IMPACT OF THE ENVIRONMENTAL CONDITIONS AND PHYSIOGRAPHIC POSITION ON DEGRADATION OF SOIL AND WATER RESOURCES AT NORTH FAYOUM DEPRESSION, EGYPT

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ABSTRACT:

This study aims to throw light on the environmental impact as related to soil degradation at north Fayoum depression, with special interest to the heavy metals pollution of some water supplied by a number of drainage canals. This trail was achieved through studying seven sites were carefully selected adjacent to the southern shoreline of Lake Qarun. By nature, these sites are fragile because of constraints imposed by the unique hydrological setting as well as parent material of calcareous in nature, gypsiferous and /or saline and climatic conditions. The obtained results showed wide variations in soil characteristics of these sites, i.e., topographic-sequence (-43 to -28 m), ground-water table depth (65 to > 135 cm), soil texture grades (loamy sand to clay), $CaCO_3$ content (8.1 to 53.3%), gypsum content (2.83-15.65%), organic matter (0.79-3.74 %), soil salinity (EC = 3.8-87.9 dS/m) and sodicity levels (ESP = 7.5-47.3), consequently they differ in their soil taxonomic units and the suitability classes for agricultural purposes. However, wetness, soil texture, $CaCO_3$, gypsum and salinity/alkalinity are the most effective limitations for soil productivity, with an intensity degree ranged between slight and very severe (rating >90 and <40). Also, the suitability classes of the studied soils could be ranged between unsuitable (N1wsıs3n) and moderately suitable (S2wsıs3n) for the current condition as well as moderately suitable (S2sı) and highly suitable (S1s3).

As a general view, soil macro-morphology showed an extremely salinity for some of the studied soils, which is one additional stressor affects the soil characteristics and the nature and distribution of vegetation. In addition, pounded Aquisalids either developed on the soil surface as brittle salt crusts or fluffy almost snow like crust. The oxidation-reduction chemical reactions (redoximorphic) in subsoil layers can cause changes in the soil pH. The micro-morphological features show that the redox concentrations (mottling) are yellowish brown (Jarosite) in the upper stratum, pale yellow (Limonite) in the mid-profile, reddish brown (Hematite) for the upper fringe of water table and yellowish (Goethite) in the deepest portion. The oxidized zone is characterized by dark grayish brown and slight hard due to the dominance of ferric oxides, while the reduced one shows a dark gray and hard, due to the dominance of ferrous oxides. Also, the SO_4^{2-} enriched deposits encouraging the microbial transformed H_2S under the reduction conditions, this medium represents a better environment for transforming amorphous ferric oxides (Fe_2O_3) to be appeared black in the form of pyrite (FeS_2). The prevailing environmental conditions are mostly affected the features of $CaCO_3$ and gypsum, which are found in either biorelicts of shell fragments or orthic lime nodules and intercalary clusters of gypsum crystals.

Soil chemical degradation emphasized by salinity and sodicity levels of the studied soil sites, which are coupled with salinity and sodicity levels of both groundwater table and the neighbouring drains. However, the drainage water will be accumulated and resulting in high more saline groundwater table (within 1.5 m of soil surface), and subsequently waterlogging, high salinization and alkalinization conditions as well as the gleization process, which leads to aquic phase. These conditions led to internal physical, biological and chemical deteriorations as well as led to a reduction in a soil's ability to inactive toxic compounds.

Heavy metal concentrations of either major nutritive (Fe, Mn, Zn and Cu) or non-nutritive (Pb, Cd, Ni and Co) showed a regular distribution pattern in the groundwater table, drainage water in drains and Lake Qarun. Also, their concentrations at the eastern and middle parts of the studied area, generally, contained higher values, and tended to decrease westwards. This may be attributed to the environmental impact of pollution sources which coming from El Batts and El Wadi drains and many anthropogenic activities. Whereas, heavy metals concentrations in soil were mostly related to soil texture, where the clayey soils exhibited higher available contents of all studied heavy metals as compared to both medium and relatively coarse textured ones. This may be due to the former soils had a larger capacity, high CEC, to adsorb these metals from soil solution

Key words: Soil degradation, heavy metals, El Fayoum depression and environmental pollution.

INTRODUCTION:

Soil degradation and pollution with heavy metals are of the most serious problems in the northern part of El Fayoum Governorate. Both major problems caused by poor drainage, which is serious in the lower lying areas, and inadequate soil leaching due to shortage of water needed. At the same time, every amount of water, salts and pollutants flows into or is produced within the depression, if not lost due to seepage or evaporation, will be accumulated and resulting in high groundwater table and subsequently waterlogging, high levels of salinization and alkalization. Such soil chemical degradation leads to a reduction in a soil's ability inactive toxic compounds, depletion of major plant nutrients, accumulation of salts and heavy metals **(Abdel Razek, 1998)**.

Lake Qarun is one of the most important physical features of the northern part of the Fayoum depression. It is an enclosed lake and located in the lowest part of El Fayoum depression, and it has an area of about 53000 acres and a depth range between 0.5 and 10.0 m. It is now a brackish water lake with a maximum chlorosity, however, most of the fresh water fish, which used to inhabit the lake, have disappeared. The volume of water flowing daily into the lake and carrying an amount of fine particles is estimated to be about 100000 m^3. This volume of water represents the excess of irrigation one (18% of the total water supplied to the Fayoum Governorate), which is passed into the lake as drainage water through two main drains, namely El Batts in the eastern part and El Wadi in the western one, in addition to some other minor drains connected to the lake shores.

During the last few years, there is a pronounced change in the water level of Lake Qarun, it is mainly attributed to the variation in both rates of drainage water supply and evaporation. The average water level fluctuates ranged between –43 and –45 m **(Meshal, 1973)**. Thus, any more drainage water would damage the neighbouring agricultural soils **(Bishai and Kirollus, 1980)**. Therefore, Lake Qarun as related to adjacent soil sediments attract attention of many authors because of its historical and scientifically importance to study its unique ecosystem. **Awadalla (2004)** reported that the damage degree for the neighbouring soil areas just adjacent to such inner brackish lake is controlling by the positive interaction between soil variables as affected by shallow groundwater table (waterlogging aspect) under different locally environments.

