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SPATIAL DISTRIBUTION OF SOIL CALCIUM CARBONATE, SALINITY, PH, SOIL TEXTURE AND ORGANIC MATTER CONTENT IN YOUSSEF EL-SEDIK DISTRICT AREA, FAYOUM GOVERNORATE, EGYPT

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ABSTRACT

Spatial distribution of soil salinity, alkalinity, calcium carbonate, organic matter and soil texture (grid system-log distance of 2 km) was identified and mapped throughout Youssef El-Sedik District area, Fayoum Governorate, Egypt, using ARC- GIS format. It was found that the ECe ranged between 0.68 and 132 dSm^{-1} and from 0.92 to 82 dSm^{-1} within the upper 10 cm and the (10 – 50 cm) soil layers, respectively. The data showed that 91.23 % and 78.97 % of the study area within the upper10cm and the (10 – 50 cm) layers respectively have ECe > 4 dSm^{-1}. About 47.62 and 30.39 % of the district soils have ECe values > 10 dSm^{-1} within the upper and subsurface layers, respectively, indicating that salt- affected soils are distributed throughout the study area. About 92.53 % of soils were calcareous (> 10 % $CaCO_3$ equivalent) due to the nature of parent material from which soils of the study area are evolved. Soil pH more than 7.5 was found in about 46.69 % and less than 1 % of soils have pH values > 8.0 with a greatest pH value of 8.2. The organic matter contents seldom exceeded 2 % in Youssef El-Sedik soils. Several different soil texture classes were found, however 46.38 % and 42.65 % of the soils were of clay texture within the (0 – 10 cm) and (10 – 50 cm) layers, respectively.

Key words: *calcium carbonate, salinity, soil texture, organic matter, Youssef El-Sedik, Fayoum.*

1. INTRODUCTION

Fayoum Governorate, is a large depression in Egypt located about 90 km southwest of Cairo, between latitudes 29 15 and 29 30 N and longitudes 30 15 and 30 45 E. It occupies 6,068.7 km^2 including two artificial lakes at Wadi El Rayan, in addition to the natural Lake Qaroun. The climate is arid with an annual average rainfall of 8 mm, and some years of no rainfall at all, while in some cases as much as 44 mm rainfalls in 1 day (Walter 1950).

The Governorate includes six administrative Districts, namely, Fayoum, Tamia, Etsa, Sinnuris, Ebshway, and Youssef El-Sedik. The study land area throughout Yousef El- Sedik District is about 388.5 km^2.

According to several researches (Hanna and Labib 1977; Shendi 1984) the Fayoum depression formation belongs to three groups of sediments of distinctly different origins: river Nile, lacustrine and desert sediments forming four terraces. The studies of Hammad *et al.* (1983) showed that the soils of Fayoum belong to three soil orders: Vertisols, Entisols, and Aridisols. The soils are expected to face the problems of salinity, alkalinity, calcium carbonate and high water table all over the depression area with a variability in their extent and spatial distribution due to variations in soil topography, slope, quality and available amount of irrigation water, drainage system and nearness to Lake Qaroun.

Studies of Abd Elgawad *et al.* (2013) on Tamia (344.4 km^2) and Fayoum (425.2 km^2) Districts and those of Howaida (2016) on Sinnuris District showed the levels of soil calcium carbonate, salinity, alkalinity, organic matter and soil texture throughout the land area of the three Districts. Very little information are available in the literature concerning the levels and spatial distribution of such properties throughout Youssef El- Sedik District area. Therefore, it is necessary to generate basic soil information which are important for better soil management and land use for Youssef El-Sedik District.

The present work was designed to study the levels, extent and spatial distribution of soil

salinity, alkalinity, calcium carbonate, organic matter, soil texture and pH throughout Youssef El –Sedik District area using ARC GIS format.

2. MATERIALS AND METHODS

Surface (0 – 10 cm) and subsurface (10 – 50 cm) soil samples were collected during the years 2012 and 2013 from 69 sites representing Youssef El-Sedik District soils. Samples were collected using a grid system at a distance of 2 km. Location of the investigated area is shown in (Fig.1). Sampling sites (Fig. 2) were identified using the global positioning system "Garmin GPS".

Soil samples were air-dried, gently ground to pass a 2-mm sieve and stored in plastic bottles. Soil samples were analyzed for the following characteristics: particle-size distribution by the adapted hydrometer method (ASTM No. 152H Temp.) using sodium hexameta phosphate-sodium carbonate as dispersing agents (Bouyoucos, 1962): Calcium carbonate content was measured using Sheibler's calcimeter as described by Houba *et al.* (1995) and pH in saturated soil paste using a pH meter. The electrical conductivity of soil saturation paste extract (ECe) was measured using a conductivity bridge as described by US Salinity Lab Staff (1954). Organic matter content was determined using Walkley and Black method (Jackson 1979).

