cd), lead (Pb), Nickel (Ni), copper (Cu).

MATERIALS AND METHODS

In fact the studied fifteen locations were chosen in Mid Nile Delta; twelve of them were irrigated with drainage water while the rest were irrigated with canal water (Table, 1). Among them one was far from the pollution at Damietta El-Gedida was used as a reference and one of the others was adjacent to El-Tawella drain (serves about 45.225 feddans) where El-Nasr fertilizer company discharge their effluent while the rest was adjacent to the combustion of Tanta city wastes. Contamination of these soils with heavy metals is mainly talked.

Soluble heavy metals in ground water; Cd, Pb, Ni, Cu, Zn and Mn were determined using the standard methods described by (American Public Health Association (APHA, 1971). Where, the collected groundwater samples were filtered and evaporated under vacuum in a water path until dryness. The residues were soaked with 10 ml of aqua regia and digested and then analysed using Atomic Adsorption Spectrophotometer (Perkin Elmer 3300).

RESULTS AND DISCUSSION

Concentration of heavy metals in the groundwater of the studied soil profiles are shown in Table (1) and Fig. (1) which revealed that the highest contents of Cd, Ni and Cu in groundwater was in profile No. 7 (0.196, 7.79 and 79.49 ppm, respectively) which irrigated with Ganag drain water after Kafr El-Zaiyat factories and companies wastes, while the highest content of Pb was 2.009 ppm in profile No. 15 (atmospheric pollution as a result of heavy metals deposition specially Pb and Irrigated with canal water). Also, the highest contents of Zn and Mn in groundwater were 245.00 and 39.73 ppm in profile No. 12 which irrigated with drainage water of lower drain No. 8 (mainly agricultural drainage), but the lowest content of all studied heavy metals was in groundwater of profile No. 14 which irrigated with canal water and far from any pollution. Profile No. 13 was higher in their contents of all studied heavy metals than profiles Nos. 14 and 15 (except Pb, Ni, Mn and Zn) although irrigated with El-Sahil canal (at Talkha), this may be due to the seepage from El-Tawella drain in which El-Nasr fertilizer company discharge their wastes. Although the vertical distribution of heavy metals concentration in studied profiles failed to manifest substantial movement of most heavy metals. It appear, that large factories of certain metal have redistributed and moved out of the soil subsurface by physical-chemical or biological processes and that there is potential for groundwater and surface waster contamination (Mc-Bride *et al.,* 1997).

Table (1): Heavy metals concentration (ppm) in the ground water samples of the polluted area in Mid Nile-Delta region.

Profile No.	Location	Irrigation water source	Depth, cm	Heavy metals (ppm)					
				Pb	Cd	Ni	Cu	Zn	Mn
P_1	At EL-Rakabea village irrigation with water of pump station of lower drain No. 1.	Drains	200	0.909	0.185	4.01	37.5	160.5	13.27
P_2	At El-Tullumbat village irrigated with water of pump station of drain No. 2		100	0.747	0.099	2.12	70.5	215.0	15.15
P_3	At El-Rawdah village irrigated with mixed water of municipal agricultural and industrial of the end of El-Tawella drain		200	0.622	0.050	1.45	30.0	123.0	15.90
P_4	At pump station No. 3 irrigated with water of drain No. 3.		90	0.843	0.095	2.16	14.45	159.0	14.90
P_5	At pump station No. 4 irrigated with water of drain No. 4 after raising the water.		190	0.323	0.086	2.27	27.41	165.0	16.31
P_6	At El-Zeet drain after El-Mehalla El-Kobra wastes		190	1.33	0.070	6.47	36.28	148.0	17.25
P_7	Al-Ganag-drain after Kafr El-Zaiyat factories and companies wastes		210	1.644	0.196	7.79	79.49	224.0	18.22
P_8	At pump station of upper drain No. 8		190	0.378	0.026	1.76	58.01	149.0	14.68
P_9	At pump station El-Mandora after drain No. 9.		170	0.393	0.030	3.98	16.93	217.0	14.69
P_{10}	At the pump station No. 11.		110	0.338	0.073	4.74	64.52	205.0	16.80
P_{11}	At the pump station El-Zeiny		80	0.465	0.020	4.41	60.31	156.0	13.92
P_{12}	At the pump station of lower drain No. 8		100	0.542	0.039	5.96	72.72	245.0	39.73
P_{13}	At Takha after El-Nasr fertilizer factory	Canals	90	0.368	0.043	2.15	76.00	42.0	19.50
P_{14}	At Damietta El-Gedida (irrigated with Halawa canal		90	0.012	0.001	0.092	1.001	18.50	2.60
P_{15}	At Tanta city adjacent to the combustion on high way between El-Mehalla and Tanta		100	2.009	0.029	6.76	67.0	214.0	29.02
Permissible maximum concentration in irrigation water Adapted from FAO (1985)				5.00	0.01	0.2	2.00	0.2	0.2