Pollution by agro-chemicals is particularly dangerous in the Fayoum depression because its enclosed nature. Studies of pollution within water canals (rivers and drains), lakes and soil sediments have been a major environmental focus, especially in the last decades. Such aspects are important sinks for various pollutants like pesticides, current inadequate sewage disposal; heavy-use of agro-chemicals, potential industrial development or human induced activities and solid waste disposal problems. These pollutants play a significant role in the remobiliza6tion of contaminants in aquatic systems under favourable conditions and in interactions between water and soil sediments **(Klavins *et al.*, 2000 and Grosheva *et al.*, 2001)**. So, knowledge of heavy metal concentrations in lake's or canal's water and adjacent soil sediments is desirable to estimate of pollution criteria .as well as for monitoring their widespread and spatial distribution in aquatic ecosystems

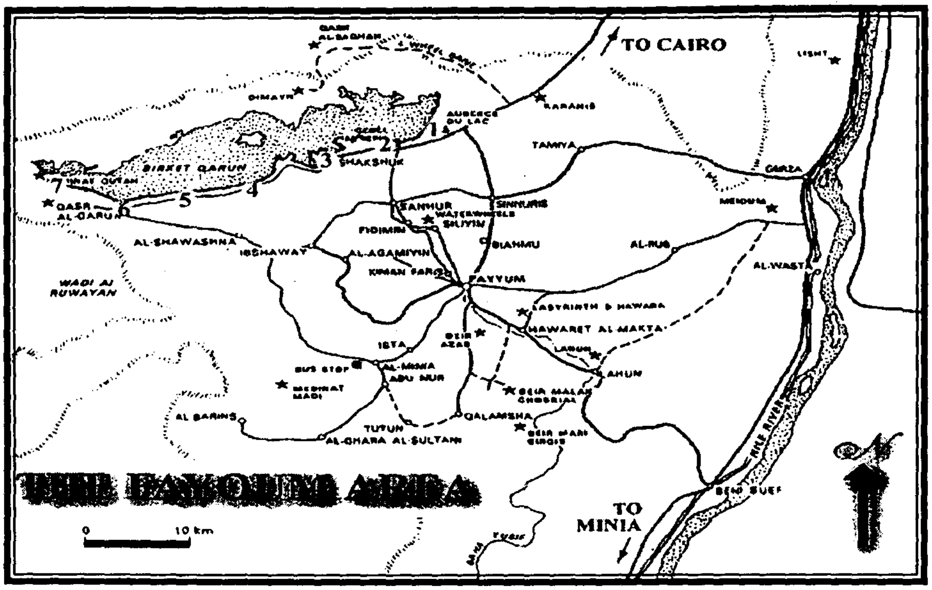
The changes in the elemental aspects of both water resources and deteriorated soils and factors affecting under the conditions of north the Fayoum depression were discussed by few Scientific Investigators such as El Naggar (1990) who found that submergence leads to decrease the soil pH as well as the concentrations of N, P, K, Zn and SO_4^{2-}, especially in the calcareous soil that attained pronounced contents of $CaCO_3$. The reverse was true for Ca^{2+} and HCO_3^-, especially with increasing the period of submergence; these obtained data reflect the effects related to soil origins, the intensity of geochemical weathering, physiographic position and prevailing climatic conditions. Also, **Farrag (2003)** found that the contents of non-nutritive heavy metals showed more pronounced increases towards soils treated with saline drainage water contaminated with sewage effluent at El Fayoum Governorate, where the relative increases reached about 2-4 folds than soils under the favourable conditions. The dominance of such elements follows the descending order of Fe > Mn > Zn > Cu > Pb > B > Ni > Co and Cd. According to the safe scale outlined by **FAO (1992)**, these element contents are still within the permissible ranges.

Concentrations of major heavy metals (Fe, Zn, Mn, Ni, Cu, Co, Pb, Cr and Cd) were determined in three sites representing east, middle and west of Lake Qarun water and adjacent soil sediments by **Mohamed and Fishar (2005)**. The authors stated that the concentrations of the studied heavy metals show gradually increases westwards away from the effect of El Batts drain. This may be attributed to the impact of pollution sources in the drainage water coming from aforementioned drain. They added that these metals tend to accumulate in various tissues of the different biomass organs and cause serious problems in human, animal and plants. They came to a conclusion that it is must to protect Lake Qarun from anthropogenic sources of pollution to reduce environmental risks.

The present work has been undertaken to evaluate the environmental impact and physiographic position of north Fayoum depression as related to soil degradation and pollution with heavy metals.

MATERIALS AND METHODS:

To achieve the aforementioned target, seven soil sites were chosen to represent the areas that suffering from seasonally subjected to submerging, flooding and saturating, due to just adjacent to brackish lake of Qarun, taken into consideration that their sediments are covering the most common parent materials, environmental impacts and physiographic positions, which are characterized the northern part of the Fayoum depression, Fig. (1).



These soils are characterized by low-lying elevation, medium to heavy clay in texture, lack of drainage system and subjected to water seepage from Lake of Qarun or the high-lying elevation alluvial terraces. Table (1) shows a briefly described for the studied area, which represents major freshwater and coastal soils according to **Mitsch and Gosselink (1986)**.

Table (1): A briefly describe for the studied area as major freshwater and coastal soils according to Mitsch and Gosselink. (1986).

Soil types	Forms	Description
NON-TIDAL FRESHWATER	Lacustrine	Partial-saturated areas in the form of lacustrine plains (playas) located adjacent to saline water bodies, less than 30 percent covered by emergent plants.