2.1. Mapping

Levels of the studied soil characteristics were classified into different categories (ranges), their geographical distribution throughout the whole area of Youssef El-Sedik District were identified and mapped using the interpolation capabilities of ARC GIS software to produce the different soil maps of each tested component.

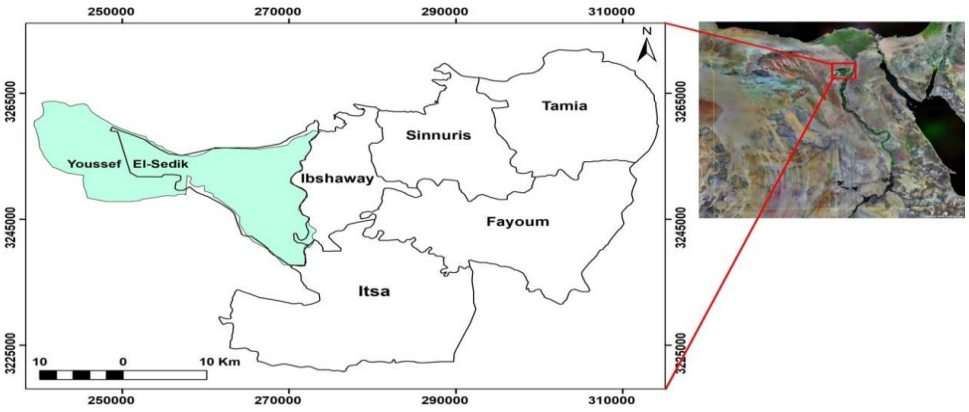

Fig. (1): Location of the investigated area (Youssef El-Sedik District) within Fayoum Governorate, Egypt.

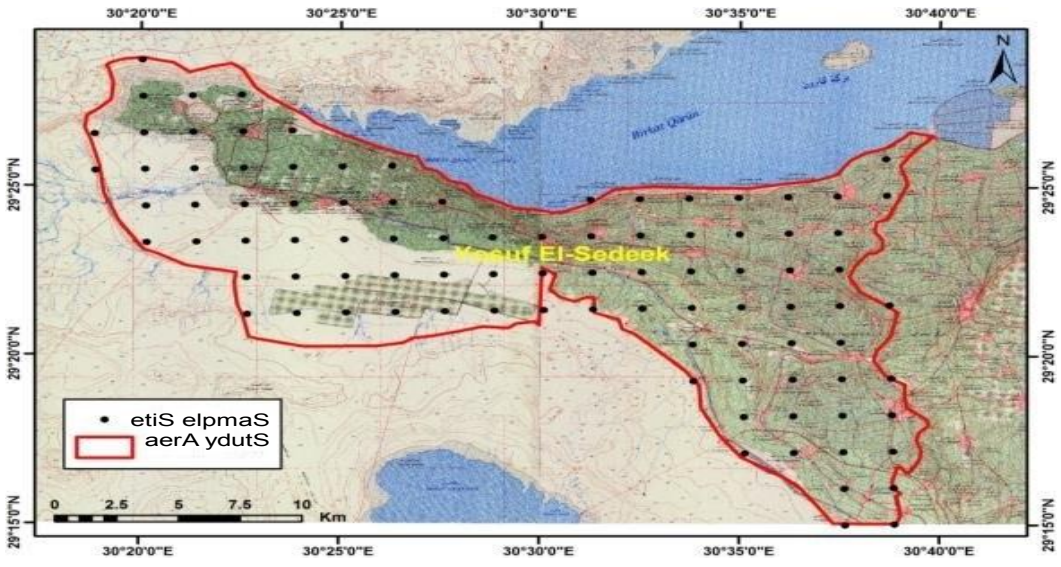

Fig. (2): Location of soil sampling sites throughout Yousef El-Sedik District area.

3. RESULTS AND DISCUSSION

3.1. Soil Salinity

The levels of ECe values in the soils of Youssef El-Sedik District area are given in Table (1). Soil salinity maps are shown in Fig. (3and4). It could be observed from the data that the soils suffer soil salinization.

The data showed that the levels of ECe within the upper 10 cm layer ranged between 0.68 dSm^{-1} and 132 dSm^{-1} with a mean value of 10.81 dSm^{-1}, while ECe values for the (10 – 50 cm) soil layer ranged between 0.92 and 82 dSm^{-1} with a mean of 7.33 dSm^{-1}. It was found that the salinity level (ECe > 4 dSm^{-1}) exist in 91.23 and 78.97 % of the District within the upper 10 cm and the 10 – 50 cm layers, respectively. About 47.62 and 30.39 % of the study area have ECe values > 10 dSm^{-1} in the upper and subsurface layers respectively.

The mean of ECe values within the upper 10 cm and the 10 – 50 cm soil layers indicated that the greatest ECe value and general mean were greater in the upper 10 cm in comparison with those of the subsurface one. Such accumulation of salts within soil surface could be due to the upward translocation of ground water and high evaporation rate under the hot arid climate of the study area.

