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Distributions and variations of the heavy metals with depth and grain size fractions in the cultivated soils, a case study in Middle Nile Delta, Egypt

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Abstract : In this study, distribution of heavy metals with depth and various particle size fractions in Middle Nile Delta cultivated soils were studied. The highest values were found in the clay fraction while the lowest values were found in the sand fraction. The concentration of heavy metals decreased with the depth, so the highest values were found in the surface layer. The concentrations of Fe, Co, Cr, Cu ,Ni, Pb, Zn, and Ba in the soil samples of Middle Nile Delta around and near Kafr EL-Zayat and Tanta cities in different depths compared with Canadian soil quality guidelines (CSQG) of Canadian Council of Ministers of the Environment [1] and average shale of [2]. The pollution of heavy metals restricted to the upper layer (surface layer) only, Where, the heavy metals originating from various organic waste sources accumulate in the surface. The organic matter content in the uppermost layer is higher than in the lower layer.
Key words: Middle Nile Delta – Pollution – CSQG – Distribution – size fractions – Depth.

1. Introduction:

During the last and present centaury, the heavy metals entering the environments due to the high rate of developments in industry, agriculture and urbanization. The heavy metals occurred in soil due to natural and human processes. Waste disposal, industrial discharges, deposition from atmosphere, urban effluent, long-term application of sewage sludge, fertilizer application in soil, and vehicle exhausts are the main sources of heavy metals in soils[3,4,5].

In urban areas with heavy traffic, the road soil side polluted by heavy metals from atmospheric deposition[6,7], gasoline, car component, oil lubricants and industrial incinerator emissions[8].

The heavy metal contents in sediments or soils depends on the physical and chemical properties, such as grain size, surface area and main geochemistry properties. Grain size is considered the very important factor for heavy metal contents in soil and sediments. It is known that the finer sediments contain more concentration of heavy metals than coarser ones. The main reason is that smaller grain- size particles have a larger surface-to-volume ratio[9,10]. Another studies stated that the coarser grain size show a similar or even higher heavy metal concentrations than finer ones[1,12].

[13]stated that the smaller grains accompanied with heavy metlas due to co- precipitation complexation processes. Thus, a major of heavy metals found in sediments due to the complex between physical, chemical and biological processes. Where, the occurrence of pollutants with sediment grains dependent upon the surface area as well as the characteristics of chemical partitioning onto the sediment[14]. [15]stated that content and distribution of heavy metals and organic matter are defined not only particle size of sediments but also the

conditions of its accumulation, particularly, the ecological state of a reservoir and climatic parameters. In Egypt, [16]reported that the mean content of total Fe, Mn, Zn, Cu, Pb and Cd in the surface soils of El-Saff area polluted by industrial wastes of iron and steel outlet. [17]found that after the irrigation with industrial wastewaters the heavy metals Fe, Mn, Cu, Zn, Cd, Co, Ni, Pb and Cr were increased. Also, after irrigation by sewage effluents in Abu-Rawash the heavy metals increased[18]. [19] were Studied the heavy metals: Fe, Mn, Zn, Cu, Pb, and Ni in gravel, sand, mud, coarse, medium, and fine sediment fractions of the upper layer of the bottom sediments of Safaga Bay. He stated that the distribution levels of these metals were increasing with grain size decreasing and these metals concentrated mainly in the fine, very fine, and particulate fractions of sediments and to many anthropogenic sources.

It was shown that the Nile Delta soils are characterized by high clay mineral contents with high concentrations of Fe. Due to the geochemical characteristics of Al, Fe and Ti they were selected as tracers and indicators of clay minerals and lithology. As conservative elements they reflect ferromagnesian minerals as source minerals from basic rocks from which the Nile sediments as well as clay minerals were derived. Elements which have significant correlations with the concentrations of Al, Fe, and Ti, follow the vertical distribution of these elements in the sediment cores analyzed, and show characteristic low variations are interpreted as reflecting a natural origin (geogenic and pedogenic). Cultivated soil is affected predominantly by (i) agricultural anthropogenic input (e.g., fertilizers, pesticides, green manure, waste water irrigation, etc) and (ii) atmospheric deposition. 7 surface and three core samples of cultivated soils were analyzed to obtain data on the concentration and distribution of elements.

[20]stated that the distribution of elements indicative of anthropogenic input with increasing depth in cultivated soil samples is characteristic of agricultural usage. While nutrients were selectively leached out by plant uptake and biomass export, excess fertilizer and organic matter were accumulated[21]. Al- and Fe-oxide increase with increasing depth in the core sample. Ba, Co, Cr, Ni, V and MnO reveal the same trend as Al- and Fe-oxides. By contrast, As, Pb, Sr, Zn and Ca and P oxides accumulate close to the surface horizons. Ce and Cu do not display any considerable trend. The organic carbon content in the uppermost part is higher (2.0 - 3.6 %) than in the lower part (0.6- 0.8 %). These indicate that organic carbon is important for the incorporation of P, Pb, Zn, and As in cultivated soil [20].

In this study, the variations and distribution of heavy metals with depth and grain size fractions were studied by using eleven representative samples collected from different sites in middle of the Nile Delta (Table. 1 and Fig. 1).

2. Materials and Methods

2.1. Study Area and Sampling

The study area in the middle Nile Delta is the cultivated soils near and around the two main cities kafr EL-Zayat and Tanta (Table. 1). The samples were collected from 11 sites (Fig. 1) in spring season 2013, all samples collected from cultivated soils in the middle of Nile Delta (six core samples and five surface samples). The sampling used topographic maps at a scale of 1:50,000, landsat images and GPS instruments.