At the same time, samples of water were taken from the groundwater table and the neighbouring drainage canals to evaluate their salinity and sodicity levels as well as their contents of heavy metal. The chosen soil profiles were dug to a depth of water table, soil samples were collected from all the studied soil profiles at different depths according the morphological features **(FAO, 1990)**, air dried, crushed to pass a 2 mm sieve and analyzed for the main soil physical and chemical properties as well as soil contents of some heavy metals (Fe, Mn, Zn, Cu, Pb, Cd, Ni and Co), as follows:

* Particle size distribution was carried out according to the International Pipette method **(Piper, 1950)** using sodium hexametaphosphate as a dispersing agent **(Richards, 1954)**.
* Calcium carbonate content was measured using the Collin's Calcimeter method **(Wright, 1939)**.

* Gypsum content was determined by precipitation method with acetone **(Richards, 1954)**.
* Organic matter content was determined using the modified Walkely and Black method as described by **Jackson (1973)**.
* Saturation soil paste extract was analyzed for determining ECe, as well as, soil pH was measured in the soil suspension 1:2.5 **(Richards, 1954)**.
* Cation exchange capacity (CEC) and the exchangeable sodium % (ESP) were determined using sodium acetate of pH 8.2 and ammonium acetate of pH 7, respectively **(Richards, 1954)**.
* Heavy metals (Fe, Mn, Zn, Cu, Pb, Cd, Ni and Co) in soil were extracted using ammonium bicarbonate DTPA extract according to **Lindsay and Norvell (1978)**. Their contents in soil extracts were measured by using the Atomic Absorption Spectrophotometer.
* Undisturbed soil samples were taken in Kubiena boxes from the distinguished layers or horizons of the different soil profiles. Thin sections were prepared on the basis of the procedure outlined by **Abd El Hamid (1973)**. Systematic description for the soil sections was recorded according to the systems of **Brewer (1964) and Stoops and Jongerius (1975)**.

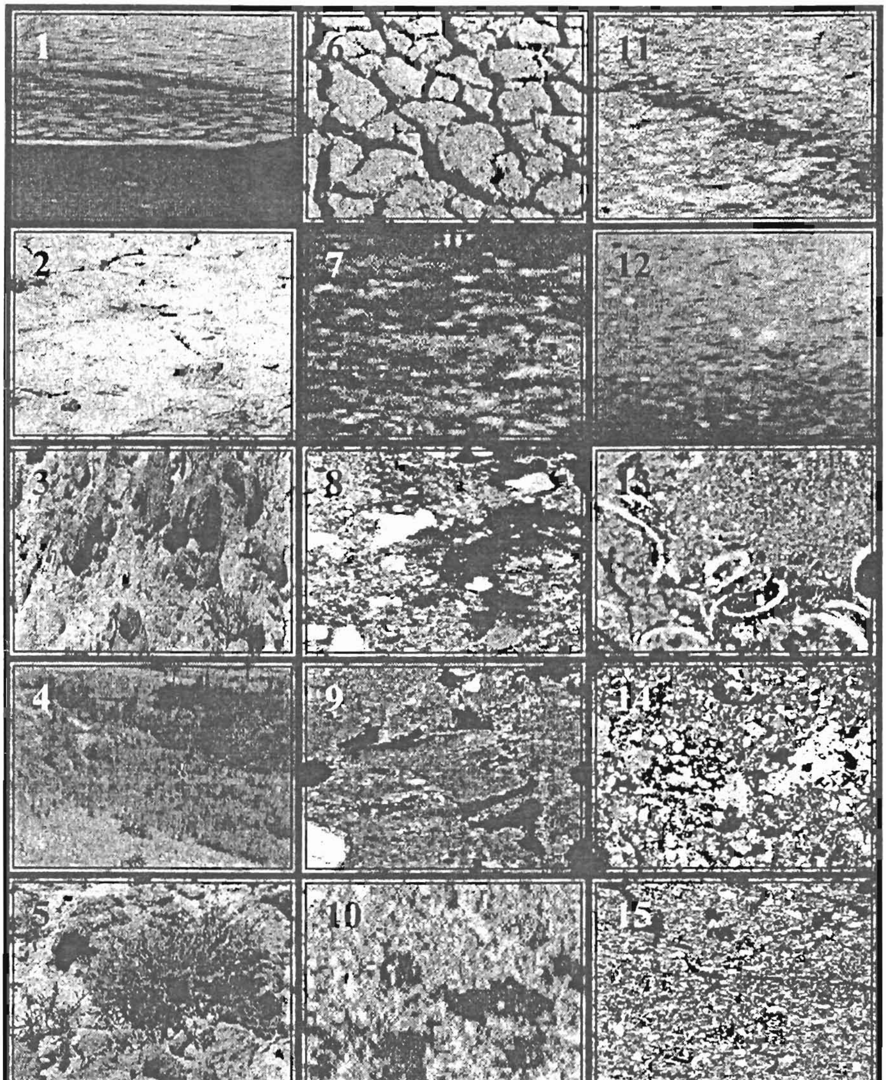
The different analysis of water samples of groundwater table and the drainage canals according to the standard methods outlined by **Black *et al.* (1965) and Page *et al.* (1982)**. The studied heavy metals (Fe, Mn, Zn, Cu, Pb, Cd, Ni and Co) in water samples of the groundwater table and the drainage canals were measured using the Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION:

Regional distribution imbalanced is one of the serious problems in the northern part of El Fayoum area, due to an enclosed nature of the depression, more drainage water flowing down the Lake Qarun vs less fresh one is flowing on the lower part of the depression. The studied soil sites are represented by scattered small areas spread on some localities just adjacent to inner brackish Lake Qarun, and they are mainly developed on different parent materials on geomorphic units under different elevation levels, as shown in Table (2).

Table (2): Location, groundwater table, elevation, parent material and geomorphic unit of the studied soil profiles.