The greatest soil salinity levels in terms of ECe values were found in scattered sites throughout the District area with no evidence for significant direct effect of the very high salinity of Lake Qaroun on soil salinity, emphasizing the influence of topography, high water table, and parent material, poor drainage and management on salinization in Youssef El-Sedik District area.

Effective control of soil salinization in the study area is impractical due to limited availability of Nile water and the limited extension of using mixed water (agriculture drainage with Nile water) to irrigate wide areas. However, salt affected areas in the District could be managed through soil improvement by appropriate land use, suitable agricultural practices and management, efficient drainage and irrigation systems, selection of salt-tolerant plant species based on salinity problem, and soil management.

3.2. Soil pH

The data presented in Table (2) indicated that soil pH in the upper layer (0 – 10 cm) ranged between 7.00 and 8.13. While pH values of the subsurface layer (10 – 50 cm) ranged between 7.00 and 8.2. the data indicated the absence of sodic alkaline soils (of pH ≥ 8.5) within the upper 50 cm throughout the District area. The data also indicated that the pH values of more than 99 % of Youssef El-Sedik District soils ranged between 7 - 8 within both the upper 10 cm and the 10 – 50 cm layers. This could be due to the presence of $CaCO_3$ at high levels in Youssef El-Sedik District lands. More than 92 % and about 88 % of the District soils have more than 10 % of $CaCO_3$ equivalent within the upper 10 cm and the 10 – 50 cm layers, respectively.

The spatial distribution of soil pH levels within the two studied depths in the different parts of Youssef El-Sedik District are shown in Fig. (5 and 6). Slight differences, with no trend were observed between the upper and the subsurface soil layers in their pH values.

3.3. Organic matter content in soils

The data in Table (3) and Figs. (7 and 8) show that soil organic matter contents of the upper 10 cm ranged between 0.26 and 2.27 % with a mean of 1.24 %. The organic matter contents ranged between 0.06 and 2.19 % with a mean of 1.36 % within the subsurface soil layer 10 – 50 cm.

The data indicated that the organic matter contents are generally higher in the upper soil layer 0–10 cm than those of the 10 –50 cm layer.

Data of the present work emphasized the poorness of Youssef El-Sedik District soils in their organic matter content and their need to sufficient yearly applications of organic fertilizers and biofertilizers in order to improve soil physical, chemical properties and fertility status that will ultimate increase crop production.

3.4. Calcium carbonate content in soils

The data in Table (4) showed that calcium carbonate contents within the upper soil layer 0 – 10 cm ranged between 3.24 and 81.38 with an average of 15.04 % and ranged between 3.57 and 51.04 with an average of 14.02 % in subsoil layer 10 – 50 cm.

More than 91% and about 87.75 % of soils of study area had more than 10 % $CaCO_3$ within the upper 10 cm and the 10 – 50 cm soil layers, Respectively (Table (4) and Figs. 9 and 10). Such high soil calcicity could be due to the calcic nature of the parent material from which soils of the study area are evolved.

3.5.soil texture

The distribution of clay contents in Youssef El-Sedik District area is presented in Figs. (11, 12) and Table (5). About 68.12 % of the studied soils contain ≥30 % clay within the upper 10 cm; however 64.71 % of soils contain ≥ 30 % clay

Table (1): Levels of ECe values in the soils of Youssef El-Sedik District area.

Soil depth (cm)	ECe (dSm^{-1})	Area (ha)	% of District area
0 – 10	0.68 - 4.00	3173	8.77
	4.01 - 10.00	15775	43.61
	10.01 - 20.00	13951	38.57
	20.01 - 40.00	2399	6.63
	40.01 - 80.00	739	2.04
	80.01 - 100.00	86	0.24
	100.01-132.00	52	0.14
mean	10.81		
10 – 50	0.92- 4.00	7607	21.03
	4.01 - 10.00	17574	48.58
	10.01 - 20.00	9522	26.32
	20.01 - 40.00	1219	3.37
	40.01 - 80.00	249	0.69
	80.01 – 82.00	4	0.01
mean	7.32		

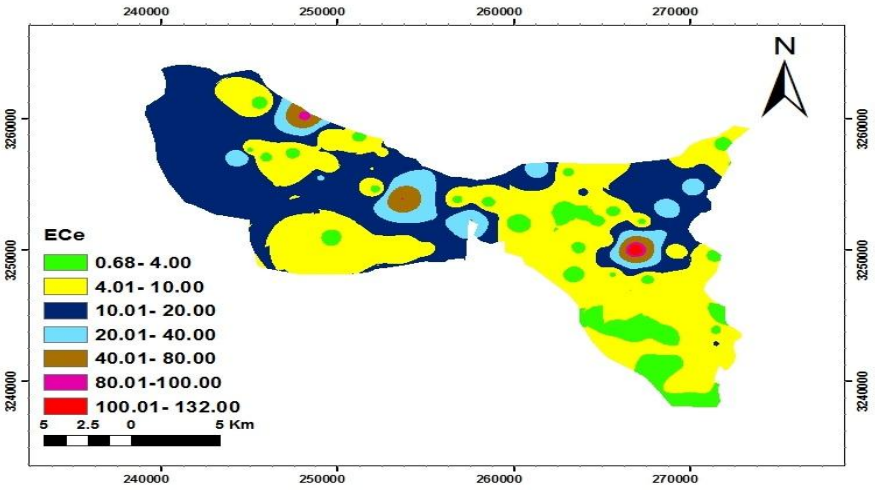

Fig. (3): Spatial distribution of the soil salinity in terms of ECe values (dSm-1) throughout Youssef El-Sedik District area (soil depth 0-10 cm).

