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Fertility Evaluation of Some Soils in Damietta Governorate, Egypt Using GIS

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ABSTRACT

Intensification of agricultural productivity, use of high yield crops, and loss of Nile deposits after building the High Dam have resulted in significant reduction in soil fertility. Accordingly, there is a critical need for evaluating soil fertility of alluvial soils in the Nile-Delta of Egypt as well as the newly reclaimed areas developed on sand dunes in the northern part of Nile-Delta. This work focus on studying the spatial variability within physiochemical properties and evaluating fertility of Damietta Governorate soils by using GIS techniques. For that reason, 30 geo-referenced and representative soil profiles were randomly distributed within the studied area and soil samples were collected at three depth intervals (0-30, 30-60, and 60-90 cm). Soil samples were analyzed for their physical, chemical and fertility properties. Water samples were also collected from irrigation and drainage canals in close proximity from each soil profile. These samples were also analyzed for their quality parameters. Ordinary Kriging (OK) was used in surface interpolation of soil physical and chemical properties in the studied area. Also, the ASLE model was used to evaluate land capability and suitability for crop Productivity.The obtained results indicated that the spatial distribution of the studied physical and chemical properties was highly associated with the origin of soil parent material. The higher values of clay content, saturation percentage (SP), organic matter (OM) and available NPK were found on soils developed on alluvial deposits, whereas the lower values were found in soils developed on sand dunes and marine deposits along the Mediterranean coast. The soil index of the studied soils ranged between excellent and good based on their physical and chemical properties. Soil fertility index was fit into two classes (poor and very poor). Water quality ranged between excellent and good, whereas the environmental conditions in the studied area were good. The final land capability index indicated that soils in the studied are fit into two classes (fair and poor). Land suitability for the selected crops varied from very suitable to permanently unsuitable. However, the former class represents the majority of the studied area. Most of the limitations for crop productivity were mainly associated with soil salinity, sodicity, heavy soil-texture, poor drainage and soil depth. However, these limitations can be eliminated through using proper fertility and land management practices.

Keywords: Soil fertility, Nile-deposits, Land evaluation, ASLE, GIS.

INTRODUCTION

Spatial interpolation techniques have been widely used in soil science to estimate the value of a certain variable at un-sampled locations. They are also used to study the patterns of spatial variations for a number of soil characteristics at different scales and with different sizes of sampling grids. They vary from simple techniques such as linear and multiple regressions to more sophisticated ones such as Kriging and co-kriging (El-Menshawy and Yehia, 2006; El-Sirafy *et al.,* 2011; Elnaggar, 2016). NajafiGhiri *et al.* (2010) have used ordinary Kriging (OK) in studying the spatial variability within the different forms of soil potassium and their relationships with clay mineralogy and other soil properties. Their results provided great help for understanding K equilibrium and K fertility status in their studied soils. Salem *et al.* (2008) used Kriging to produce prediction maps for soil salinity and total carbonates. El-Gammal *et al.* (2012) studied the spatial distribution of bulk density for Damietta soils and found that its values ranged between 1.21 and 1.60 g cm^{-3}. The higher values were found in the subsurface layers of hammock and high-elevated sand sheets. They also found that the values in the surface layers were lower than that in the subsurface layer. They attributed this to the relatively higher contents of soil organic matter, higher porosity and good soil structure. El-Nahry *et al.,* (2008) and Wahab *et al.,* (2010) reported that the soil texture in Damietta soils was clayey to sandy, where the fine texture was attributed to the flood plain. They also found that the soils pH values were slightly alkaline, ranging from 7.4 and 8.63 in the different soils, whereas the EC values ranged between 1.8 to 11.39 dSm^{-1} in the surface layer. They attributed the higher EC values to the origin of parent material and the high water table. Abbas *et al.* (2003) found highly significant positive correlation between total and DTPA extractable Mn and Zn with silt, clay and CEC in soil types of the Northern Nile-Delta. In the contrary, highly significant but negative correlation was found with sand content.

In the recent years, land evaluation systems get also benefit from the huge development in data acquiring, processing, manipulation and analyses techniques. Remote sensing imagery and GIS techniques have been integrated in many of currently used land evaluation and digital soil mapping techniques. Examples of these GIS-based land evaluation systems include ALES, LECS and ASLE (Sys *et al.,* 2009; Ganzorig, 2008; Ismail *et al.,* 1994). These systems integrate extensive information about soil physical, chemical and fertility characteristics as well as other critical information related to crop productivity such as water quality, climatic conditions, and environmental factors (Dengiz *et al.,* 2009; Elnaggar *et al.,* 2016). These techniques proved their efficiency in providing highly accurate, less expensive, time-wise data, which is required by decision makers for maintaining land resources and environmental sustainability.