Profile No.	Location	Water table (cm)	Elevation (m)	Parent material	Geomorphic unit
1	2 km west-north Menshat Sannuris	65	-43	Fluvio-lacustrine	Recent lake terraces
2	1.5 km north Ezbet Yousef	85	-42		
3	0.5 west-north Shakshouk	100	-43	Lacustrine	
4	1.5 km north Kahk El Bahriya	105	-35	Fluvio-lacustrine	
5	3 km north El Mesharaq	120	-33		
6	2 km north Ezbet Mezar	130	-28	Colluvial-lacustrine	Old lake terraces
7	0.5 km north Ezbet Abbazah	135	-30		



1. Shallow water table adjacent to enriched shell fragment layer (profile 2).	6. Morphological features (surface cracks) of alkaline soil (profile 4).	11. A better environment for transforming amorphous Fe_2O_3 to pyrite (profile 5).
2. Bounded Aquisalids, brittle salt crust (profile 1).	7. Fe- yellow mottled zones of Jarosite and limonite (profile 2).	12. Undulic plasmic fabric or S-matrix stained with iron oxides (profile 6).
3. Fluffy or almost snow like salt crust (profile 3)	8. Reddish brown vo-hypo-ferric argillans (profile 4).	13. Bio-accumulations of $CaCO_3$ (biorelicts of shell fragments, profile 3).
4. Natural vegetation for moderately saline soil (profile 7).	9. Reddish brown band of hematite at the upper fringe of water table (profile 5).	14. Orthic lime nodule contains skeleton grains (profile 6).
5. Natural vegetation for extremely saline soil (profile 3)	10. Black organo-manganic compounds impeded in S-matrix (profile 1).	15. Intercalary clusters of gypsum crystals (profile 7).

Some macro- and micro-morphological features of the studied soil profiles.

Also, these soil sites, however, in dry climates have formed under high evaporation rates coupled with low effective precipitation, which concentrated salts in the studied soil profiles of these locally wet zones. Therefore, the pedo-morphological features, nature of salt concentrations, geo-origin sources and hydric conditions of these soil sites are of important for studying.

I. Macro, micro-morphological features and some analytical data of the studied soil sites:

The macro-morphology studies showed that the main characteristics that support the soil sites under investigation are wetness, shallow water table (65-135 cm, Photo 1), anaerobic conditions, different soil texture classes (loamy sand to clayey, Table 3), pounded Aquisalids either develop on the soil surface as brittle salt crusts or fluffy and almost snow like crust (Photos 2 and 3). As a general view, an extremely salinity for some of the studied soils (i. e., profiles 1, 2 and 3), which is one additional stressor affects the soil characteristics as well as the nature and distribution of vegetation (Photos 4 and 5), where its hazardous effect includes increasing the osmotic potential of the soil solution as compared to those of lower salinity levels. These morphological feature were emphasized by the obtained analytical data in Tables (3, 4 and 5), which showed soil salinity levels ranged from non-saline to an extremely salinity (3.8-87.9 dS/m).

Table (3): Particle size distribution, total $CaCO_3$ and its distribution among soil mechanical fraction of the studied soil profiles.

Profile No.	Depth (cm)	Particle size distribution%			Texture class*	$CaCO_3$	$CaCO_3$ distribution %		
		Sand	Silt	Clay			Sand	Silt	Clay
1	0-25	12.7	25.4	61.8	Clay	12.5	0.4	2.3	9.8
	25-40	8.6	27.9	63.5	Clay	9.3	0.5	1.2	7.6
	40-65	7.0	30.7	62.3	Clay	8.7	0.3	1.9	6.5
2	0-15	76.3	9.6	13.9	SL	29.7	23.6	4.9	1.2
	15-50	69.2	12.5	18.3	SCL	21.4	16.8	3.1	1.5
	50-85	28.0	21.4	50.6	Clay	11.6	1.1	1.2	9.3
3	0-20	84.4	5.5	10.1	LS	15.9	3.0	11.2	1.7
	20-60	62.6	9.8	27.6	SCL	25.2	3.6	19.3	2.3
	60-100	38.1	13.7	28.2	SCL	12.8	2.7	3.7	6.4
4	0-35	24.1	21.5	54.4	Clay	10.9	0.2	1.8	8.9
	35-70	12.6	28.3	59.1	Clay	9.3	0.4	1.5	7.4
	70-105	5.4	32.9	61.7	Clay	8.1	0.5	0.9	6.7
5	0-40	62.4	11.9	25.7	SCL	26.8	2.5	3.9	20.4
	40-80	64.7	17.1	18.2	SL	15.1	11.6	2.3	1.2
	80-120	21.1	35.4	43.5	Clay	11.8	0.7	1.5	9.6
6	0-25	29.3	38.4	32.3	CL	11.8	0.9	1.2	9.7
	25-80	28.5	41.8	29.7	CL	20.4	1.3	1.9	17.2
	80-130	13.6	62.9	23.5	SiL	8.2	0.5	1.4	6.3
7	0-35	84.7	4.8	10.5	LS	18.4	12.9	4.7	0.8
	35-70	67.3	13.5	19.2	SL	37.9	31.4	5.1	1.4
	70-135	40.7	28.9	30.4	CL	53.3	39.8	7.8	5.7

* LS=Loamy sand, SL=Sandy loam, SCL=Sandy clay loam, CL=Clay loam and SiL=Silt loam

Table (4): Chemical analysis of soil paste extract of the studied soil profiles.

Profile No.	Depth (cm)	ECe (dS/m)	Soluble cations (m molc L^{-1})				Soluble anions (m molc L^{-1})			
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
1	0-25	56.2	33.4	140.3	391.5	2.7	0.00	2.7	430	135.2
	25-40	41.7	39.3	86.8	293.2	1.9	0.00	2.9	298	120.3
	40-65	34.5	29.8	73.9	246.0	1.3	0.00	3.1	232	114.6
2	0-15	27.5	23.8	59.1	196.7	1.1	0.00	2.5	185	92.1
	15-50	22.7	19.5	56.8	153.0	0.9	0.00	2.7	167	60.5
	50-85	16.9	14.7	36.9	118.6	0.8	0.00	3.2	101	69.2
3	0-20	87.9	75.1	218.5	589.0	4.7	0.00	2.4	643	241.9
	20-60	55.2	77.2	115.9	367.0	3.0	0.00	2.6	282	278.5
	60-100	43.8	39.6	109.3	294.0	2.5	0.00	2.7	319	123.7
4	0-35	7.9	7.0	16.0	56.5	1.6	0.40	4.2	48	28.1
	35-70	8.4	8.2	15.1	60.0	1.2	0.80	4.7	54	25.0
	70-105	11.7	10.5	20.7	85.8	0.9	1.30	5.1	69	42.5
5	0-40	8.9	32.4	18.7	38.7	0.9	0.00	2.4	50.	38.3
	40-80	11.7	43.6	21.8	53.1	0.7	0.00	2.5	62	54.7
	80-120	13.4	49.2	27.5	58.2	0.5	0.00	2.6	70	62.8
6	0-25	3.8	9.8	12.9	15.4	0.6	0.00	2.2	20	16.5
	25-80	4.2	11.0	14.4	16.6	0.5	0.00	2.5	23	17.0
	80-130	6.1	16.2	20.9	24.5	0.3	0.00	2.6	27	32.3
7	0-35	4.7	13.1	15.7	17.9	1.2	0.00	2.7	30	15.2
	35-70	6.1	20.2	19.5	20.3	0.8	0.00	3.0	37	21.8
	70-135	9.8	45.7	21.3	32.1	0.6	0.00	3.1	38	57.6

