Egypt. J. Soil Sci. **45**, No. 4, pp. 481 - 489(2005)

Pedological Studies and Land Capability on the Soils Adjacent Qarun Lake, El - Fayoum Depression, Egypt, Part (I)

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THE SOILS adjacent Qarun Lake is about 13632 feddan representing 3.3% of the total area of El Fayoum Depression. These soils include three geomorphic units, which are Nile alluvial deposits. Desertic formation and interference zone between lacustrine and desertic deposits. This study aims to classify the soils according to the relation between salinity and water table and land capability assessment of some parts south Qarun Lake. These soils have been developed under arid conditions with different parent materials. Drainage played an important role in the soil formation through the effect on the salinization of the soil. The soils have been classified using the American Soil Taxonomy (2003) to the sub group level as, Typic Haplocalcids, Typic Haplosalids, Typic Haplotorrerts, and Typic Torrifluvents. Arc _GIS 9.0 software was used in this study for soil units and land capability mapping. The correlation between soil salinity and ground water depth were carried out, consequently the soils were classified to nine units the given data reveals that the most of the studied soils are threaten by water logging and soil salinity. The obtained data reveal that the ground water depth ranges between 25 and 105 cm and the soil EC is 1.4 to 17.00 dS/m. According to land capability results the studied area has been classified to two main groups as:

Class III: These soils are high $CaCO_3$ content, high alkaline and poor drainage system.

Class IV: These soils are highly saline, alkaline and poor drainage system; these soils give very low yield.

Keywords: El - Fayoum Depression, Salinity, Water table, Land capability.

El- Fayoum Depression is a circular old deep depression at the northern part of the Western Desert of Egypt between 29° 10′ to 29° 34′ latitude and 30° 15′ to 31° 06′ longitudes (Fig. 1). The depression is about 1704 km² (*i.e.*, 408960 feddan). Almost about 1588 km² (381120 feddan) are the cultivated area. Qarun Lake is deepest part of the depression; the level of its surface is - 45 m (b. s. l) the lake has an elongated slope with along axis laying east-west direction. The major part of depression shapes to the northwest direction from about +23 m (a.s.l.) to – 45 m (b.s.l.).

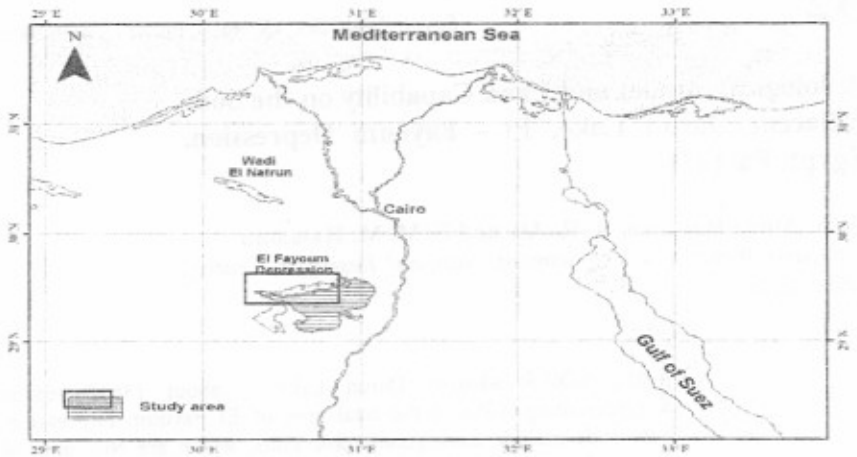


Fig.1. Location of the study area .