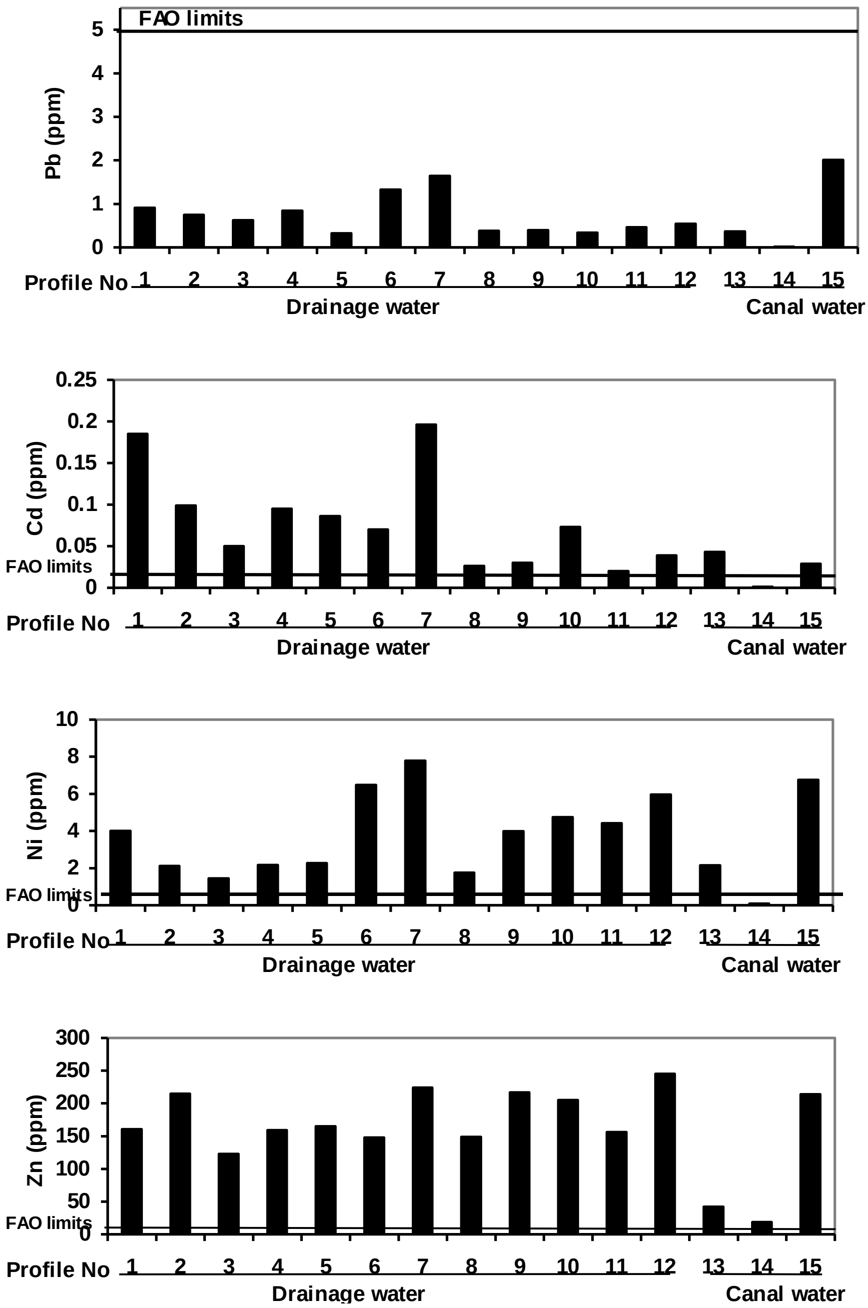
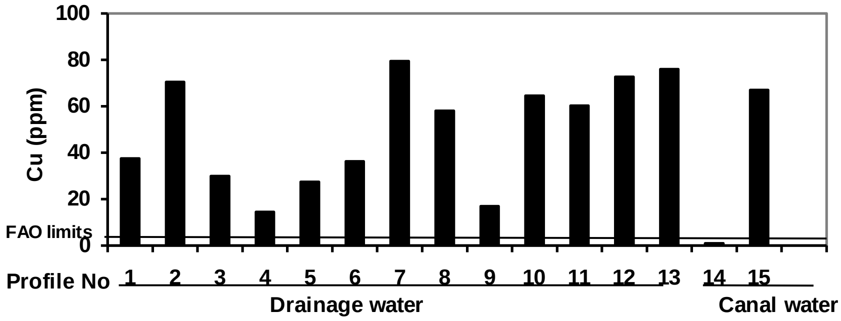