Table (5): Some chemical characteristics of the studied soil profiles.

Profile No.	Depth (cm)	pH (1:2.5 soil susp.)	SAR	ESP	Organic matter %	Gypsum %
1	0-25	7.95	42.01	19.8	3.64	3.92
	25-40	7.83	36.93	24.2	2.85	4.15
	40-65	7.69	34.17	28.5	1.72	6.87
2	0-15	7.85	30.54	10.9	2.96	5.74
	15-50	7.93	24.76	14.6	1.65	6.96
	50-85	8.21	25.35	21.4	0.89	7.25
3	0-20	7.81	48.60	23.9	2.08	2.83
	20-60	7.92	37.33	27.4	1.67	3.90
	60-100	7.98	34.07	31.6	0.92	5.09
4	0-35	8.54	16.67	36.4	3.15	3.79
	35-70	8.69	17.59	41.6	2.32	5.14
	70-105	8.73	21.72	47.3	0.97	7.69
5	0-40	7.67	7.66	9.7	2.46	4.82
	40-80	7.71	9.28	11.2	1.89	7.05
	80-120	7.75	9.40	13.5	0.97	8.63
6	0-25	7.83	4.57	9.7	2.43	5.32
	25-80	7.95	4.66	10.2	1.18	9.57
	80-130	8.12	5.68	8.9	0.79	13.18
7	0-35	8.13	3.79	7.5	1.97	4.17
	35-70	8.20	4.46	9.1	1.25	7.94
	70-135	8.32	5.79	9.7	0.81	15.65

Also, increasing soil pH (> 8.50) and ESP (36.4-47.3%) values, beside the occurrence of soluble CO_3^{2-} (0.4-1.3 m mol_c L^{-1}), are mainly attributed to the dominance of soil alkalinity, as shown at soil site 4 and illustrated in Tables (4 and 5), which reflected the morphological features of surface cracks (Photo 6). The studied micro-morphological features of mottling, in subsoil layers due to redox concentrations, show that the colours of Fe-mottled zones (Photos 7 and 8) are yellowish brown (Jarosite) in the upper stratum, pale yellow (Limonite) in the mid-profile, reddish brown (Hematite, Photo 9) for the upper fringe of water table and yellowish (Goethite) in the deepest portion. The iron transformation accompanied the fluctuation of shallow water table indicates that the oxidized zone is characterized by dark grayish brown and slight hard due to the dominance of ferric oxides, while the reduced one shows a dark gray and hard, due to the dominance of ferrous oxides.

Organo-manganic compounds can cause some redox concentrations to appear black (Photo 10). Fe can be also appeared black in the form of pyrite (Photo 11), which reflects the SO_4^{2-} enriched deposits, then microbial transformed to H_2S under the reduction conditions. These media represent a better environment for transforming amorphous ferric oxides of Fe_2O_3 to FeS_2 (pyrite). Also, gleization process is more pronounced at the subsoil layers, which leads to aquic phase. In addition, some pedogenic Fe-features are represented by either an undulic plasmic fabric stained with iron oxides (Photo 12) or orthic concretions of vo-hypoferri-argillans (Photo 8). Organic matter accumulation (0.79-3.64 %) is an important characteristic of the studied soils due to the heavy density of natural vegetation in some localities (Photo 4), and reduced decomposition of organic materials under the extremely saline media in another ones that result in the development of organic-rich surface soil layers. Also, the oxidation-reduction chemical reactions (redoximorphic) can cause metabolic products of microbial reducing reactions under the anaerobic conditions, and in turn it causes changes in the soil pH.

The studied micro-morphological features of both soil $CaCO_3$ (8.1-53.3 %) and gypsum contents (2.83-15.65 %) reflect the effects of soil origin, intensive of weathering type and environmental conditions, where they are occurred either as a fine fraction (secondary feature of silt and clay in fluvio-lacustrine deposits) or as coarse one (primary form of sand in the colluvial-lacustrine ones) as well as intercalary crystals (gypsum), Tables (3 and 5). These prevailing environmental conditions are mostly affected the features of $CaCO_3$, which are found in the bio-accumulations (biorelicts of shell fragments, Photo 13), secondary stage (orthic lime nodule contains skeleton grains, Photo 14) and gypsum accumulations exhibited as intercalary clusters of gypsum crystals (Photo 15).

II. Soil taxonomy and evaluation:

Based on the obtained data of soil morphology and physico-chemical properties, the soils under investigation could be classified up to the family level into seven taxonomic units according to **Soil Survey Staff (2003)**, as shown in Table (6).

Table (6): Taxonomic units of the studied soils at the family level.