According to Abu El- Einane (1977); Hammad, & Abu El–Eniane (1983); Abdel All (1984); Shendi (1984); Ghabour (1988); Khatter & Khandil (1989) and Abd El-Razek, (1998). The main geomorphic units in the area are alluvial deposits, interference zone and desertic formation. These units include different landforms, *i.e.*, lake terraces, basins, gullies, abandoned channels, depressions and escarpments. The soil parent materials are of two types; transported or residual, in both types there is no much differentiation and it is only confined to the formation of salic, gypsic, calcic, and gley horizons. The properties of the depression soils are controlled by their position as it being effect by their nearness to the limestone cliffs and the depth of the water table. The soil texture varies from clayey to sandy soils, $CaCO_3$ content ranges from 0.86 to 68.1 % and the soil profiles are shallow to deep. The soils of the depression are classified into three orders, Vertisols, Entisols and Aridisols. The major parts of the depression soils are Vertisols which have deep water table and high content of clay (more than 35% clay), the Entisols soils are found in the middle and north western parts, where the soils of Aridisols are found in different patches in the middle and north eastern parts. The depression is a lacustrine sedimentary basin which has under gone alternating periods of erosion and deposits.

The irrigation water in the depression is amount to 2 million m^3 / year supplied from the Nile by Bahr Yousef. Most of cultivated area in El-Fayoum Depression is drained by gravity through two main drains, these are El-Batts and El-Wadi Drains.

El-Fayoum Depression characterized by long hot and dry summers, wild cold winters, with scanty rainfall. The mean annual temperature ranges between 28° and 21.4 C°, the annual maximum temperature differ from 28.8° to 29.5°, and the minimum from 13.6° to 15.6°. El Fayoum receives a very low amount of rainfall,

where the average rate is located between 9-17 mm/year. The mean annual relative humidity ranges between 28 and 67% The depression is a lacustrine sedimentart basin which has under gone alternating periods of erosion and deposits (CLAC, 2004).

Material and Methods

Nine soil profiles were chosen (Fig. 2), the morphological descriptions were carried out according to guideline for soil description (FAO, 1990), soil color were determined using Munssel Color Charts (1975). Soil samples were collected from the different layers and horizons, samples were air-dried and sieved through 2 mm sieves, physical and chemical analyses were carried out using the Soil Survey Laboratory Methods Manual (USDA, 2003). Soils were classified according to the American Soil Taxonomy (USDA, 2004).

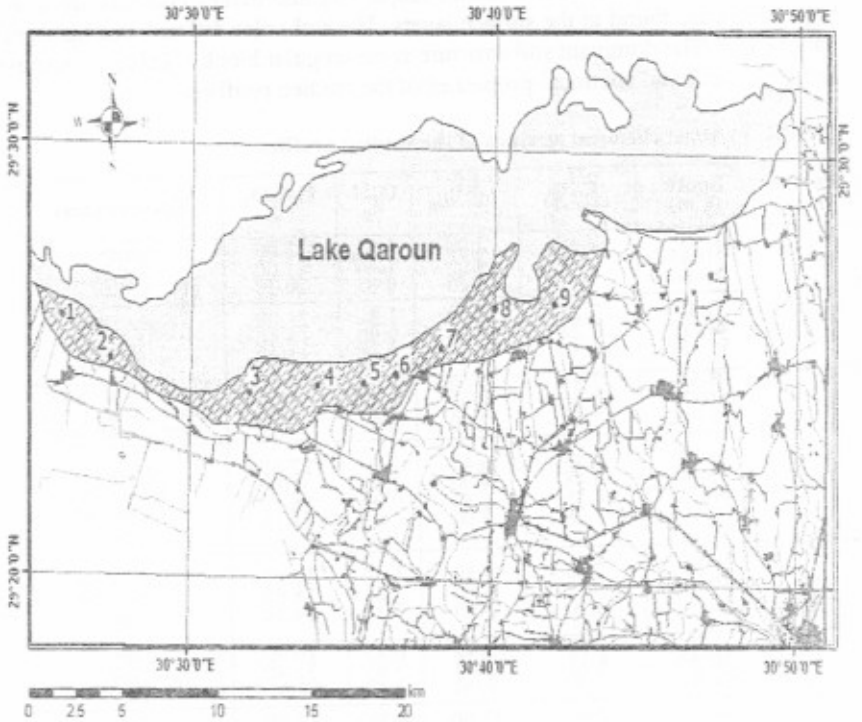


Fig. 2. Location of the studied soil profiles .