The objectives of this work were to study the spatial variability within soil physical and chemical properties and evaluate the soil fertility of Damietta Governorate soils using GIS techniques. This is in addition to studying the relationships between the studied soil properties.

MATERIALS AND METHODS

1. Description of study area

Damietta governorate is located at the Mediterranean Sea to the northeast of the Nile-Delta. It is lies between these coordinates 31° 28' 29" to 32 ° 03' 32" E and 31 ° 09' 28" to 31 ° 31' 45" N as represented in Fig. 1. It covers an area of about1029 km^2 and it represents about 4.7% of the Delta-region and about 1.22% of Egypt total area. It is divided into 4 districts and includes 10 major cities, 47 rural units, 85 villages and 722 Kafr. Total population is about 1.18 millions according to the census data in 2010. The cultivated area is about 435 km^2 and the common crops are wheat, rice, maize, potato, tomato, date palm and guava.

It is characterized by a Mediterranean climate, which is cold and wet in winter and hot and dry in summer. The minimum air temperature varies from 9°C in January to 21.8°C in July, whereas the maximum air temperature varied from 17.9°C in January to 30.6°C in July (The general authority of Meteorology, unpublished data). The mean annual precipitation is about 125.4 mm. Elevation of the studied area ranged between 0 to 2 m above the sea level and the area is almost leveled. Geology of study area includes Nile silt deposits, which cover the majority of the area. This is followed by stabilized sand dunes, sand dunes, undifferentiated quaternary deposits and sabkha deposits (Conoco, 1987).

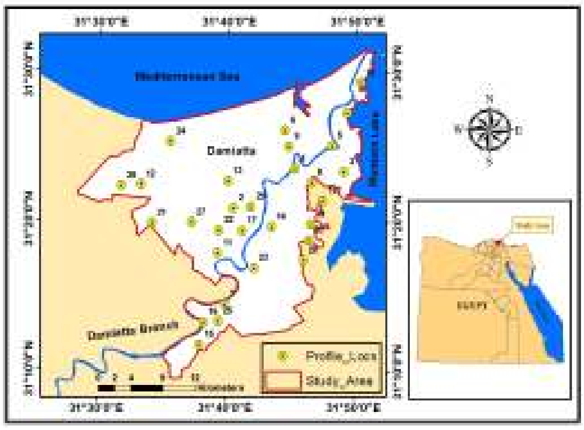

Fig. 1. Study area and locations of soil profiles in Damietta Governorate.

2. Soil and water samples

Representative soils samples were collected from 30 random locations at three soil depths (0 – 20, 20 – 30, and 40 – 60 cm). The coordinates of these locations were recorded using Garmin etrex GPS unit and represented on the Damietta governorate map. The collected soil samples were air– dried, crushed, sieved using a 2- mm sieve and stored for the subsequent analyses. Also, representative water samples were collected from the irrigation canals adjacent to the sample locations.

3. Soil and water analyses

Mechanical analysis was carried out using the international pipette method as described by (Black, 1965). Total carbonates were determined as $CaCo_3$ using Collin's Calcimeter as described by (Dewis and Freitas (1970). Soil pH was measured in saturated soil paste using the pH meter according to Jackson (1967). Electrical conductivity was measured in soil paste extract (Jackson, 1967). Soluble cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+) and anions (Co_3^{2-} , HCO_3^-, Cl^- and SO_4^{2-}) were measured in the soil paste extract as described by (Jackson, 1967). Available potassium was determined by extracting soil with 1.5 N ammonium acetate at pH 7.0 as described by (Dewis and Freitas, 1970), available nitrogen was determined as NH^+_4 or NO^-_3 as the method described by (Dewis and Freitas, 1970) and the available phosphorus was determined by Olesen method as described by (Dewis and Frietas, 1970). Soil organic matter (SOM) was determined by (Walkley and Black) method as described (Hesse, 1971). Exchangeable sodium percentage was calculated as described by (Hesse, 1971).

Water samples were analyzed for their chemical properties (cations, anions, pH, and EC) using the above mentioned methods to evaluate their quality for crop irrigation.

4. Geostatistical analyses

The spatial distribution of the studied soils parameters was carried out using ordinary Kriging under the geo-statistical analyst in Arc GIS, 10.1. The semivariogram was developed between each pairs of points versus their separation distances. This semivariogram was used in predicting the studied physical and chemical properties.

5. Land capability evaluation

Evaluation of land capability and suitability of soils in the studied area was carried out using the Applied System for Land Evaluation (ASLE), developed by Ismail *et al.* (1994). This approach takes into account four major factors: soil properties, soil fertility status, irrigation water quality and environmental condition. This computer program was developed to facilitate the calculation of the final land capability class according to Storie (1933 and 1944). It is also used to evaluate suitability for certain crops.