Order	Soil site	Taxonomic unit
Vertisols	1	Aquic Salitorrerts, very fine clayey, smectitic, hyperthermic
	2	Typic Calcigypsids, clayey, smectitic, hyperthermic
Aridisols	3 & 6	Typic Calcigypsids, fine loamy, mixed, hyperthermic
	4	Typic Gypsitorrerts, fine clayey, smectitic, hyperthermic
	5 & 7	Typic Calcigypsids, coarse loamy, mixed, hyperthermic

The results of soil evaluation in Table (7), which are based on the parametric system undertaken by **Sys and Verheye (1978)**, show that the estimated current ratings of the studied soils. The obtained values range between 6.83 and 51.30, indicate that they could be categorized into two classes, i.e., unsuitable (N1ws1s3n) and moderately suitable (S2ws1s3n). For raise their capability potential, smooth land leveling, lowering groundwater table, removing the excess of soluble salts and ESP should be carried out under an efficient drainage ditches as well as applying the gypsum requirements and organic fertilization. Such agro-management practices will be corrected the ratings of soil potential suitability classes to be ranged 65.00-90.00, and potential soil suitability becomes two classes, i.e., moderately suitable (S2s1) and highly suitable (S1s3). It is noteworthy to mention that the prevailing salinization and sodicity, beside the anaerobic condition, represent adversely affecting through unsuitable media for nutrients availability and mechanism of nutrients uptake by plant roots

Table (7): Soil limitations and rating indices for the evaluation of the studied soils.

Soil site	Suitability condition	Topography (t)	Wetness (w)	S: Soil texture (s1)	S: Soil depth (s2)	S: CaCO$_3$ (s3)	S: Gypsum (s4)	Soil salinity/ Alkalinity (n)	Rating (Ci)	Suitability class	Suitability subclass
1	Current	100	35	65	100	100	100	30	6.83	N1	N1ws1n
	Potential	100	100	65	100	100	100	100	65.00	S2	S2s1
2	Current	100	50	85	100	90	100	75	28.89	S3	S3ws1s3n
	Potential	100	100	85	100	90	100	100	76.50	S1	S1s1s3
3	Current	100	70	95	100	90	100	58	34.71	S3	S3ws1s3n
	Potential	100	100	95	100	90	100	100	85.50	S1	S1 s1s3
4	Current	100	50	85	100	100	100	50	21.25	N1	N1ws1n
	Potential	100	100	85	100	100	100	100	85.00	S1	S1s1
5	Current	100	70	95	100	90	100	85	50.87	S2	S2w s1s3n
	Potential	100	100	95	100	90	100	100	85.50	S1	S1 s1s3
6	Current	100	95	100	100	90	100	90	76.95	S1	S1ws3n
	Potential	100	100	100	100	90	100	100	90.00	S1	S1s3
7	Current	100	95	75	100	80	100	90	51.30	S2	S2w s1s3n
	Potential	100	100	75	100	80	100	100	60.00	S1	S1 s1s3

III. Chemical analysis of water samples collected from both groundwater table and the neighbouring drains:

Data in Tables (4, 5 and 8) emphasized that salinity and sodicity levels of the studied soil sites are coupled with salinity and sodicity levels of both underlain groundwater table and the neighbouring drains. The drainage water in the studied areas (the lower lying north part of El Fayoum depression) is a function of an incised drains system developed on the Fayoum depression and the deepest of these drains today carry the Wadi and El Batts drains,.where Lake Qarun receives the drainage water from these drains.

Table (8): Chemical analysis of water samples collected from groundwater table and the neighbouring drains.

Soil site	Water sample	pH	ECe (dS/m)	Soluble cations (m molc L^{-1}) Ca^{2+}	Mg^{2+}	Na^+	K^+	Soluble anions (m molc L^{-1}) CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	SAR
1	G	7.65	41.3	36.6	10.3.1	272.6	3.2	0.00	6. 5	297	112.0	27.13
	D*	7.52	4.3	5.7	8.2	29.1	0.8	0.00	5.2	24.4	14.2	11.02
2	G	7.71	20.6	18.3	51.7	135.0	2.5	0.00	7.2	148.0	53.3	22.80
	D	7.63	3.4	4.8	6.2	24.0	0.6	0.00	6.0	18.0	11.6	10.21
3	G	7.83	59.7	54.0	153.6	393.0	4.7	0.00	6.1	369.0	230.2	38.57
	D	7.71	5.8	11.5	14.4	31.9	2.9	0.00	4.9	32.5	22.3	8.86
4	G	8.15	38.5	41.6	80.3	266.5	3.7	0.00	7.5	235.0	149.6	34.12
	D	7.96	4.7	10.9	12.7	22.5	2.1	0.00	6.4	31.0	10.8	6.54
5	G	7.80	9.8	31.9	20.1	46.4	2.7	0.00	5.3	51.5	44.3	9.12
	D	7.62	2.9	7.0	7.8	12.5	1.5	0.00	6.7	13.3	8.8	4.59
6	G	7.83	5.3	8.4	19.3	23.9	2.1	0.00	7.9	32.5	13.3	6.42
	D	7.77	2.8	6.7	7.5	12.3	1.6	0.00	5.8	12.6	9.7	4.62
7	G	7.95	6.9	11.7	25.2	32.3	1.7	0.00	6.8	42.9	21.2	7.53
	D	7.65	2.8	6.9	7.6	13.2	1.4	0.00	6.1	13.0	10.0	4.87
Lake Qarun		7.92	39.8	32.8	95.9	269.6	4.9	0.00	7.1	294	102.1	33.49

G=Groundwater table and D=Drain

*1=Batts Said, 2= Khour El Heitan, 3= El Sheikh Allam, 4=El Hammam, 5= Batn Ahreit, 6=El Mesharaq & 7=El Eslah.

Consequently, Qarun Lake levels are negatively influenced on the adjacent soils, this is mainly associated with increasing lateral seepage of its saline drainage water to the neighbouring soils and acceleration of the rise in groundwater tables. Concerning the specific soluble ions, it is noteworthy to mention that the soluble cations and anions showed a regular distribution pattern in the extremely saline soils and both groundwater table and drainage water. It could be categorized the soluble ions in the studied water samples at a descending order of $Na^+ < Mg^{2+} < Ca^{2+} < K^+$ for soluble cations vs $Cl^- < SO_4^{2-} < HCO_3^- < CO_3^-$ for soluble anions.