Fig. (1):Heavy metal concentration (ppm) in ground water samples in Mid Nile Delta.



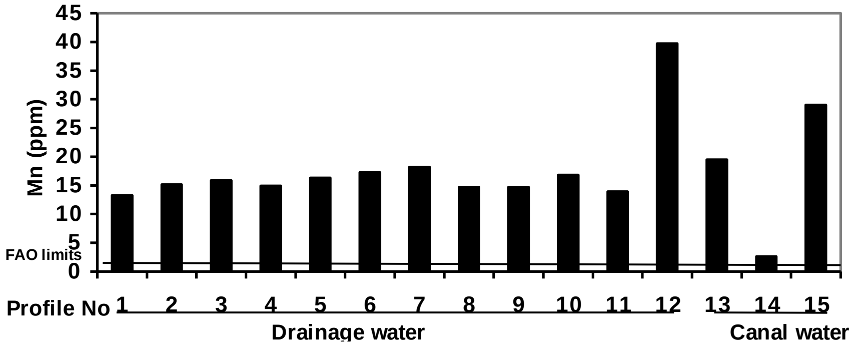


Fig. (1): Cont.

Data of the same table and figure showed that these metals, could be arranged according to their content in the studied groundwater as in this order Zn > Cu > Mn > Ni > Pb > Cd. This order is in agreement with that obtained by Zein *et al.* (2002) for the same metals except Ni in groundwater of El-Hamoul and Baltium (Nile Delta soils) which was as follows: Zn > Cu > Mn > Pb > Cd > Ni. This means that enrichment of Ni in groundwater of studied soil: where 4 factories of oil & soap (i.e. Tanta, Kafr El-Zaiyat, Kafr El-Sheikh and El-Mehalla El-Kobra) used Ni as a catalyst agent in manufacturing processes and drain their effluents in drainage water which finally reaches to pump stations of area which suffering from the water shortage and obligate farmers to reuse drainage water again in planting.

Data also showed that the concentration of Cd, Ni, Cu, Zn and Mn in the groundwater of the studied soil profiles were higher than the permissible limits of irrigation water, while the concentration of Pb a was lower than the permissible limit according to FAO (1985). Koriem *et al.* (2002), found that Cd, Ni and Mn content were higher than the permissible limits while Pb, Cu, Zn were lower than the permissible limits of FAO (1985), for groundwater of some locations in Kafr El-Sheikh soils. This means that the quality of the studied Mid Nile Delta groundwater is in continuos deterioration.