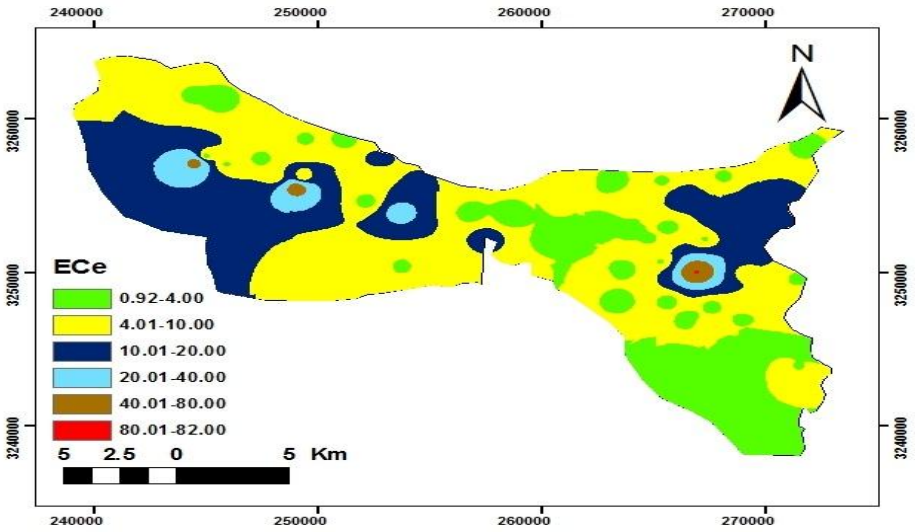

Fig. (4): Spatial distribution of soil salinity in terms of ECe values (dSm-1) throughout Youssef El-Sedik District area (soil depth 10-50 cm).

Table (2): Levels of pH values in the soils of Youssef El-Sedik District area.

Soil depth (cm)	Soil pH	Area (ha)	% of District area
0-10	7.00 – 7.50	19287	53.32
	7.51 – 8.00	16838	46.55
	8.01 – 8.13	51	0.13
10-50	7.00 – 7.50	11487	31.75
	7.51 – 8.00	24572	67.92
	8.01 – 8.2	116	0.33

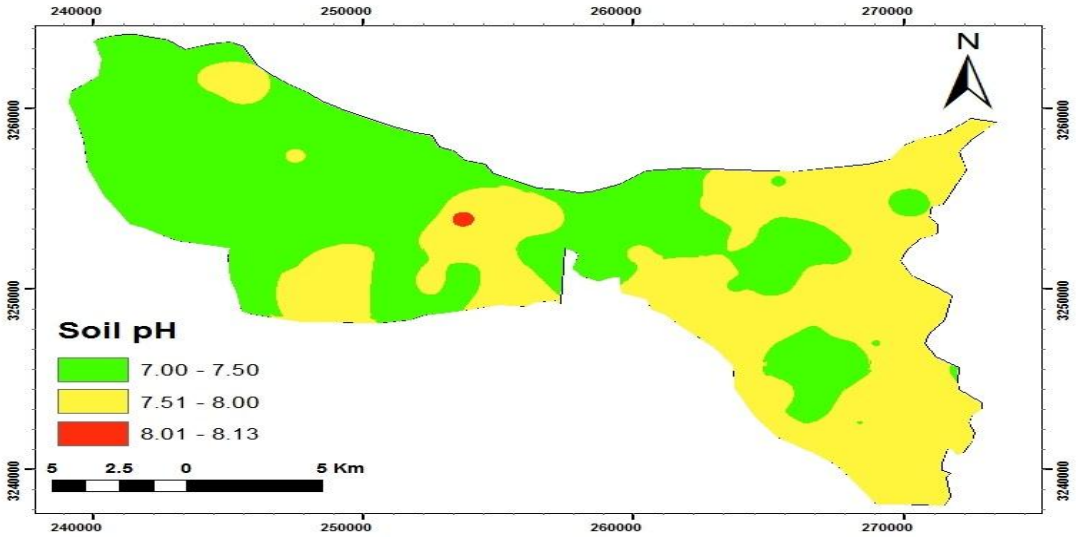

Fig .(5): Spatial distribution of the soil pH levels throughout Youssef El-Sedik District area (soil depth 0-10 cm).