RESULTS AND DISCUSSION

1. Soil physical properties and their spatial distribution

Data in Table 1 show the ranges of soil physical properties in the three soil depth within the studied area. Coarse sand varied from 0.35 to 28.42% and it has an average value of 6.44%. Fine sand varied from 4.72 to 75.63% and it has an average value of 29.63%. The total sand varied from 5.31 to 97.45% with an average value of 36.07%. This wide variability in total sand is associated with the type of soil parent materials in the studied area. The higher values were observed in the soil developed on sand dunes and the undifferentiated quaternary deposits in the northern parts of the studied area as represented in Fig. 2. On the other hand, the lower values were found in the middle and southern parts, where soils are developed on Nile-silt deposits.

Silt content ranged between 1.22 and 47.00% with an average value of 24.37%. Clay content varied from 1.33 to 84.17% with an average value of 39.57%. The spatial distribution of both silt and clay took the same trend in the studied area as illustrated in Figs. (3 and 4). They were also associated with soil parent materials, where the higher values were observed in soils developed on Nile-silt. According to these results the dominant soil texture in the studied area is clayey.

Saturation percentage (SP) varied from 33 to 109% and it has an average value of 76%. These values were associated with the clay content in the studied soils as represented in Fig. 5. Organic matter was very low in the studied soils and it varied from 0.06 to 0.80% and it has an average value of 0.40%. The lower values were found in coarse textured soils in the northern parts and the higher values were in the fine textured soils in the middle and southern parts of the studied area as illustrated in Fig. 6. Total carbonates, represented as $CaCO_3$ were varied from 0.04 to 6.83% and it has an average value of 2.64%. The higher values are in the southern parts of the studied area as shown in Fig. 7. These results are in agreement with those obtained by Abdou (2012).

Table 1. Ranges of soil physical properties in the three soil depths within the studied area.

Property	Minimum	Maximum	Average	STD*
Coarse Sand (%)	0.35	28.42	6.44	7.29
Fine Sand (%)	4.72	75.63	29.63	21.81
Total Sand (%)	5.31	97.45	36.07	28.15
Silt (%)	1.22	47.00	24.37	11.06
Clay (%)	1.33	84.17	39.57	22.91
Texture	--	--	Clayey	--
SP (%)	33.00	109.00	76.00	31.00
Organic Matter (%)	0.06	0.80	0.40	0.22
CaCO3 (%)	0.04	6.83	2.64	1.94

***STD= Standard deviation of the studied variables.**

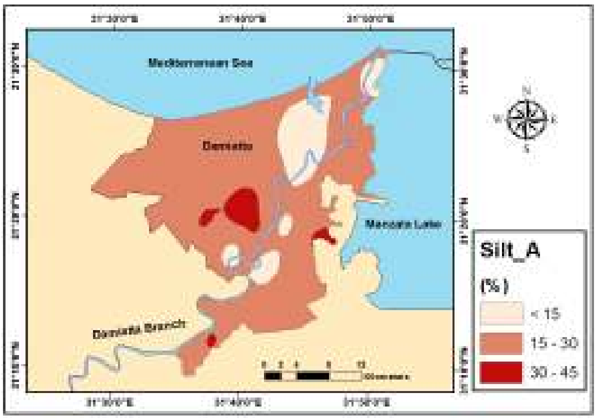

Fig. 3. Spatial variability of silt content in surface layer within the studied area.

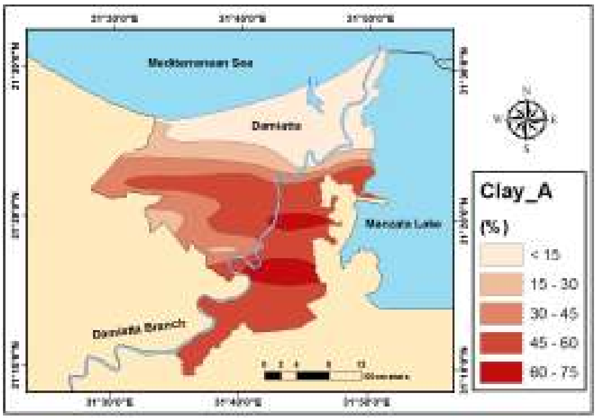

Fig. 4. Spatial variability of clay content in surface layer within the studied area.