Table. (1) Textural classification of the collected samples of the Middle Nile Delta

Samples	Sand %	Silt %	Clay %	classification
1CSCI	12	25	63	Silty clay
2CSCI	11	22	67	Silty clay
3CSCI	13	20	67	Silty clay
4CSCI	14	24	62	Silty clay
5CSCI	15	22	63	Silty clay
6CSCI	16	22	62	Silty clay
7CSS	8	27	65	Silty clay
8CSS	13	25	62	Silty clay
9CSS	12	25	63	Silty clay
10CSS	12	24	64	Silty clay
11CSS	8	26	66	Silty clay

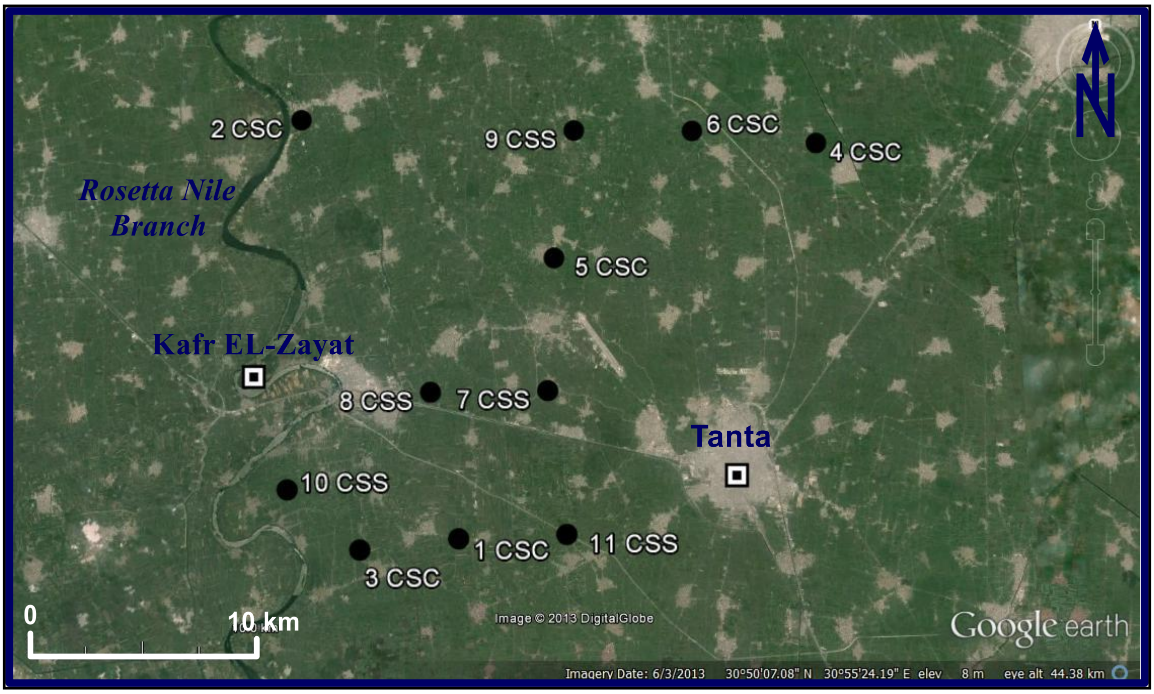

Fig.(1). Location map and sites of sampling

2.2. Laboratory Analysis:

2.2.1. Mechanical Analysis:

The samples were air-dried, crushed to pass a 2mm sieve, then subjected to different physical and chemical analyses according to[22]. Soil samples were prepared for heavy metals analyses in different fractions. Separation of clay, silt and sand were carried out according to the hydrometer method[23].The determination of the size distribution of soil particles is known as mechanical or particle size analysis. Soil texture is the composition of the soil particles expressed as the percent of particles in the sand, silt, and clay size separates after organic matter, carbonates, and iron and manganese oxides and other cementing or binding agents are removed. The hydrometer method [23] is based on the change of density of a soil and water suspension upon the settling of the soil particles. The hydrometer method was used to separate sand, silt and clay in each sample also used to divide sand separates into classes. The Bouyoucos hydrometer method used to separate silt from clay paticles. The Bouyoucos hydrometer method of mechanical analysis which relies on the principles of dispersion and sedimentation.

2.2.2. Chemical Analysis:

The use of flame atomic absorption spectrometer is still regarded as the most convenient and appropriate technique for the purpose of heavy metal analysis in most cases. Soil samples were air dried, and then, the < 63μm size fraction was recovered by sieving. This size fraction is widely used to eliminate the effect of particle size and to obtain a more homogeneous grain distribution[24]. This fraction is also the most chemically active sediment phase consisting primarily of clay and silt particulates[25]. About (1.0 gm) of the most fine dried grains were digested with a mixture of conc. H2O2, HCl and HNO3 as the method described in [22] and preserved in a refrigerator till analysis. The digestion solutions were analyzed using an air-acetylene flame atomic absorption spectrophotometer (AAS) (Perkin Elmer, Model 2380) at optimum instrument operating conditions recommended by the manufacturer. The sediment pH was determined by mixing dry sediment with distilled water [26]. Total organic carbon analysis was carried out by[27].

All collected samples mechanically analyzed to sand, silt and clay by hydrometer method (Six core samples and five surface samples) (Table.1).The heavy metals concentrations, PH, OC and OM were determined in core and surface samples (Table. 2 and 3) according to the previous methods.

3. Results and discussion:

3.1.Distribution and Variation of heavy metals

Distribution of heavy metals with depth and various particle size fractions in Middle Nile Delta cultivated soils are listed in Table 2 and 3. They have high amounts of heavy metals due to the large amounts of wastes of the industrial and residential activities at kafr EL-Zayat and Tanta cities in the Middle of Nile Delta. Soil problems arise in the region around and near Kafr EL-Zayat and Tanta cities, where industrial and residential wastes which contain large amounts of heavy metals are dumped into the irrigation canals used in cultivated soils.