Statistical analysis (simple correlation & regression) between heavy metal concentration of groundwater and their depth's, Table (2) and Fig. (2) showed that Pb, Cd, Ni and Zn were slightly increased with increasing water depth, while Mn and Cu had opposite trend. This may be due to immobilization of dissolved Mn and Cu by oxidation of organic matter and associated with organic matter which is responsible for observed fixation of Pb, Cd, Ni and Zn with depth. These results were in agreement with Ismael (1995), Hegab (1998) and El-Sanafawy (2002) who found that the power of organic matter to accumulate the trace elements is generally higher due its traverse of the entire water column which allows the necessary time and exposure to complex or chelate the trace elements. Data also showed that significant positive correlation between Mn and each of Cu (0.601*), Zn (0.576*), Ni (0.591*) and highly significant positive correlation between Ni and each of Pb & Zn (0.733** & 0.660**). This may be due to the isomorphous substitution in the main of inorganic constitutes of soil such as pyroxene and amphiboles in oxides (Sposito *et al.,* 1982).

Table (2): Correlation coefficient between ground water depths (cm) and its content of heavy metals (ppm).

	Mn	Cu	Zn	Ni	Cd	Pb
Gw. D	-0.144n.s	-0.359n.s	0.156n.s	0.159n.s	0.445n.s	0.207n.s
Mn		0.601*	0.576*	0.591*	-0.049n.s	0.383n.s
Cu			0.282n.s	0.280n.s	-0.151n.s	0.116n.s
Zn				0.660**	0.197n..s	0.443n.s
Ni					0.432n.s	0.733**
Cd						0.374n.s.

Gw.d. = ground water depth. n.s. = Non significant
*** = Significant at 5% level ** = Significant at 1% level**

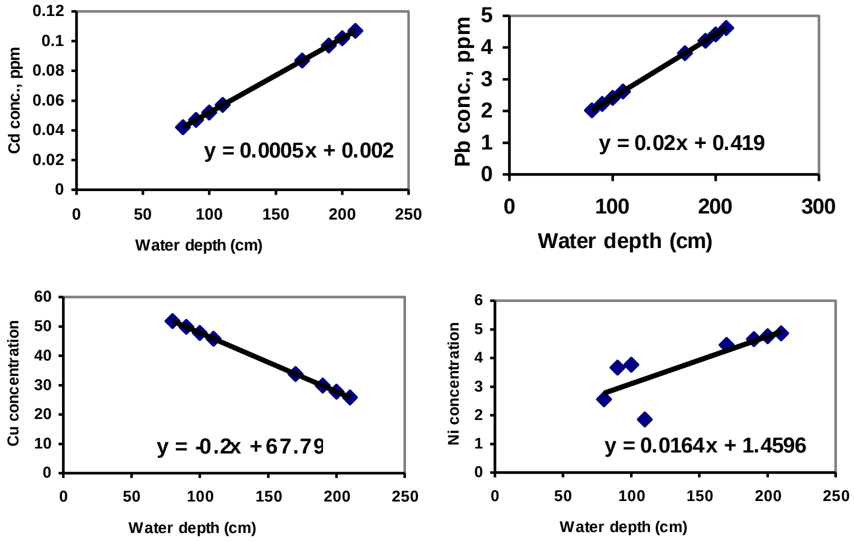


Fig. (2): Correlation regression between groundwater depth (cm) and concentrations of heavy metals (ppm)

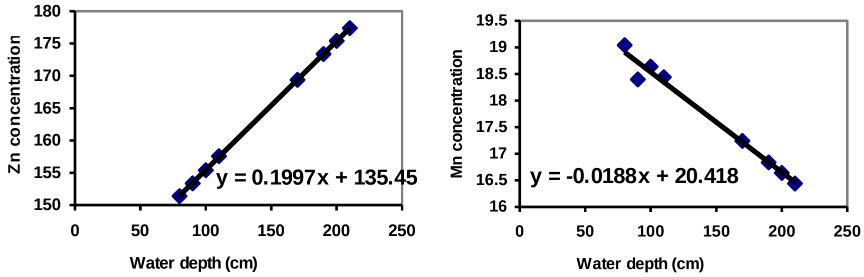


Fig. (2): Cont.