Land capability was classified to classes and sub classes using the methodology developed by Klingebile & Montgomery (1961) based on soil physical and chemical characteristics and climatic condition.

Arc-GIS 9.0 software has been used as the main software of Geographic Information System, for geometric correction and mapping.

Results and Discussion

According to field studies and laboratory analyses, the soils of the studied area are covered by salt crust from 1 to 4 cm thick in different parts and the drainage condition is imperfectly too poor. The texture class of these soils varied widely between sandy to clay texture. The water table depth is less than 100 cm from the surface in the most studied profiles. The pH values ranged between 7.2 and 8.8, soil salinity varied between moderate and high saline as the EC values differ from 2 to 17 dS/cm. The EC values are decreased with depth in the studied profiles except profile no. 8. These soils are moderate alkaline, CaCO3 percentage ranged between 6.0 and 32.4 %, the high values are found in the subsurface layers of profiles 5, 6 and 7 and deep layer of profile 4 . Most of the CaCO3 are mainly found as concretion form in different size and shape. Organic matter contents are low, the high values are found in the surface layers. The soil color differs from light gray to dark brown. The dominant soil structure is sub-angular blocky. Table 1 represents some physical and chemical properties of the studied profiles.

TABLE 1 . Some chemical analysis of the studied profiles .

Profile no.	Depth (Cm)	pH_{es} (1:2.5)	EC (dS/m)	O.M %	$CaCO_3$ %	Texture class
1	0-10	7.49	2.00	1.95	22.00	Sandy
	10-45	7.55	4.00	1.40	21.00	Sandy
	45-60	7.41	3.75	0.65	20.35	Sandy
2	0-40	7.20	7.00	1.30	21.00	Silty Clay
	40-55	7.24	8.00	0.90	16.50	Silty Clay
	55 - 80	7.30	7.00	0.65	13.00	Silty Clay
3	0-50	7.89	2.00	1.90	17.50	Loamy Clay Sand
	50-75	7.60	2.00	1.30	8.00	Loamy Clay Sand
	75 - 90	7.50	2.00	0.85	6.00	Loamy Clay Sand
4	0-35	8.43	6.40	1.30	22.60	Clay
	35-60	8.48	4.00	1.10	9.00	Loamy Clay
	60-75	8.25	6.80	0.90	26.20	Loamy Clay
	75-105	8.28	7.00	0.65	31.10	Clay
5	0-30	7.98	4.30	3.67	16.00	Loamy Clay
	30-50	8.12	5.40	3.24	18.60	Loamy Clay
	50-90	8.00	5.20	2.10	24.50	Clay
6	0-30	7.92	3.40	6.15	16.00	Clay
	30-50	8.13	3.00	5.85	32.40	Clay
	50-90	8.03	5.00	3.12	7.00	Clay
7	0-20	7.83	17.00	6.35	11.30	Clay
	20-55	7.74	16.20	4.35	13.20	Clay
	55-90	7.72	12.00	3.12	11.00	Clay
8	0-15	7.92	8.20	5.15	15.60	Clay
	15 - 45	7.88	9.40	3.40	15.50	Clay
9	0-30	8.80	2.00	1.70	13.20	Loamy Clay
	30-55	8.54	1.70	0.98	12.00	Loamy Clay
	55-85	8.58	1.40	0.78	10.00	Loamy Clay

According to Soil Taxonomy basis (2003), these soils could be classified as:
Haplocalcids, as found in soil profiles no. 1, 2 and 6
Haplosalids, as found in soil profiles no. 7 and 8
Haplotorrerts, as found in soil profiles no. 4 and 5
Torrifluvents, as found in soil profiles no. 3 and 9

The water samples were collected from different sources, the chemical analyses of the collected samples are given in Table 2. The obtained data reveal that the pH and EC values are 7.05 and (EC) 30 dS/cm in the Qarun Lake water. The water table has a pH value ranges from 6.8 to 7.9 and EC from 7.4 to 34 dS/cm. Irrigation water has a pH value ranges from 7.1 to 8.1 and EC from 2.6 to 4.0 dS/cm. Drainage water has a pH value differ from 7.2 and EC of 9.6 dS/cm.