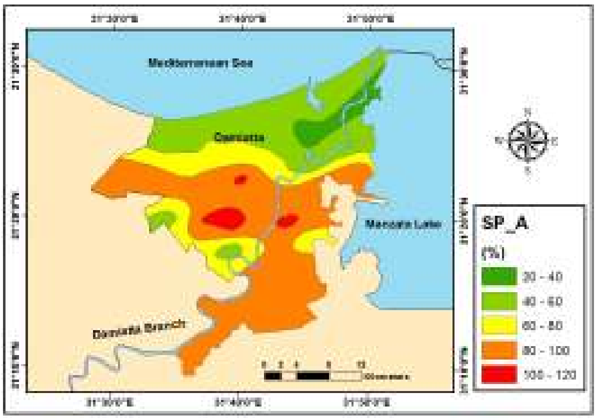

Fig. 5. Spatial distribution of saturation percentage (SP) in surface layer within the studied area.

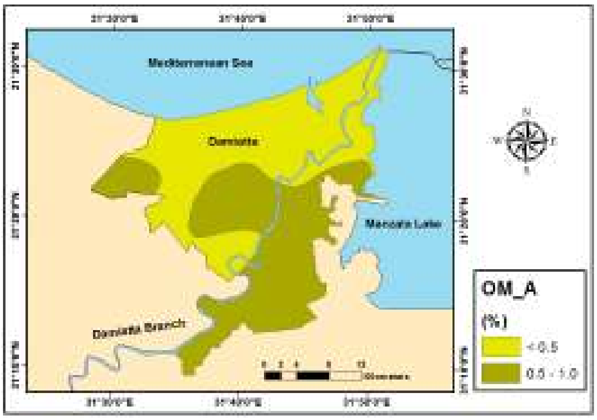

Fig. 6. Spatial distribution of organic matter (OM) in surface layer within the studied area.

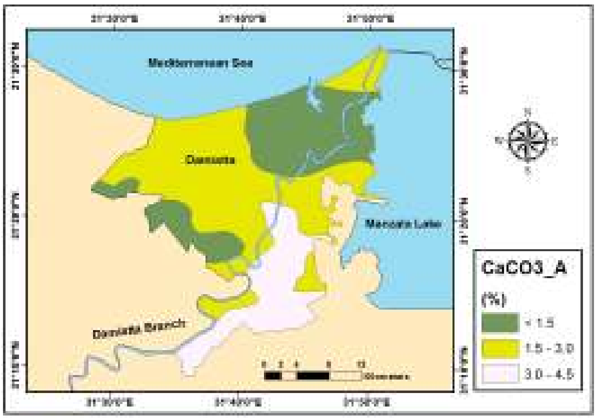

Fig. 7: Spatial distribution of calcium carbonates ($CaCO_3$) in surface layer within the studied area.

2. Soil chemical properties and their spatial distribution

Data in **Table 2** show the ranges of soil chemical properties within the three soil depths in the studied soil profiles. Sodium was the prevalent cation in the soil solution of the studied soils followed by calcium, magnesium, and potassium; respectively. Calcium ions (Ca^{2+}) varied from 0.28 to 1.89 cmol kg^{-1} (1.00 cmol kg^{-1} in average). Magnesium ions (Mg^{2+}) ranged between 0.31 to 1.48 cmol kg^{-1} (0.82 cmol kg^{-1} in average). Sodium ions (Na^{+}) varied from 0.26 to 2.46 cmol kg^{-1} (1.40 cmol kg^{-1} in average). Potassium ions (K^{+}) varied from 0.02 to 0.27 cmol kg^{-1} (0.08 cmol kg^{-1} in average).

On the other hand, chloride was the dominant anion followed by bicarbonate and sulfate, respectively. Carbonates were almost undetected in the soil solution of the studied soils. Bicarobonates (HCO_3^-) varied from 0.08 to 2.10 cmol kg^{-1} (0.92 cmol kg^{-1} in average). Sulfates (SO_4^{2-}) varied from 0.13 to 1.33 cmol kg^{-1} (0.77 cmol kg^{-1} in average). Chlorides (Cl^-) ranged between 0.33 and 2.65 cmol kg^{-1} (1.61 cmol kg^{-1} in average).

The majority of soils in the studied area were moderately alkaline, where the pH values varied from 7.40 to 8.43 with an average value of 8.02 as represented in Fig. 8. Electrical conductivity (EC) varied from 2.66 to 7.54 and it has an average of 4.49 dS m^{-1}. Saline soils (EC > 4 dSm^{-1}) were observed in the middle and northern parts of the studied area as illustrated in Fig. 9. These areas are close to the Mediterranean Sea and Manzala Lake. Cation exchangeable capacity (CEC) varied from 2.55 to 95 cmol kg^{-1} and it has an average of 35.08 cmol kg^{-1}. These values were associated with the soil texture as illustrate in Fig. 10. Exchangeable sodium percentage (ESP) varied from 0.22 to 56.14% and it has an average of 11.34 %. The higher ESP values were found in the southern parts of the studied area as demonstrated in Fig. 11.