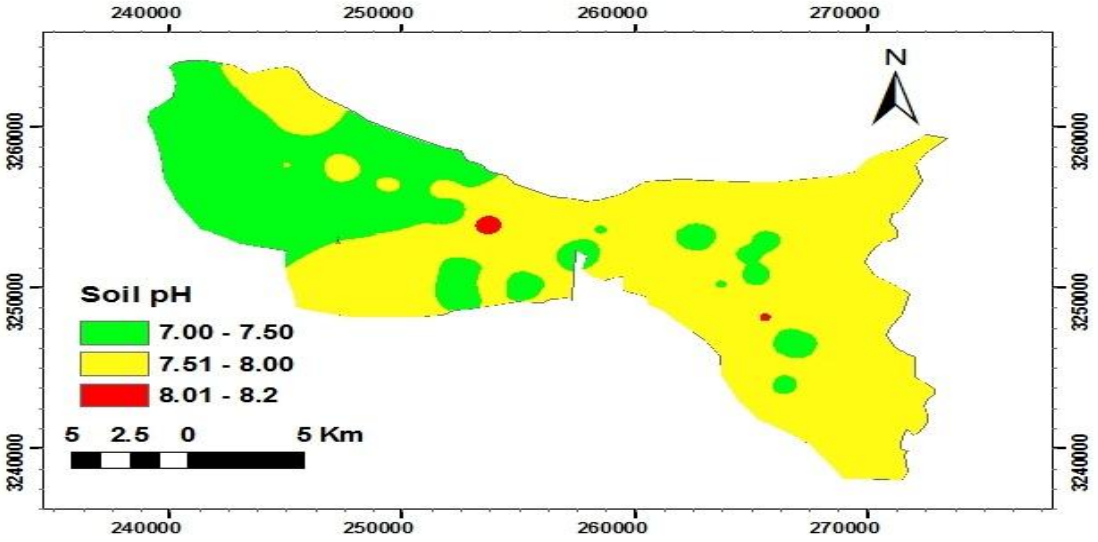

Fig .(6): Spatial distribution of the soil pH levels throughout Youssef El-Sedik District area (soil depth 10-50cm).

Table (3): Levels of organic matter content in the soils of Youssef El-Sedik District area.

Soil depth (cm)	Soil organic matter %	Area (ha)	% of District area
0 – 10	0.26 - 0.50	204	0.57
	0.51 - 1.00	12224	33.79
	1.01 - 1.50	17342	47.94
	1.51-2.00	6275	17.35
	2.01-2.27	130	0.35
mean	1.24		
10 – 50	0.06 - 0.50	491	1.36
	0.51-1.00	12126	33.51
	1.01-1.50	21642	59.83
	1.51-2.00	1888	5.22
	2.01-2.19	28	0.08
mean	1.13		

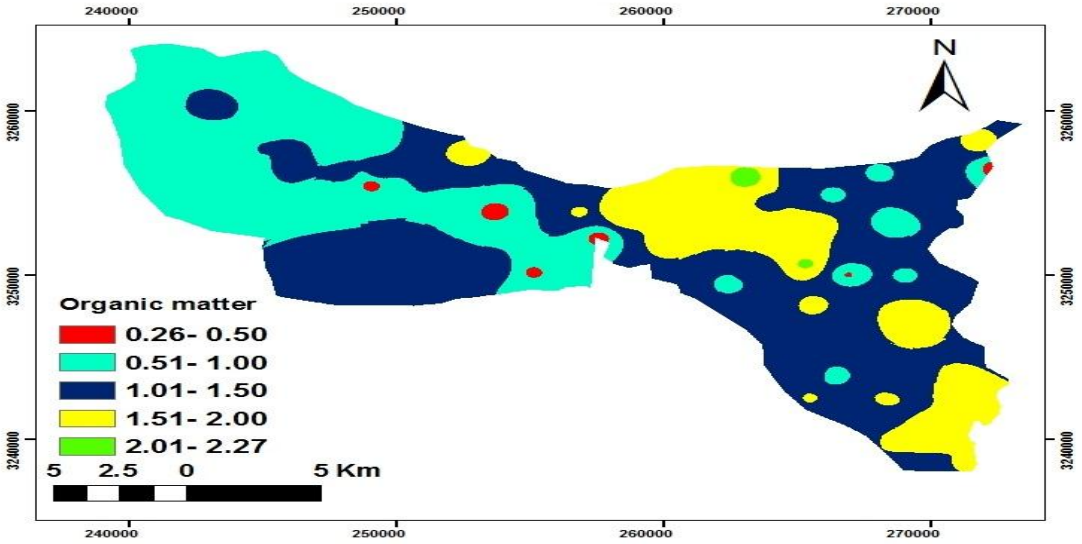

Fig. (7): Spatial distribution of the soil Organic matter contents (%) throughout Youssef El-Sedik District area (soil depth 0-10 cm).