TABLE 2. Some chemical analysis of the water samples.

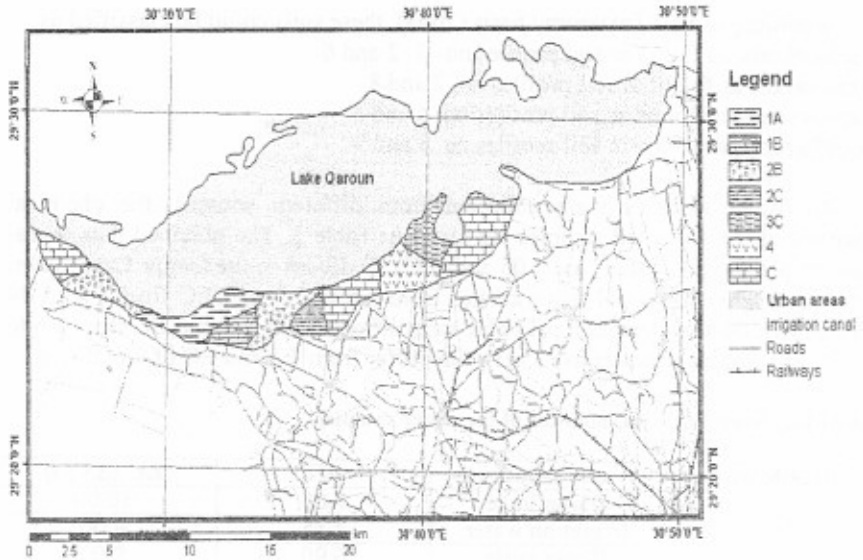
Profile no.	Water resources	pH	EC (dS/m)
--	Qarun Lake	7.05	30.00
1	Irrigation water	7.15	4.00
1	Water table	6.90	8.00
4	Irrigation water	7.98	2.65
5	Water table	7.93	8.40
9	Irrigation water	8.16	2.70
9	Water table	7.35	7.40
9	Drainage water	7.2	9.60

The high values of the groundwater salinity due to the intrusion of lake water, this will be affecting the soil salinity, as it has high evapo-transpiration condition. The Ec of irrigation water is rather high as it reaches to 4.0 dS/m in some areas, so that the leaching requirements and water management are highly recommended.

Table 3 shows the soil classes based upon the relation between the soil salinity and water Table. The obtained data indicate that the soils classes ranges between 1A and class 4 as show in Map 1.

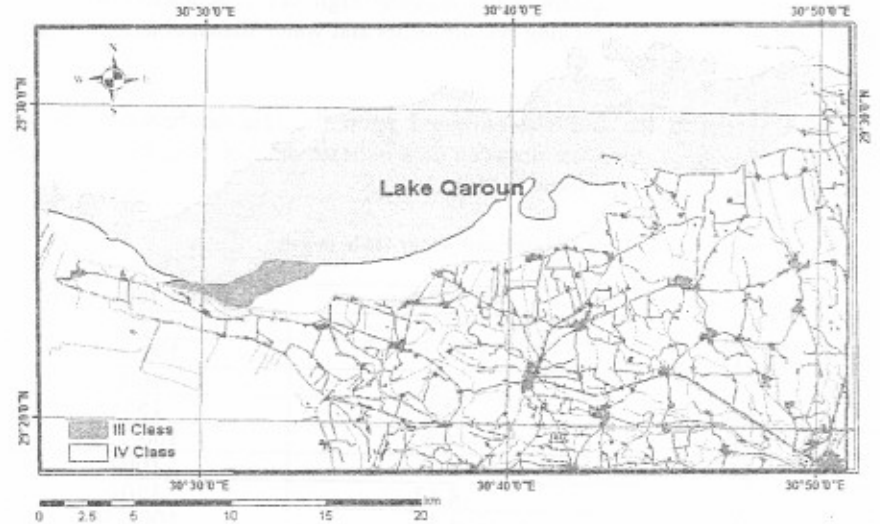
TABLE 3. Relation between salinity and water table depth .