Table 2. Ranges of soil chemical properties in the three depths within the studied area.

Property		Minimum	Maximum	Average	STD
Soluble	Ca^{2+}	0.28	1.89	1.00	0.40
Cations	Mg^{2+}	0.31	1.48	0.82	0.32
(cmol	K^{+}	0.02	0.27	0.08	0.06
kg^{-1})	Na^{+}	0.26	2.46	1.40	0.58
Soluble	CO_3^{2-}	0.00	0.10	0.00	0.02
Anions	HCO_3	0.08	2.10	0.92	0.57
(cmol	SO_4^{2-}	0.13	1.33	0.77	0.29
kg^{-1})	Cl^-	0.33	2.65	1.61	0.55
pH		7.40	8.48	8.02	0.26
EC (dS m^{-1})		2.66	7.54	4.49	0.97
CEC (cmol kg^{-1})		2.55	95.00	35.08	19.45
ESP (%)		0.22	56.14	11.34	9.62

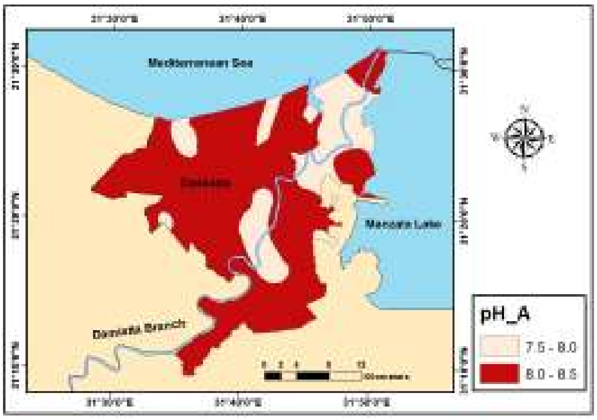

Fig. 8. Spatial variability within soil pH in the studied area.

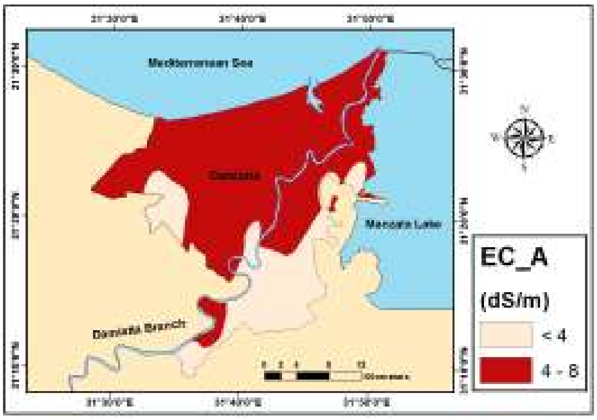

Fig. 9. Spatial distribution of EC in the studied area

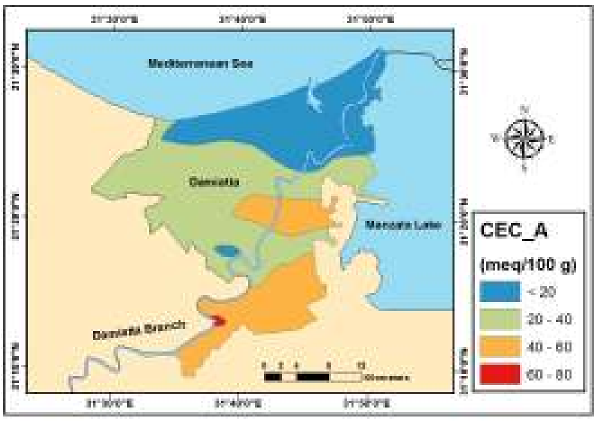

Fig. 10. Spatial distribution of CEC in the studied area.