The data presented in Table 2 indicate that in all soils samples, the highest contents of heavy metals were in the clay fraction, where, the abundance of heavy metals in the various fractions as following order: clay> silt > sand. In all samples (Table. 2 and Figs. 2,3,4,5,6), the highest values were found in the clay fraction while the lowest values were found in the sand fraction; due to the soils differ in their retention power of each size fraction for various heavy metals. The relation between the particle-size distribution and the heavy metals contents [28,29] as well as organic carbon in soils have been studied by several authors[30,31]. The fine particles show higher concentration of heavy metals due to increased surfaces areas, higher clay minerals and organic matter content, and the presence of Fe-Mn oxide phases[32], where the smaller grain sizes are of more concern than larger grain sizes because they have relatively high surface area, which facilitates the adsorption of pollutants.

The distribution of heavy metals in different grain size fraction related to the soil mineral composition [33] and amount of adsorption sites in each size fraction. The concentrations of Fe, Co, Cr, Cu, Ni, Pb, Zn and Ba are high in clay and silt fraction compared to the sand fraction.

Table.(2) Heavy metals concentration in the various particle size fractions and organic matter

Samples	Fractions	Fe	Co	Cr	Cu	Ni	Pb	Zn	Ba	O.M
7CSS	Sand	33908	28	112	49	74	13	101	398	1.36
	Silt	72897	38	133	71	81	17	116	411	1.33
	clay	73212	40	143	83	95	19	122	443	1.40
Average		60005	35.33	129.33	67.66	83.33	16.33	113	417.33	1.36
8CSS	Sand	44256	31	112	31	67	12	101	418	2.1
	Silt	71345	37	129	64	79	15	106	456	2.42
	clay	73276	39	159	75	89	24	117	480	1.82
Average		62959	35.66	133.33	56.66	78.33	17	108	451.33	2.11
9CSS	Sand	36548	32	111	49	56	18	113	354	1.22
	Silt	69345	40	134	63	68	21	123	413	1.41
	clay	72548	44	149	95	87	27	137	499	2.1
Average		59480	38.66	131.33	69	70.33	22	124.33	422	1.57
10CSS	Sand	49254	26	101	31	62	15	99	444	2.3
	Silt	71986	31	129	45	72	18	101	460	2.5
	clay	73298	38	162	74	91	23	110	498	1.87
Average		64846	31.66	130.66	50	75	18.66	103.33	467.33	2.22
11CSS	Sand	55421	29	101	49	77	14	113	411	1.39
	Silt	70378	32	129	71	85	17	116	431	1.33
	clay	73298	41	144	85	96	19	123	444	1.41
Average		66365	34	124.66	68.33	86	16.66	117.33	428.66	1.37

CSS=Cultivated surface soil O.M=organic matter

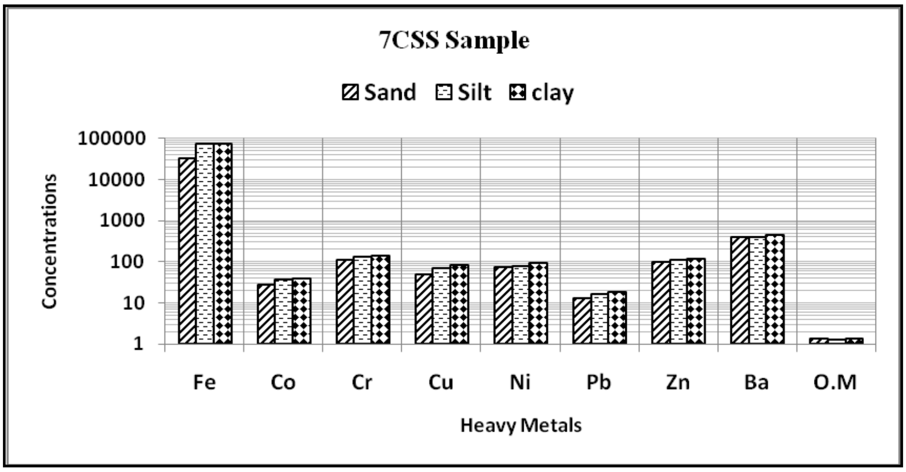

Fig. (2) Variation of heavy metals and organic matter in the various fractions size of 7CSS sample in the study area

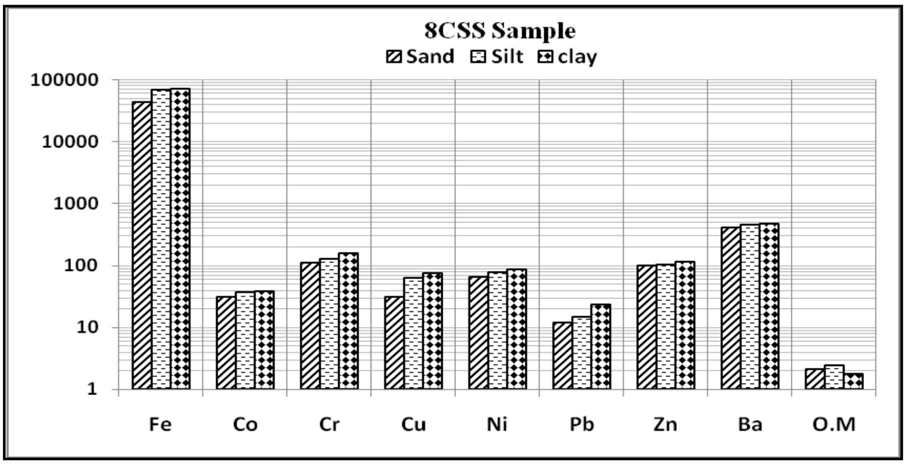

Fig. (3) Variation of heavy metalsand organic matter in the various fractions size of 8CSS sample in the study area