IV. Soil degradation:

Soil degradation status is of the most serious problems in the studied area of north Fayoum depression, due to it is just adjacent to Lake Qarun as well as those with an uncontrolled population growth without a corresponding increase of the efficiency of the soils subsequently. This phenomenon is a specially serious in such lower lying areas, and mostly attributed to poor drainage as well as due to the lateral seepage from the saline water bodies (Lake Qarun). In addition, it is already inadequate soil leaching under shortage of water due to its lying on the tail end areas of the Fayoum depression. So, every amount of water or salts flows into or is produced within this area of the depression, if not lost due to seepage or evaporation, will be accumulated and resulting in high more saline groundwater table (within 1.5 m of soil surface) and subsequently waterlogging, high salinization and alkalinization levels (Tables 2, 4 and 5). One of the categories of human induced activities, soil degradation is internal soil deterioration, i.e., physical, biological and chemical deteriorations. Also, it is noticed that soil salinity and alkalinity levels are therefore the coupled relation between both the neighbouring drainage canals and Lake Qarun water in these lower lying areas within the closed environment of the Fayoum depression.

Therefore, regional distribution imbalanced is one of the serious problems in the Fayoum depression of an enclosed nature, due to more drainage water flowing down the Lake Qarun vs less fresh one is flowing on the lower part of the depression, since the latter is located at the tail ends. Moreover, soil chemical degradation resulted in deterioration of soil structure due to dispersion of stable aggregates by Na and Mg salts, especially in the subsoil layers (sodification) as well as led to a reduction in a soil's ability to inactive toxic compounds. Also, the gleization process is more pronounced at the subsoil layers, which leads to aquic phase, as discussed before. These obtained results are emphasized by the data of salinity map updated in 1995 and outlined by **Abd El Motaleb (1997)** who found that the saline areas (ECe >8 dS/m) increased by about 34346 feddans than those of found in 1982 **(SWRI, 1982)**. The author mentioned also that these recent saline areas are concentrated mainly around Lake Qarun.

V. Pollution of soil and water resources:

Risks serious water and soil pollution in the studied areas in the Fayoum depression are high because of many factors, i. e., current inadequate sewage treatment of the villages which pass for domestic purposes, heavy use of agro-chemical, pesticides, potential industrial development and solid water disposal problems. Such factors caused a pronounced development of toxicities, especially in the paddy fields of the studied soil sites (Table 9).

Table (9): Soluble and DTPA extractable heavy metals in water samples (water table and drain) in $\mu g\ L^{-1}$ and surface layer of soil ($\mu g\ kg^{-1}$) for the studied sites.

Site No.	Sample	Fe	Mn	Zn	Cu	Pb	Cd	Ni	Co
1	S	12016	2307	1695	1101	1407	76	554	413
	G	1085	216	160	135	127	13.6	85	124
	D	743	155	127	93	87	9.7	59	85
2	S	6520	1452	1097	697	863	51	398	302
	G	689	139	108	89	78	9.2	60	83
	D	587	140	113	85	79	8.3	52	72
3	S	5118	1067	865	549	678	42	310	285
	G	1165	231	171	145	136	14.6	91	133
	D	1002	209	169	125	117	13.1	79	114
4	S	10132	2115	1512	1078	1312	72	513	375
	G	987	193	151	129	115	12.5	79	118
	D	812	160	128	104	96	10.6	62	89
5	S	8643	995	789	529	623	41	292	267
	G	782	117	89	78	71	7.8	48	72
	D	518	104	86	72	65	7.2	42	58
6	S	7270	837	675	468	574	37	254	235
	G	369	55	42	37	34	3.7	23	34
	D	478	96	79	66	60	6.5	39	66
7	S	6021	702	563	359	417	25	207	196
	G	473	96	86	68	61	7.1	42	57
	D	502	101	90	71	64	6.7	40	68

S=Soil, G=Groundwater table and D=Drain

At the same time, pollution by agricultural chemical is particularly dangerous because the enclosed nature the Fayoum depression. Nowadays, the main sources of heavy metals are attributed to the heavy metal impurities in fertilizers that reach surface water through agricultural run-off, leaching and drainage flows. Also, the great risk of biocides, particularly persistent herbicides residues, and leaching through the relatively coarse texture into the drainage system and lakes. In this concern, in spite of the reuse of drainage water, either directly or mixed with the Nile water, is initiated to alleviate irrigation water shortages, yet such option causes one of the environmental serious problems due to salts and pollutant contents of drainage water, which negatively reflect on the just adjacent soils (Table 9).

Concentrations of major nutritive (Fe, Mn, Zn and Cu) and non-nutritive (Pb, Cd, Ni and Co) heavy metals were determined in the surface soil layers, underlain groundwater table and the neighbouring drains, beside Lake Qarun. From these data, Table (9), it could be noticed that the concentrations of heavy metals showed a regular distribution pattern in groundwater and both drainage water either in Lake Qarun or drains. At the same time, these water resources (drainage water and groundwater table) at the eastern and middle parts of the studied area, generally, contained relatively high concentrations of soluble heavy metals, then their values tended to decrease westwards away from the effect of both drains, except site 2. This may be attributed to the environmental impact of pollution sources in both parts, which coming from El Batts and El Wadi drains and many anthropogenic activities. These results are in agreement with those obtained by **Mohamed and Fishar (2005)**. In this concern, the clayey soils exhibited higher available contents of all studied heavy metals as compared to both medium and relatively coarse textured ones. This may be due to the former soils had a larger capacity, high CEC, to adsorb these metals from soil solution. The aforementioned two findings are in agreement with those reported by **Dohiem *et al.* (2005) and Reddy and Dunn (1986)**, respectively.