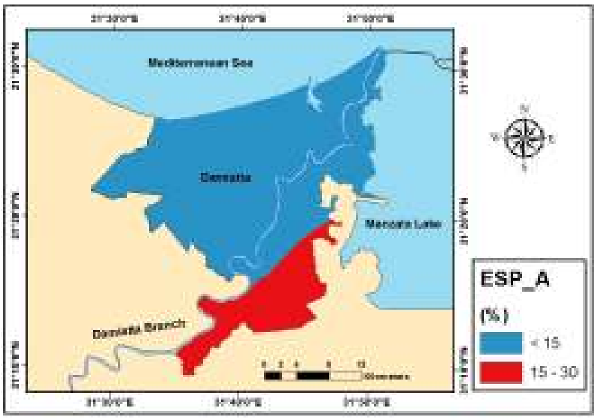

Fig. 11. Spatial distribution of ESP in the studied area

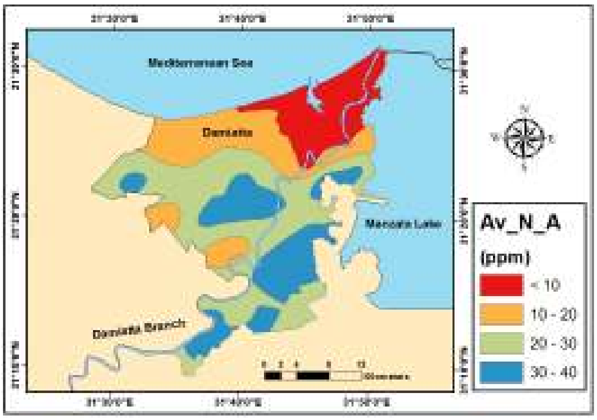

Fig. 12. Spatial distribution of available N in the studied area.

3. Soil fertility properties and their spatial distribution

The ranges of available NPK in the studied soils are represented in Table 3. Available nitrogen in the studied area varied from 0.5 to 40 mg kg^{-1} with an average value of 19.9 mg kg^{-1}. The lower values were found in the coarse-textured soils at the northern parts of the studied area, whereas the higher values were found in fine-textured soils in the rest of the area as illustrated in Fig. 12. Available phosphorus in the studied soils varied from 3 to 18 mg kg^{-1} with an average value of 11.07 mg kg^{-1}. This indicates that most of soils in the studied area have lower contents of available P. Also, there was no obvious pattern in the spatial distribution of available P within the studied soils as illustrated in Fig. 13. Available potassium varied from 63 to 955 mg kg^{-1} with an average value of 463 mg kg^{-1}. This indicates that the majority of soils in the studied area had very high concentrations of available K. The spatial distribution of available K took a similar pattern as that of available N as illustrated in Fig. 14. Abdo (2012), found a decreasing trend in the values of available k from the southern parts of the study area towards the coastal area. The C/N ratio was relatively high in the studied soils and varied from 30 to 102, with an Average of 75.

Table 3. Ranges of soil fertility properties in the three depths within the studied area.

Property	Min.	Max.	Average	STD*
Available K (mg kg^{-1})	63	955	463	230
Available P (mg kg^{-1})	3.00	18.00	11.07	3.46
Available N (mg kg^{-1})	0.50	40.00	19.90	11.04
Total N (mg kg^{-1})	17.00	49.00	34.10	9.94
TN (%)	0.0017	0.0049	0.0034	0.001
OC (%)	0.03	0.47	0.23	0.13
C/N Ratio	30.60	101.74	74.56	26.62

***STD= Standard deviation of the studied variables.**

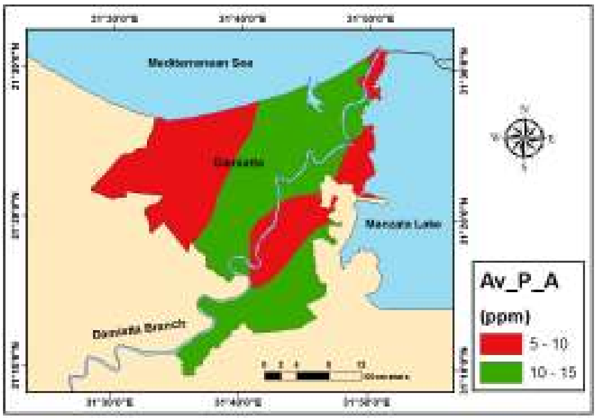

Fig. 13. Spatial distribution of available P in the studied area.

4. Land capability

The capability of soils in the studied area was evaluated using the ASLE model; which is developed based on soil physical, chemical, and fertility indices, water quality index, and environmental index. These five indices are integrated to come up with a final land capability index; which is divided into five classes (Excellent (C1), Good (C2), Fair (C3), Poor (C4), and Very poor (C5)). The Percentages of areas allocated for each class under the studied land capability indices are represented in Table 4. Soils in the studied area were fit into three classes (C1, C2 and C3) according to their physical index and in one class (C1) based on their chemical index. Consequently, the soil index (physical plus chemical) was fit in two classes (C2 and C3), where they represent about 64 and 36% of the studied area, respectively as illustrated in Fig. 15. On the other hand, the fertility index was fit into two classes (C4 and C5), where they represent about 72 and 28% of the studied area, respectively as shown in Fig. 16. This poor and very poor soil fertility could be attributed to the intensification of agricultural productivity in the studied area.