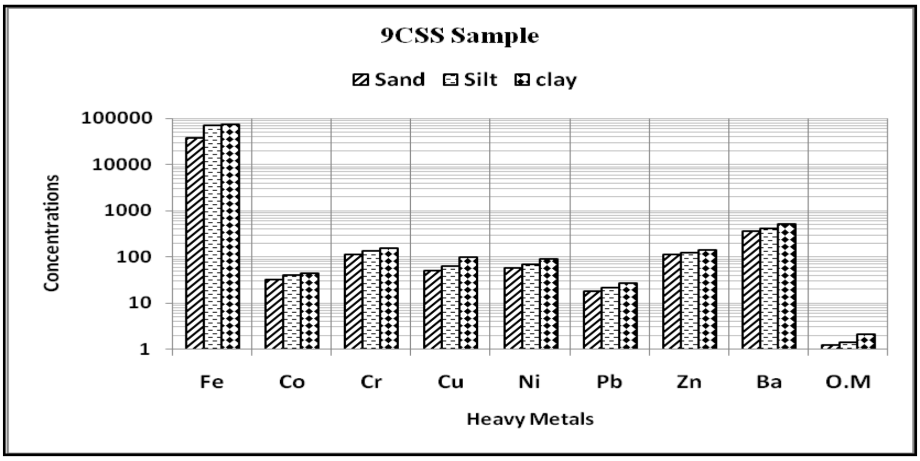

Fig. (4) Variation of heavy metals and organic matter in the various fractions size of 9CSS sample in the study area

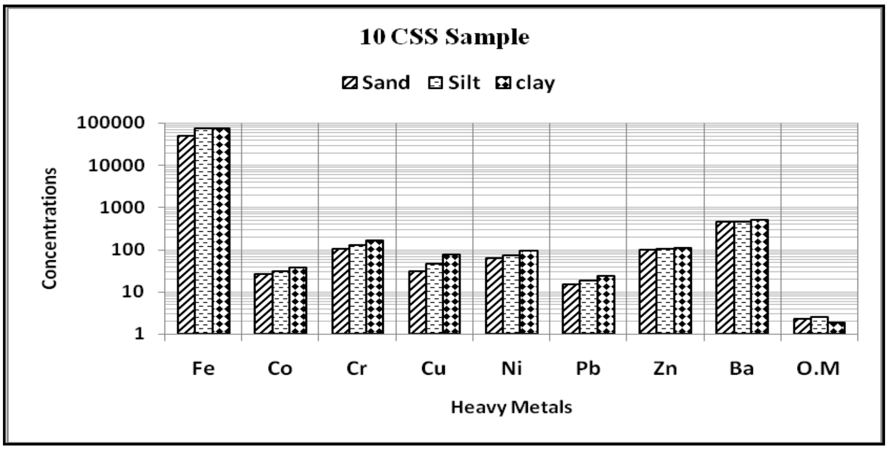

Fig. (5) Variation of heavy metals and organic matter in the various fractions size of 10CSS sample in the study area

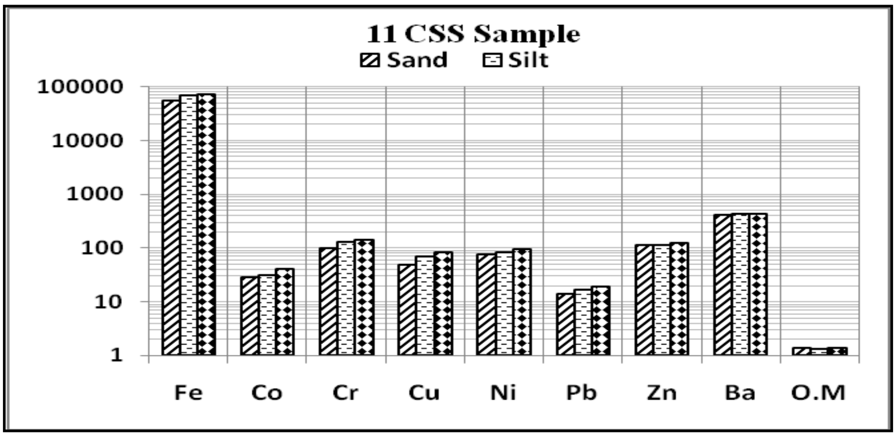

Fig. (6) Variation of heavy metals and organic matter in the various fractions size of 11CSS sample in the study area

These results agree with [34], who discussed the retention and mechanism adsorption of these metals with fine fractions of soil. Most of these metals such as Cr, Zn, Ni, Cuare strongly bound to clay minerals [35] and reveal high adsorption by very fine fraction, where, Barium is strongly adsorbed by clay minerals [36,37]. [34] mentioned that the enrichment of Pb in the finer fraction may probably take place when it was released by the weathering processes as irrigation with polluted water or from fall outs. These elements, like most other heavy metals, are strongly adsorbed to functional groups on the particle surface and may then occluded, for example in hydrated oxides precipitating on the same surfaces. Thus, the coarse sand fraction was more affected by pollution of heavy metals than the clay fraction. Due to the texture of Middle Nile Delta soils are silty clay and the irrigation by industrial and residential wastewaters, these soils are highly polluted by heavy metals. The variation of heavy metals with depth were studied (Table. 3 and Figs. 7,8,9,10,11,12). As in Table 2, the average Fe content ranged between 61376 and 67687 mg/kg , Co from 34.33 to 37.66 mg/kg, Cr from 125.66 to 143.33 mg/kg, Cu from 51 to 81.66 mg/kg, Ni from 62.66 to 88.66 mg/kg, Pb from 14.66 to 16.66 mg/kg, Zn from 87.33 to 105 mg/kg, and Br from 417.66 to 472 mg/kg. The concentration of heavy metals decreased with the depth (Table 2), so the highest values were found in the surface layer. These results indicate that the heavy metals originating from various organic waste sources accumulate in the surface and their fate depends on the chemical and physical properties of the soil. The surface layers of Middle Nile Delta soils polluted by heavy metals due to irrigation with industrial and residential wastes. All layers of these soils are silty clay texture, thus the heavy metals are high in these soils.The relation of organic matter with particle size and depth where studies (Table 2,3). In most samples, organic matter content in upper layer of soils is high and it also high in fine fraction (Clay). The organic matter in some sites may be does not depend on particle size. Thus, organic matter distribution in the sediments does not clearly depend on grain size but it depends on the conditions of the sediment formation. The mean pH ranged between 7.7 to 8.03, where the soils of the Middle Nile Delta is neutral.