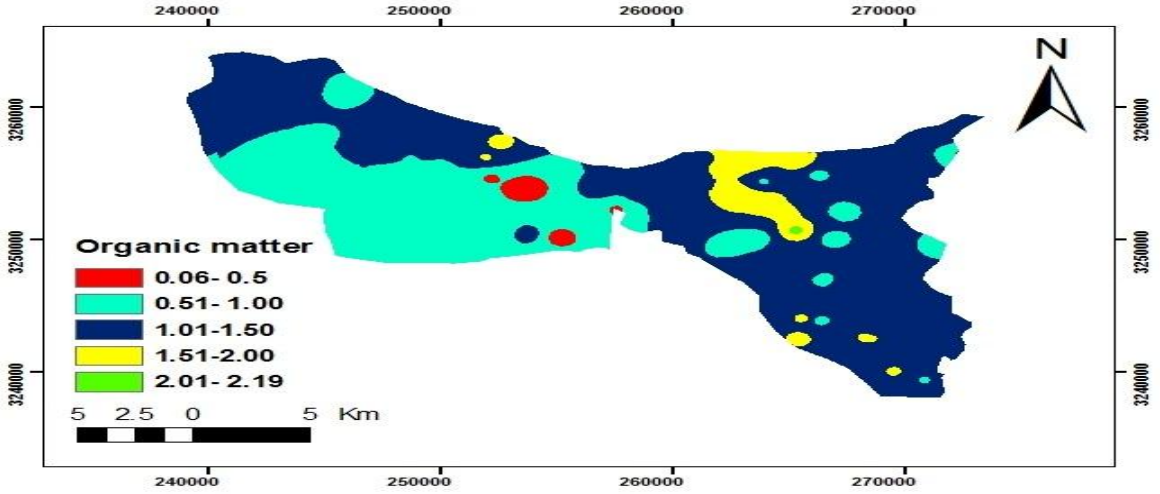

Fig. (8): Spatial distribution of the soil organic matter contents (%) throughout Youssef El-Sedik District area (soil depth 10-50)

Table (4): Levels of calcium carbonate content in the soils of Youssef El-Sedik District area.

Soil depth (cm)	$CaCO_3$ equivalent %	Area (ha)	% of District area
0 – 10	3.24 - 4.9	47	0.13
	5.00 - 10.00	2656	7.34
	10.01 - 20.00	27637	76.40
	20.01 - 40.00	5462	15.10
	40.01 - 60.00	261	0.72
	60.01 - 81.38	113	0.31
mean	15.04		
10 – 50	3.57 - 4.90	12	0.04
	5.00 - 10.00	4429	12.24
	10.01 - 20.00	24821	68.61
	20.01 - 40.00	6739	18.63
	40.01 - 51.04	174	0.48
mean	14.02		

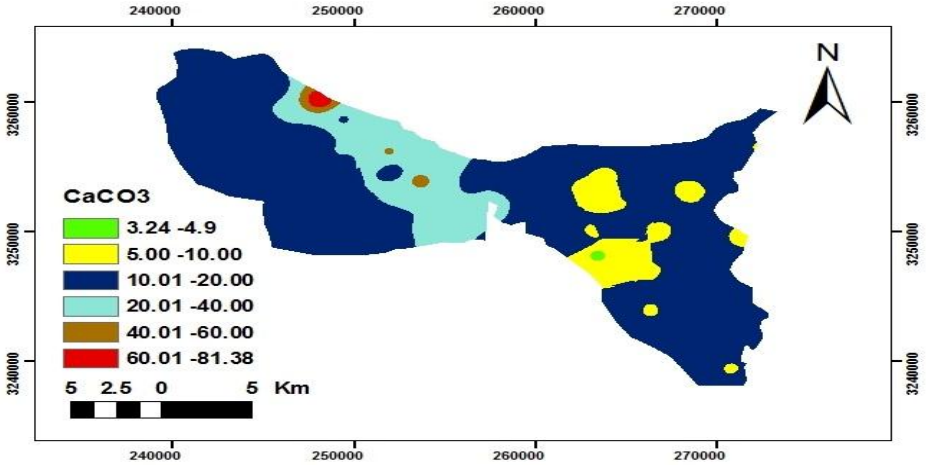

Fig. (9): Spatial distribution of calcium carbonate equivalents (%) in the soils throughout Youssef El-Sedik District area (soil depth 0-10 cm).

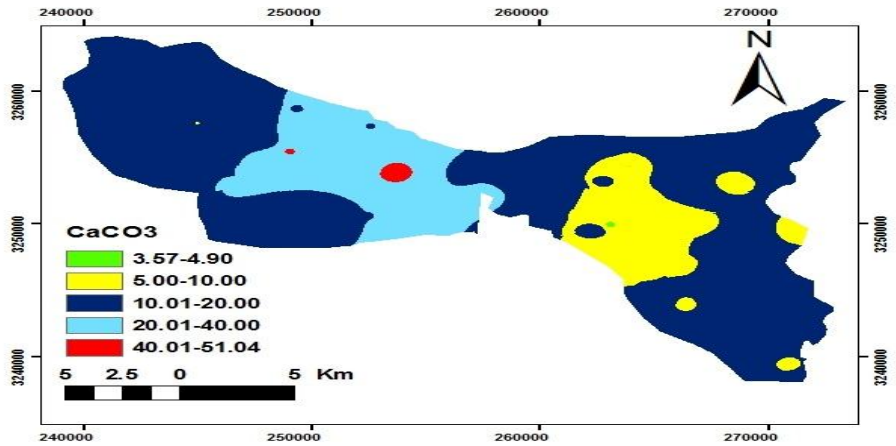

Fig. (10): Spatial distribution of calcium carbonate equivalents (%) in the soils throughout Youssef El-Sedik District area (soil depth 10-50 cm).