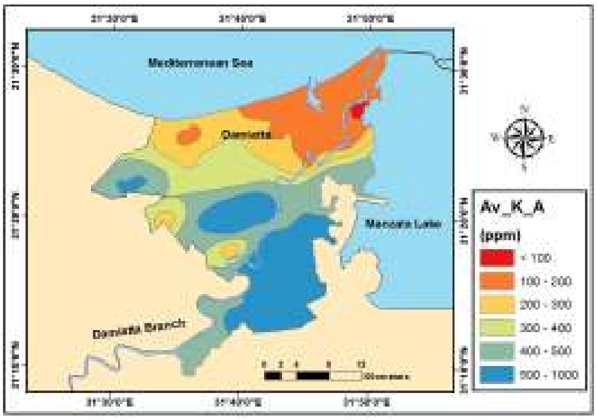

Fig. 14. Spatial distribution of available K in the studied area.

This is in addition to, the lower addition of organic fertilizers and loss of Nile-silt after building the High Dam (El-Agrodi et al., 1998 and Elnaggar et al., 2016). The quality of irrigation water in the studied area was excellent and good, where the majority of these areas are irrigated by the Nile River water. These two classes represent about 87 and 13% of the studied area, respectively. The environmental index was fit into one class, which is good. As a result, soils in the studied area were fit into two classes according to the final land capability index; which are fair (C3) and poor (C4). These classes represent about 75 and 25% of the studied area, respectively as illustrated in Fig. 17. However, these restrictions for crop productivity of soils in the studied area are not permanent and they can be eliminated through application of good fertility and land management practices.

Table 4. Percentage of areas allocated for each class under the studied land capability indices.

Index	C1 (%)	C2 (%)	C3 (%)	C4 (%)	C5 (%)	Total (%)
Physical Index	35.24	43.80	20.97	--	--	100
Chemical Index	99.56	0.44	--	--	--	100
Soil Index	--	64.26	35.74	--	--	100
Water Index	87	13	--	--	--	100
Fertility Index	--	--	--	72.31	27.69	100
Environmental Index	--	100	--	--	--	100
Land Capability Index	--	--	75.23	24.77	--	100

C1= Excellent, C2= Good, C3= Fair, C4=Poor,andC5= Very poor.

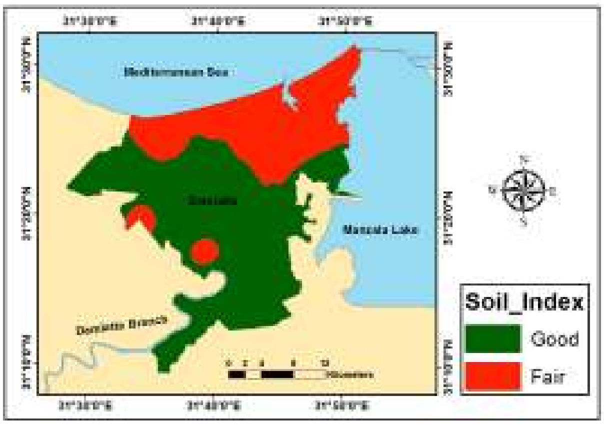

Fig. 15. Soil index (sum of physical and chemical indices) of the studied soils in Damietta governorate.

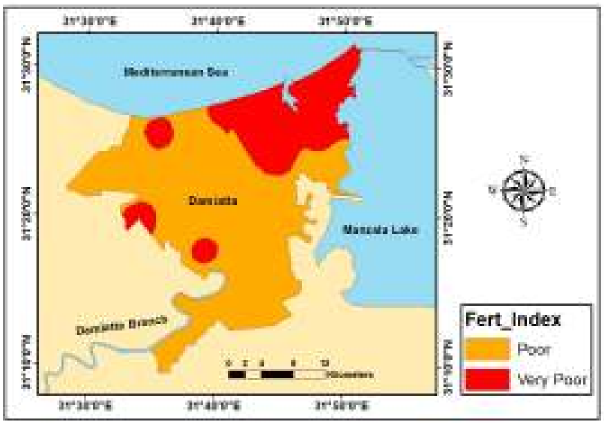

Fig. 16. Soil fertility index of the studied soils in Damietta governorate.