Table.(3) Heavy metals concentrations, organic matter, and PH of the core samples collected from Middle Nile Delta

Samples	layer	Depth	Fe	Co	Cr	Cu	Ni	Pb	Zn	Ba	O.M	pH	Texture
1CSC	**I**	0 – 15	70876	38	148	68	84	22	108	488	2.3	7.8	Silty clay
	Π	15 – 40	61987	37	124	48	56	15	96	428	1.6	7.8	Silty clay
	ΠΙ	40 - 50	52263	31	108	37	48	11	58	389	0.95	8.1	Silty clay
Average			61708.67	35.33	126.66	51	62.66	16	87.33	435	1.61	7.9	
2CSC	**I**	0 – 15	72946	38	129	85	90	21	105	436	1.96	7.6	Silty clay
	II	15 – 40	61879	38	129	80	88	14	105	408	1.2	7.6	Silty clay
	III	40 - 50	52236	37	119	80	88	12	104	409	0.56	7.9	Silty clay
Average			62353.67	37.66	125.66	81.66	88.66	15.66	104.66	417.66	1.24	7.7	
3CSC	**I**	0 – 15	71876	36	145	65	82	20	105	480	2.66	7.8	Silty clay
	Π	15 – 40	60987	36	141	65	80	15	96	470	1.33	7.9	Silty clay
	ΠΙ	40 - 50	51265	36	140	56	78	15	95	438	0.35	8.2	Silty clay
Average			61376	36	142	62	80	16.66	98.66	462.66	1.44	7.96	
4CSC	**I**	0 – 20	71089	37	143	88	79	18	104	486	2.99	7.6	Silty clay
	II	20 – 40	62112	35	143	61	79	13	95	462	2.02	7.7	Silty clay
	III	40 - 55	52998	31	136	60	75	13	90	450	1.2	8.0	Silty clay
Average			62066.33	34.33	140.66	69.66	77.66	14.66	96.33	466	2.07	7.76	
5CSC	**I**	0 – 15	71946	37	126	81	91	22	101	445	3.6	7.9	Silty clay
	II	15 – 35	69879	37	126	75	91	14	101	436	1.66	7.9	Silty clay
	III	35 - 50	61236	36	125	70	81	13	100	433	1.1	8.3	Silty clay
Average			67687	36.66	125.66	75.33	87.66	16.33	100.66	438	2.12	8.03	
6CSC	**I**	0 – 20	72089	38	147	90	88	19	109	488	1.99	7.5	Silty clay
	Π	20 – 40	62112	37	146	65	81	14	103	464	1.58	7.9	Silty clay
	ΠΙ	40 - 55	61998	37	137	62	80	13	103	464	0.38	8.2	Silty clay
Average			65399.67	37.33	143.33	72.33	83	15.33	105	472	1.31	7.86	
CSQG (Agricultural soil)			**-**	**40**	**64**	**63**	**50**	**70**	**200**	**750**			
Average shale			**47200**	**19**	**90**	**45**	**68**	**20**	**95**	**580**			

CSC= Cultivated soil core O.M=organic matter - Average shale, after [2] -CSQG of Agricultural soil ,Canadian soil quality guidelines [1]