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تأثير الظروف البيئية والموقع الفيزيوجرافى على تدهور المصادر الأرضية والمائية فى شمال منخفض الفيوم – مصر

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تهدف هذه الدراسة إلى إلقاء الضوء على التأثير البيئى وعلاقته بتدهور التربة فى شمال منخفض الفيوم، مع إعطاء أهمية خاصة للتلوث بالعناصر الثقيلة من بعض الموارد المائية المتصلة بعدد من مجارى الصرف. ولقد تحققت هذه المحاولة من خلال دراسة سبعة مواقع مختارة بدقة متاخمة للشاطىء الجنوبى لبحيرة قارون، وبالطبيعة فان هذه المواقع فريدة فى التركيب الهيدرولوجى ومادة الأصل ذات الطبيعة الجيرية الجبسية–الحديدية أو الملحية بالإضافة إلى الظروف المناخية. وتبين النتائج المتحصل عليها أن هناك تباين كبير فى خواص المواقع الأرضية تحت الدراسة ممثل فى تتابع إنحدار سطح الأرض (–٤٣ إلى –٢٨ م)، عمق الماء الأرضى (٦٥ إلى أكثر من ١٣٥سم)، قـوام التربة (رملى طميى– طينى)، المحـتوى من $CaCO_3$ (٨,١–٥٣,٣٪)، الجبس (٢,٨٣–١٥,٦٥٪)، ومادة عضوية (٠,٧٩–٣,٧٤٪)، ملوحة التربة (٣,٨–٨٧,٩ ديسيسيمنز/م)، مستوى الصودية (ESP=7.5-47.3)، ومن ثم فانها تختلف فى وحداتها التقسيمية ودرجات صلاحيتها فى المجالات الزراعية. كما تمثل عوامل الترطيب، قوام التربة، والمحتوى من كربونات الكالسيوم والجبس، والملوحة والقلوية أهم المحددات لإنتاجية التربة بدرجات شدة تتراوح بين بسيطة–شديدة جدا (٩٠<–٤٠>)، وتراوحت درجات الصلاحية بصورتها الحالية ما بين متوسطة (S2s1s3n) إلى غير صالحة (N1ws1s3n)، وتصل بقدرتها الكامنة إلى عالية الصلاحية (S1s3)، متوسطة الصلاحية (S2s1).

وبنظرة عامة، فان الوصف المورفولوجى للتربة يبين تأثرها بمظاهر الملوحة الشديدة فى بعض المواقع تحت الدراسة، والتى تعتبر واحدة من العوامل شديدة التأثير على خواص التربة وطبيعة وتوزيع الغطاء النباتى الطبيعى. بالإضافة إلى أن مظاهر التملح (Aquisalids) السطحى تظهر فى صورة قشرة ملحية هشة أوقشرة إسفنجية شبيهة بقشرة البرد، مع حدوث تفاعلات كيميائية أكسدة–إختزال (Redoximorphic) فى طبقات تحت التربة مصاحبة لتذبذب مستوى الماء الأرضى تسبب عنها تغيرات فى قيم الـــSoil pH. وتوضح المظاهر الميكرومورفولوجية أن تركيزات الـRedox (التبقع اللونى) تأخذ اللون البنى المصفر (معدن الجاروسيت) فى الجزء العلوى، والأصفر الباهت فى منتصف القطاع (معدن الليمونيت)، والبنى المحمر (معدن الهيماتيت)، والمصفر (معدن الجيوثيت) فى الجزء السفلى عند الحافة العلوية للماء الأرضى، كما تتميز منطقة الأكسدة باللون البنى الرمادى الداكن وضعف الصلابة لسيادة أكاسيد الحديديك، بينما منطقة الإختزال بالصلابة واللون الرمادى الداكن لسيادة أكاسيد الحديدوز. كما وأن غنى الرسوبيات بأنيون SO_4^{2-} يشجع من تكوين كبريتور الأيدوجين بفعل النشاط الميكروبى تحت ظروف الإختزال، ومثل هذه الظروف البيئية تعتبر وسطا جيدا لتحويل أكاسيد الحديديك الأمورفية إلى كبريتيد الحديد (معدن البيريت ذات اللون الأسود). وتؤثر الظروف البيئية السائدة على مظاهر التكوينات الكالسية ممثلة فى كل من كربونات الكالسيوم والجبس حيث تتواجد فى شكل Biorelicts of shell fragments and orthic lime nodules بالنسبة لكربونات الكالسيوم أو Intercalary clusters of gypsum crystals بالنسبة للجبس.

ويتأكد التدهور الكيميائى للتربة فى منطقة الدراسة بسيادة مستويات التملح والصودية ، والتى تتزاوج مع مستويات ملوحة وصودية كل من الماء الأرضى ومجارى الصرف المجاورة، حيث يتجمع ماء الصرف ويتسبب فى إرتفاع مستوى الماء الأرضى المالح فى عمق ١,٥٠م من سطح التربة، ومن ثم مظاهر الغدق والتملح والقلوية وعملية الجلاى . ومثل هذه الظروف قد أدت إلى حدوث تدهور فيزيائى وحيوى وكيميائى بجانب حدوث إختزال فى التربة وقابليتها إلى تكوين مركبات سامة غير نشطة. وتبين النتائج أن هناك توزيع متناسق لتركيزات المعادن الثقيلة– سواء كانت ضرورية أو غير ضرورية للنبات– (Fe, Mn, Zn, Cu, Pb, Cd, Ni and Co) ما بين الماء الأرضى ومياه الصرف وكذا مياه بحيرة قارون. كما وأن تركيزاتها فى الجزئين الشرقى والأوسط من المساحة المدروسة كانت ذات قيم أعلى نسبيا من باقى المواقع حيث تتجه إلى الإنخفاض صوب الغرب، وربما يرجع ذلك إلى التأثير البيئى لمصادر التلوث الواردة من مصرفى البطس والوادى وكثير من الأنشطة البشرية. كما وأن تركيزاتها ترتبط بقوام التربة، حيث تظهر الأراضى الطينية قيما أكبر لقدرتها على إدمصاص قدر أكبر من محلول التربة وذلك لإرتفاع قيم سعتها التبادلية الكاتيونية مقارنة بالأراضى خشنة القوام. وهذه النتيجة تدعو إلى التفكير الجدى فى وضع خطة مستقبلية للإحالة دون حدوث نمو فى التلوث البيئى من مصادره المختلفة فى هذين الموقعين.