Soil unit	EC (dS/m)	Water table (Cm)
1A	0-4	150<
1B	0-4	100-150
C	0-4	100>
2A	4-8	150<
2B	4-8	100-150
2C	4-8	100>
3A	8-12	150<
3B	8-12	100-150
3C	8-12	100>
4	12<	150



Map 1. Distribution of the soil units in the studied area.

The land capability of the investigated areas was classified based on the factors of wetness, salinity, alkalinity, soil depth, slope, texture class, erosion, CaCO3 content and climate Map 2. Then the soils were grouped into two classes whish as III and IV where:



Map 2. Land capability classes in the studied area.

Class III: represented by profiles no. 3 whish has high CaCO3 content, high alkaline and poorly drained condition. These soils give a moderate yield production, and need careful management to decrease alkalinity and improvement the drainage condition.

Class IV: represented by the soil profiles no. 1, 2, 4, 5, 6, 7, 8 and 9, these soils are highly saline, alkaline, and poorly drained. The yield production in these soils is low because of sever limiting factors. These soils need to salt leaching and drainage improvement.

Conclusion

The soils adjacent to Lake Qarun are shallow, poorly drained, low moisture holding capacity, saline, alkaline and have a saline ground water. So these soils need a careful management especially for irrigation, drainage. Removing gravels and salt crust, and leaching are much recommended for improving the land capability.

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(*Received* 6/2005;
accepted 11/2005)

دراسات بيدولوجية و القدرة الانتاجية للاراضى المتاخمة لبحيرة قارون

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تبلغ مساحة الأراضى المجاورة لبحيرة قارون حوالى ١٣٦٣٣ فدان ، وتمثل حوالى ٣,٣٪ من المساحة الكلية لمنخفض الفيوم . تشمل هذه الأاراضى ثلاث وحدات جيومورفولوجية هى : الترسيبات النهرية ، التكوينات الصحراوية و منطقة التداخل بين الترسيبات البحيرية و الصحراوية. و تطورت هذه الأاراضى تحت الظروف الجافة ومواد أصل مختلفة. و للصرف دور فعال فى تكوين هذة الاراضى نظراً لتأثيرة على ملوحة التربة. تم اختيار ودراسة تسعة قطاعات أرضية ممثلة للوحدات الأرضية المختلفة لهذه المساحة وتم تقسيم هذه الأاراضى باستخام التقسيم الأمريكى (٢٠٠٣) حتى مستوى تحت المجموعة كما يلى :

Typic haplocalcids, Typic haplosalids, Typic haplotorrerts, and Typic torrifluvents

وتمت دراسة العلاقة بين ملوحة التربة و عمق الماء الأرضى و بناء على هذه العلاقة تم تقسيم هذه الأراضى الى تسعة (٩) وحدات. ومن البيانات المتحصل عليها يتضح أن عمق الماء الارضى يتراوح بين ١٥-١٠٥ سم ، و تتراوح ملوحة التربة بين ١,٤-١٧,٠٠ ملليموز / سم . و فى هذة المنطقة تظهر خطورة أرتفاع مستوى الماء الارضى و ملوحة التربة .

تم تقسيم هذه الأراضى الى مجموعتين (٢) من حيث القدرة الانتاجية و هى : الدرجة الثالثة (III) و تتميز هذه الأراضى بارتفاع محتواها من كربونات الكالسيوم ، ارتفاع القلوية و نظام صرف ردئ، والدرجة الرابعة (IV) و تتميز بارتفاع محتوى الملوحة و القلوية لها و رداءه نظام الصرف و إنتاجها المحصولى منخفض جداً.