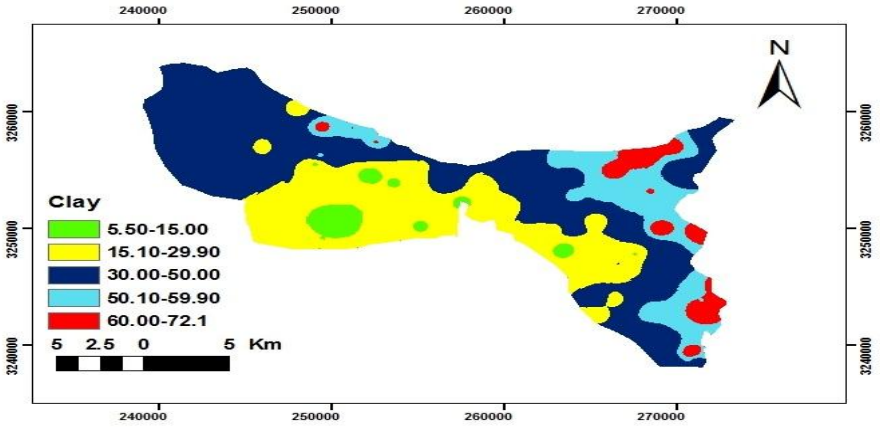

Fig. (11): Spatial distribution of clay contents (%) in the soils throughout Youssef El-Sedik District area (soil depth 0-10 cm).

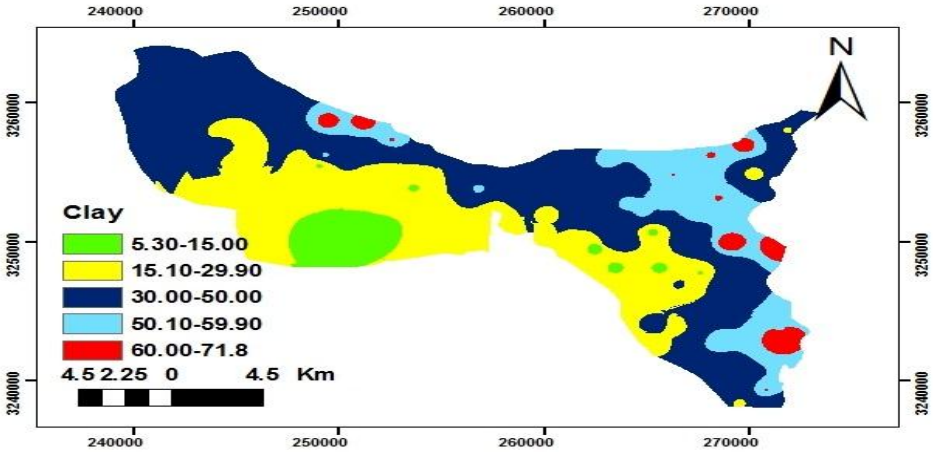

Fig. (12): Spatial distribution of clay contents (%) in the soils throughout Youssef El-Sedik District area (soil depth 10-50 cm).

Table (5): Levels of clay content in the soils throughout Youssef El-Sedik District area.

Soil depth (cm)	Clay, %	Area (ha)	% of District area
0 – 10	5.50 – 15.00	1199	3.30
	15.10 - 29.90	10718	29.63
	30.00 - 50.00	17605	48.67
	50.01 - 59.00	5002	13.83
	60.00 - 72.10	1651	4.57
mean	39.53		
10 – 50	5.30 - 15.00	2083	5.75
	15.10 - 29.90	11115	30.73
	30.00 - 50.00	16797	46.43
	50.10 - 59.90	5284	14.61
	60.00 - 71.8	896	2.48
mean	38.42		

within the 10–50 cm soil layer. About 49.28% and 42.65 % of the studied soils were found to contain ≥ 40 % clay within the upper 10 cm and 10 - 50 cm layers, respectively. Very little differences were observed between the upper 10 cm and the 10 – 50 cm soil layers in their mean

values, maximum and minimum contents of clay.