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مدى تلوث الماء الارضى بالعناصر الثقيلة فى منطقة وسط الدلتا

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أجريت هذه الدراسة بهدف تقدير مدى تلوث الماء الارضى بالعناصر الثقيلة مثل الرصاص ـ الكادميوم ـ النيكل ـ النحاس ـ الزنك والمنجنيز بمنطقة وسط الدلتا وتقدير العلاقة بين محتوى هذه العناصر وعمق الماء الارضى. تقع منطقة الدراسة فى وسط الدلتا بين خطى طول٣٠ ٣٥° ، ٤٣ ٣١° شرقا وخطى عرض ٥٧ ٣٠° ، ٣٠ ٣١° شمالا وتغطى مساحة قدرها ٣٩٧٤ كيلو متر مربع وتشمل اربع محافظات وهى الغربية وكفرالشيخ والدقهلية ودمياط وتمتد شمالا حتى بحيرة البرلس والبحر الابيض المتوسط ولتحقيق الهدف من الدراسة تم عمل ١٥ قطاع ارضى واخذت ١٥ عينة ماء ارضى ممثلة لهذه القطاعات منها ١٢ قطاع ممثلين للاراض التى تروى من مياه نهايات المصارف عند محطات رفع مياه الصرف لضخها الى بحيرة البرلس او البحر الابيض المتوسط حيث يضطر المزارعين هناك للرى منها نتيجة لنقص المياه والثلاثة قطاعات الاخرى تروى بمياه الترع احداهما عند دمياط بعيدا عن التلوث والثانى عند مدينة طنطا حيث يقع على الطريق السريع بين طنطا والمحلة الكبرى و متاخم لمحرقه الزبالة لمدينة طنطا أما الثالث فيقع بعد مصنع الأسمدة بطلخا ومتاخم لمصرف الطويلة حيث يصرف فيه مصنع الأسمدة مخلفاته. وأجريت التحليلات لهذه العينات ويمكن تلخيص النتائج المتحصل عليها كما يلى:

- يمكن ترتيب محتوى الماء الأرضى للعناصر الثقيلة بالمنطقة المدروسة كالأتى: زنك > نحاس > منجنيز > نيكل > رصاص > كادميوم.
- كان محتوى العناصر الثقيلة (بالجزء فى المليون) لكل من الكادميوم والنيكل والنحاس والزنك والمنجنيز فى عينات الماء الأرضى المدروسة أعلى من الحدود المسموح بها لمياه الرى طبقا لمنظمة الأغذية والزراعة الدولية (FAO, 1985) بينما كان محتوى الماء الأرضى من الرصاص أقل من الحدود المسموح بها.
- وكان أيضا محتوى الماء الأرضى من العناصر الثقيلة المدروسة عاليا فى القطاعات المتاخمة لمحرقه الزبالة بطنطا ومصنع الأسمدة بطلخا بينما كانت أقل التركيزات فى الماء الأرضى بعيدا عن التلوث.
- أظهرت التحليلات الاحصائية أن هناك علاقة موجبة غير معنوية بين عمق الماء الأرضى وكل من الرصاص والكادميوم والزنك والنيكل بينما كانت العلاقة سالبة مع كل من النحاس والمنجنيز. وكما أظهرت التحليلات أيضا أن هناك علاقة موجبة معنوية بين المنجنيز وكل من النحاس (*٠,٦٠١) ، الزنك (*٠,٥٧٦) ، والنيكل (*٠,٥٩١) وعلاقة موجبة عالية المعنوية بين النيكل وكل من الرصاص (***٠,٧٣٣) ، والزنك (**٠,٥٦٦٠). أى أن تركيزات العناصر المدروسة تزداد كلما أصبح الماء الأرضى قريب من سطح الأرض ونوصى بأخذ تركيزات العناصر الثقيلة فى الماء الأرضى فى الاعتبار عند تحديد نوعية هذا الماء لاستعماله كوسيلة لرى الأراضى الزراعية فى المناطق التى تعانى من نقص المياه.