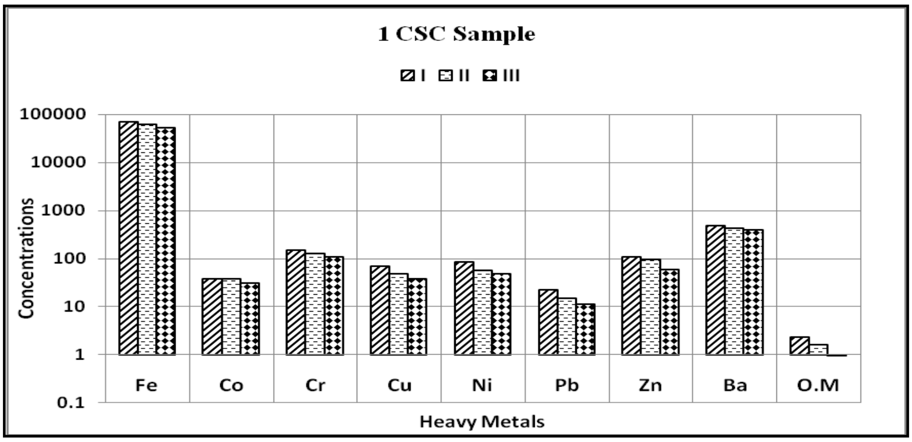

Fig. (7) Variation of heavy metals with depths of 1CSC sample in the study area

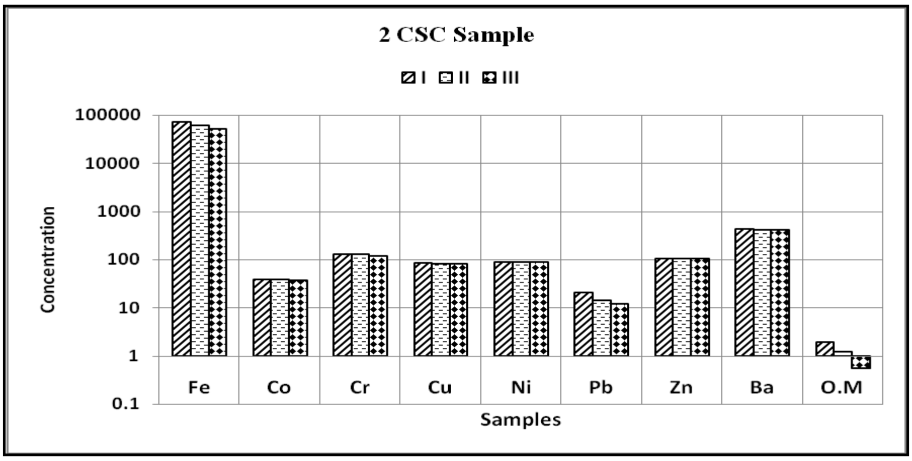

Fig. (8) Variation of heavy metals with depths of 2CSC sample in the study area

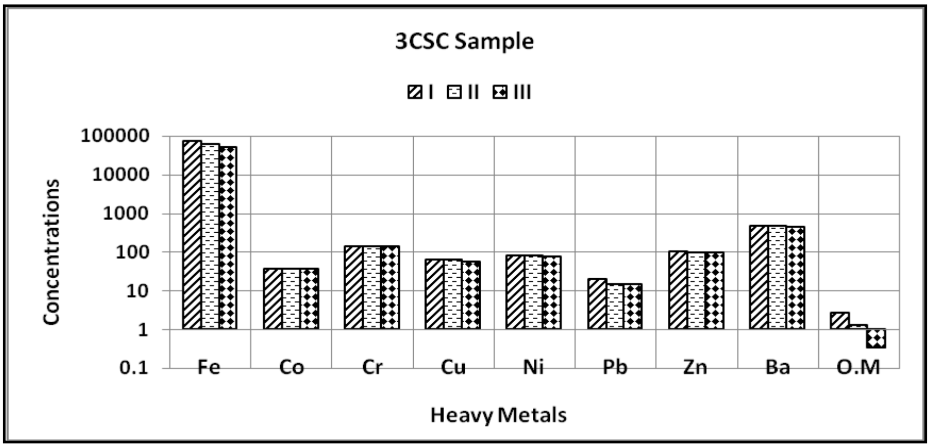

Fig. (9) Variation of heavy metals with depths of 3CSC sample in the study area

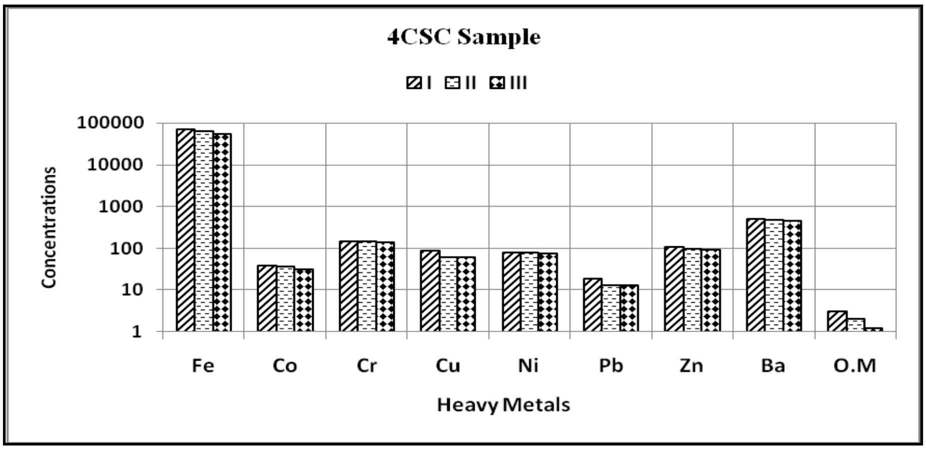

Fig. (10) Variation of heavy metals with depths of 4CSC sample in the study area

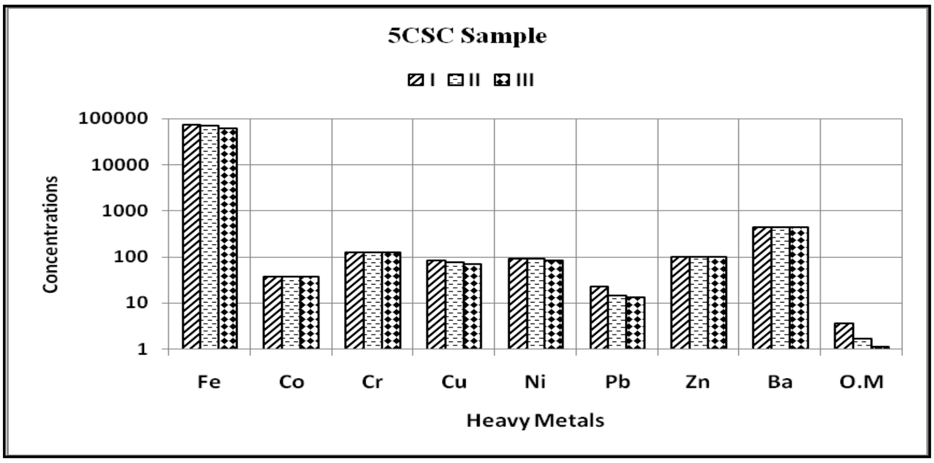

Fig. (11) Variation of heavy metals with depths of 5CSC sample in the study area

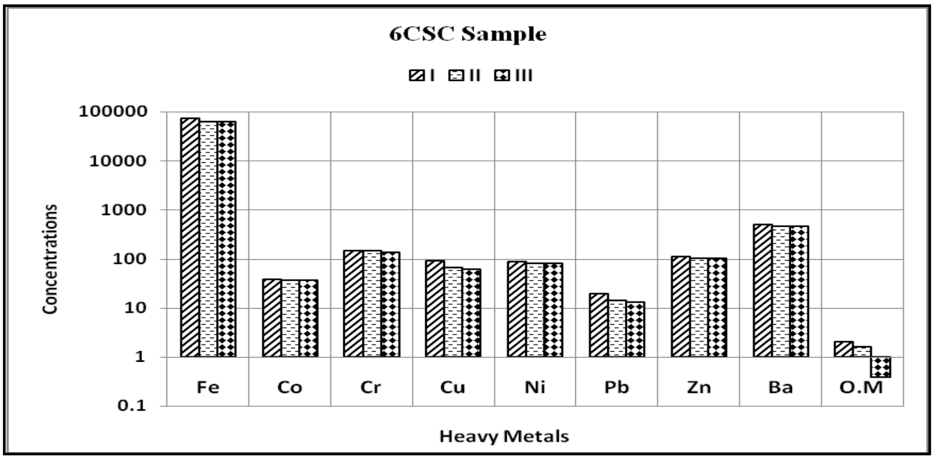

Fig.(12) Variation of heavy metals with depths of 6CSC sample in the study area

3.2.Heavy metals pollution

The concentrations of Fe, Co, Cr, Cu ,Ni, Pb, Zn, andBa in the soil samples of Middle Nile Delta around and near Kafr EL-Zayat and Tanta cities in different depths (Table. 2) compared with Canadian soil quality guidelines (CSQG) of Canadian Council of Ministers of the Environment [1] and average shale of [2] (Fig 13).

Average Fe concentrations in the study area more than the average shale values of [2] (Table.1 and Fig. 13). The permissible iron concentrations in the soils range from 0.2% to 55% (20,000 to 550,000 mg/kg) [38], and concentrations can vary within localized areas, due to soil types and the presence of other sources. Where, the average of iron more than the range of [38].

Average Co concentrations of the study area are less than that of CSQG and more than average shale of [2] (Table 2 and Fig 13). Cobalt occurs with other metals such as Cu, Ni, Mn and Ar. Small amounts are found in most rocks, soil, surface and underground water, plants and animals. Cobalt occurred in the natural in soil, dust, seawater, volcanic eruptions and forest fires. It is also released to the environment from burning coal and oil, from car, truck and airplane exhausts, and from industrial processes that use the metal or its compounds. The toxicity of cobalt is quite low compared to many other metals in soil. The concentrations of Cobalt are higher in the samples due to the irrigation of agricultural lands with untreated industrial and residential wastewater which led to the accumulation of Co in the soils.