The data in Table (6) showed that soil texture classes of the upper 10 cm were clay in 46.38 % of the studied soils, 5.8 % sandy clay, 10.14 % clay loam, 18.84 % sandy clay loam, 1.45 % loamy, 13.04 % sandy loam and 4.35% loamy sand. Soil texture classes of the subsurface 10 – 50 cm layers were clay in about 42.65 %, 1.47 % silty clay, 7.53 % sandy clay, 8.83 % clay loam, 20.59 % sandy clay loam, 1.47 % loamy, 1.47 % silt loam, 10.29 % sandy loam and 5.88 % of the studied soils loamy sand.

Table (6): Distribution of the soil texture classes throughout Youssef El-Sedik District area.

Soil depth (cm)	Soil texture class	% of District soils
(0-10)	Clay	46.38%
	Sandy clay	5.80%
	Clay loam	10.14%
	Sandy clay loam	18.84%
	Loam	1.45%
	Sandy loam	13.04%
	Loamy sand	4.35%
(10-50)	Clay	42.65%
	Silty clay	1.47%
	Sandy clay	7.35%
	Clay loam	8.83%
	Sandy clay loam	20.59%
	Loam	1.47%
	Silty loam	1.47%
	Sandy loam	10.29%
	Loamy sand	5.88%

It could be concluded from the data of the present work that the soils of Youssef El-Sedik District suffer problems associated with soil salinity, high calcium carbonate, poorness in organic matter content. The degree, extent and spatial distribution of such problems throughout the District area were well defined. These problems, in addition to those of irrigation water deficiency and quality, hot weather and aridity are facing decision makers.

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التوزيع الجغرافى لكربونات الكالسيوم و للملحية والرقم الهيدروجينى والقوام ومحتوى التربة من المادة العضوية فى أراضى مركز يوسف الصديق – محافظة الفيوم – مصر

محمود عبد الجواد محمد - عبد العاطى محمد أبراهيم - عبد الناصر أمين أحمد عبدالحفيظ، - أماني عبد الناصر أحمد

قسم الأراضي والمياه – كلية الزراعة – جامعة الفيوم –الفيوم – مصر.

ملخص

أُستخدمت نظم المعلومات الجغرافية ARC-GIS Format في دراسة ورسم خرائط ملونة للتوزيع الجغرافى لمستويات الملحية، والجيرية، ومحتوى التربة من حبيبات الطين والمادة العضوية، والقوام والرقم الهيدروجينى للتربة بتطبيق النظام الشبكي على مسافات 2.0 كيلو متر خلال أراضى مركز يوسف الصديق – محافظة الفيوم – مصر. بينت النتائج المتحصل عليها أن قيم التوصيل الكهربي لمستخلص عجينة التربة المشبعة (ECe) يتراوح بين 0,68 الى 132 ديسيسمنز / متر خلال الطبقة السطحية (عمق 0-10سم) ويتراوح بين 0.92 إلى 82 ديسيسمنز / متر فى الطبقة (10 – 50 سم)، وقد وجد أن 91.23٪، 78.97٪ من مساحة أراضى المركز توصيلها الكهربي يزيد عن 4 ديسيسمنز / متر فى الطبقتين (0-10سم) و(10-50سم) ، على الترتيب. كما وجد أن 47.61٪، 30.39٪ من المساحة يزيد توصيلها الكهربي عن 10 فى الطبقتين على الترتيب. وتوضح هذه النتائج أن الأراضى المتأثرة بالملحية تنتشر بشكل كبير خلال أراضي مركز يوسف الصديق. وبينت النتائج أيضا أن 92.53٪ من أراضي المركز تعتبر أراضي جيرية (تحتوى >10٪ كربونات كالسيوم) وذلك بسبب طبيعة مادة الأصل الجيرية التى نشأت منها التربة فى منطقة الدراسة كذلك وجد أن 46.69٪ من الأراضي رقمها الهيدروجيني > 7.5 وأن أقل من 1٪ منها رقمها الهيدروجيني > 8، ونادرا مازادت نسبة المادة العضوية عن 2٪ حيث وجد أن نسبة الأراضي التى تحتوى على 2 - 2.27٪ تبلغ 0.36٪ فى الطبقة السطحية من أراضى المركز ، وبشكل عام احتوت الطبقة السطحية على نسبة أعلى من المادة العضوية مقارنة بالطبقة التحت سطحية. وتنوعت رتب قوام التربة الا أن نسبة الأراضى ذات القوام الطينى بلغت 46.38٪ ، 42,65 ٪ من أراضى المركز في الطبقتين (0-10سم) ، (10-50سم)، على الترتيب. وتعتبر خرائط التربة التي تم رسمها لأراضي المساحة المدروسة في هذه الدراسة من خلال نظم المعلومات الجغرافية ذات فائدة كبيرة للمسئولين عن صناعة القرار فى مجال استخدامات التربة المناسبة وحفظ الأراضى وادارتها وكذلك كمعلومات اساسية للدارسين والباحثين لأجراء البحوث المستقبلية فى منطقة هذه الدراسة.

المجلة العلمية – كلية الزراعة – جامعة القاهرة – المجلد (70) العدد الأول (يناير 2019):43-52.