Average Cr concentrations of the study area are more than that of CSQG and average shale of [2] (Table 2 and Fig 13). Naturally Cr is occurred in the Earth's crust and can be come to most of environmental media. At many industrial and waste disposal locations, chromium has been released to the environment via leakage and poor storage during manufacturing or improper disposal practices [39,40]. Chromium concentrations are higher in some sites due to irrigation by untreated industrial and residential wastewater. Chromium may be lower in some sites due to the continuous removal of heavy metals by the food crops grown in this area and also due to leaching of heavy metals into the deeper layer of the soil and to the ground water. Average Cu concentrations of the study area more than that CSQG Values except in samples 1CSC and 3 CSC and more than average shale of [2], (Table. 2 and Fig. 13). Most copper compounds will settle and be bound to water, sediments or soil particles. The concentrations of copper are higher in some samples due to the irrigation of agricultural lands with untreated industrial and residential wastewater which led to the accumulation of Cu in soils. The Cu concentrations are lower due to the continuous removal of heavy metals by the food crops grown in this area and also due to leaching of heavy metals into the deeper layer of the soil and to the ground water.

Average Ni concentrations in the soil samples of the study area are higher than that of CSQG and more than average shale of [2] except in sample 1CSC (Table 2 and Fig. 13). Nickel occurs naturally in soils as a result of the weathering of the parent rock [41]. Agricultural fertilizers, especially phosphates, are also a significant source of nickel in soil but it is unlikely to build-up in soil in the long term from their use [41]. The irrigation by industrial and residential wastewater and uses of agricultural fertilizers led to the increasing the Ni concentrations.

Average Pb concentrations of the study area are lower than that of CSQG and average shale of [2] (Table 2 and Fig 13). Lead may be occurred in the soil from flaking lead paint, from incinerators (and similar sources), and from motor vehicles that use leaded gasoline. Lead is toxic to humans, and poisoning can occur either through ingestion of lead or by breathing in lead dust. Both long-term low-dose and short-term high-dose exposure can permanently damage the nervous, renal (kidney), and hematopoietic (blood-forming) systems. The concentrations of Lead is lower due to the study area has a little sources of Lead, where little vehicles and populations.

Average Zn concentrations of the study area are lower than that of CSQG and more than that of average shale of [2] except in sample 1CSC (Table 2 and Fig. 13). It is released to the environment from both natural and anthropogenic sources; however, releases from anthropogenic sources are greater than those from natural sources. The main sources of anthropogenic zinc in soil due to discharges of smelter slags and wastes, mine tailings, coal and bottom fly ash, and the use of commercial products such as fertilizers and wood preservatives that contain zinc. Although zinc usually remains adsorbed to soil, leaching has been reported at waste disposal sites. The lower concentrations of the Zn than the safe limits of CSQG might be due to the continuous removal of heavy metals by the food crops grown in this area and also due to leaching of heavy metals into the deeper layer of the soil and to the ground water.

Average Ba concentrations of the study area are lower than that of CSQG and that of average shale of [2] (Table 2 and Fig 13).

Barium occurs in nature only in a combined state, the majority of barium in sediments is in the form of barite[42]. Barium may be is occur in small rates in igneous rocks and in feldspar and micas. Anthropogenic sources of barium are mainly from industrial activities. Barium is also present in waste water due to metallurgical and industrial processes. The terrestrial abundance of barium has been estimated at 250 g/tone, and its occurrence in sea water is 0.006 g/tone [43].

Barium is present in the soil through the natural process of soil formation, which includes the breakdown of parent rocks by weathering. The soils formed from shales, limestones and biotite micas contain high rates of Barium[44]. Barium in the study area in the Middle Nile Delta is low due to the soils (silty clay texture) are formed mainly from silt and clay and the PH of the soils nearly neutral.

Finally, the pollution of soil arise in the region around and near Kafr EL-Zayat and Tanta cities, where industrial and residential wastes which contain large amounts of heavy metals are dumped into the irrigation canals used in cultivated soils. The pollutants of this soil similar to that occurred in other soil beside the lakes, where the probable source of the pollutants is anthropogenic, arising from agricultural activities, Electroplating materials and lubricants used near the lake[45]. According to [46] the heavy metals in the soils were mainly obtained from marine, alluvial and peat deposits. Thus the soils of the study area polluted from agricultural wastes with other main source of pollution. There are many methods to calculate the indices according to[47] ordinary and new contamination factors (CFs) can used. The new CFs is more accurate than ordinary CFs due to using Canadian soil quality guidelines (CSQGs) values, where these values are the permissible limits of heavy metals in soils. This area in the middle Nile delta polluted by the industrial activities and due to the excess of clay fraction of soils.

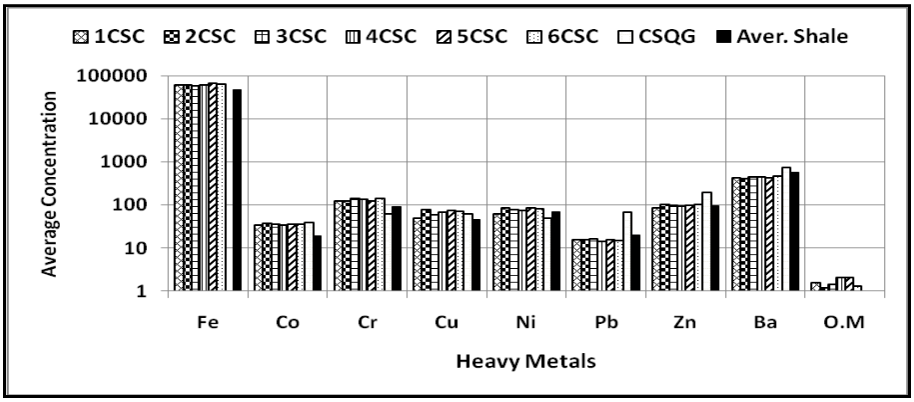

Fig. (13) Comparision of concentrations of heavy metals and organic matter with values of CSQG and Average Shale

4. Conclusions:

In this study, Soil problems arise in the region around and near Kafr EL-Zayat and Tanta cities, where industrial and residential wastes which contain large amounts of heavy metals are dumped into the irrigation canals used in cultivated soils. The highest contents of heavy metals were in the clay fraction, where, the abundance of heavy metals in the various fractions as following order: clay> silt > sand. The highest values were found in the clay fraction while the lowest values were found in the sand fraction; due to the soils differ in their retention power of each size fraction for various heavy metals. In this study, there are agreement with[32], where, the fine particles show higher concentration of heavy metals due to increased surfaces areas[9,10], higher clay minerals and organic matter content, and the presence of Fe-Mn oxide phases.

The variation of heavy metals with depth were studied, where, the concentration of heavy metals decreased with the depth, thus the highest values were found in the surface layer. These results indicate that the heavy metals originating from various organic waste sources accumulate in the surface and their fate depends on the chemical and physical properties of the soil. The surface layers of Middle Nile Delta soils polluted by heavy metals due to irrigation with industrial and residential wastes. All layers of these soils are silty clay texture, thus the heavy metals are high in these soils. Heavy metals pollution were studied by the comparison the concentrations of Fe, Co, Cr, Cu ,Ni, Pb, Zn, and Ba in the soil samples of Middle Nile Delta around and near Kafr EL-Zayat and Tanta cities in different depths with Canadian soil quality guidelines (CSQG) of Canadian Council of Ministers of the Environment[1] and average shale of[2].

Average Fe concentrations in the study area more than the average shale values of[2]. Average Co concentrations of the study area are less than that of CSQG and more than average shale of[2]. Average Cr concentrations of the study area are more than that of CSQG and average shale of[2] . Average Ni concentrations in the soil samples of the study area are higher than that of CSQG and more than average shale of[2] except in sample 1CSC. Average Pb concentrations of the study area are lower than that of CSQG and average shale of[2]. Average Zn concentrations of the study area are lower than that of CSQG and more than that of average shale of Turekian and Wedepohl (1961) except in sample 1CSC . Average Ba concentrations of the study area are lower than that of CSQG and that of average shale of[2]. The organic matter content in the uppermost layer is higher than in the lower layer.

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