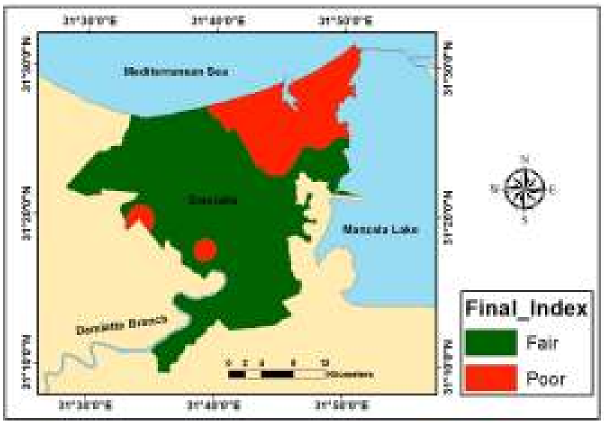

Fig. 17. Final land capability index of the studied soils in Damietta governorate.

5. Land suitability

After evaluating land capability for agricultural productivity in general, soil suitability was also evaluated for certain field crops, vegetables, and fruit trees. Data in Table 5 show the results of land suitability for the selected crops. These results reveal that soils in the studied area ranged between highly suitable (S1) and marginally suitable (S4) for the studied field crops (wheat, barley, rice, maize, peanut, faba bean, clover, sorghum, sugar beet, cotton, and sunflower). For the studied vegetable (potato, tomato, pepper, pea, soy bean, onion, watermelon, and cabbage), the studied soils varied in their suitability from highly suitable (S1) to currently unsuitable (N1).

This may be due to the sensitivity of these crops to soil salinity, alkalinity and heavy soil-texture. On the other hand, the studied soils varied in their suitability for growing fruit trees from highly suitable (S1) to permanently unsuitable (N1). Most of the limitations for growing fruit trees in some of the studied areas were mainly associated with soil salinity, poor drainage, and soil depth. Figs. 18 to 20 show the spatial distribution of land suitability for some of the studied crops.

Table 5. The studied field crops and the percentage of areas allocated of each suitability class.

Profile No.	Crop	S1 (%)	S2 (%)	S3 (%)	S4 (%)	N1 (%)	N2 (%)	Total (%)
1	Wheat	76.90	23.10	--	--	--	--	100
2	Barley	76.55	23.45	--	--	--	--	100
3	Rice	66.80	33.20	--	--	--	--	100
4	Maize	--	23.77	76.23	--	--	--	100
5	Peanut	--	--	77.94	22.06	--	--	100
6	Faba bean	--	74.48	19.73	5.78	--	--	100
7	Clover	61.77	38.23	--	--	--	--	100
8	Sorghum	70.84	23.99	4.05	1.12	--	--	100
9	Sugar Beet	91.78	8.22	--	--	--	--	100
10	Cotton	90.60	8.78	0.62	--	--	--	100
11	Sunflower	93.74	6.26	--	--	--	--	100
12	Tomato	--	--	98.70	1.30	--	--	100
13	Potato	17.10	75.22	5.71	1.96	--	--	100
14	Pepper	--	--	86.20	13.80	--	--	100
15	Pea	2.77	80.26	14.09	2.88	--	--	100
16	Soybean	--	74.48	19.84	5.68	--	--	100
17	Onion	--	--	51.20	46.36	2.44	--	100
18	Watermelon	--	--	67.67	32.33	--	--	100
19	Cabbage	60.70	39.30	--	--	--	--	100
20	Citrus	9.41	79.21	10.96	0.42	--	--	100
21	Grape	35.47	58.02	5.03	1.48	--	--	100
22	Banana	5.97	87.64	4.89	1.50	--	--	100
23	Fig	71.35	19.71	7.28	1.65	--	--	100
24	Olive	1.11	6.71	81.47	9.79	0.91	--	100
25	Date Palm	90.53	8.80	0.49	0.17	--	--	100

Where: S1= Very suitable, S2= Suitable, S3= moderately suitable, S4= marginally suitable, N1= currently unsuitable, and N2= permanently unsuitable.

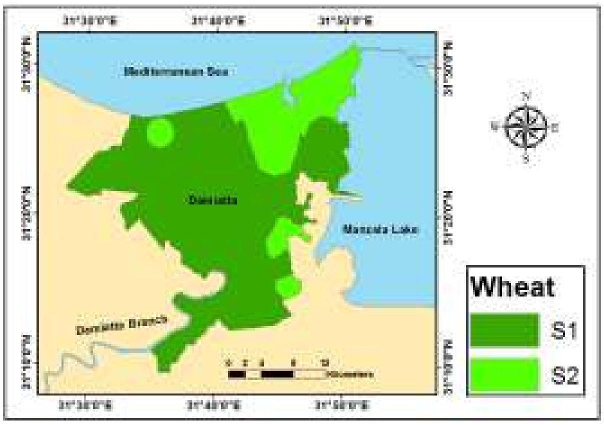

Fig. 18. Suitability of soils in the studied area for growing wheat.

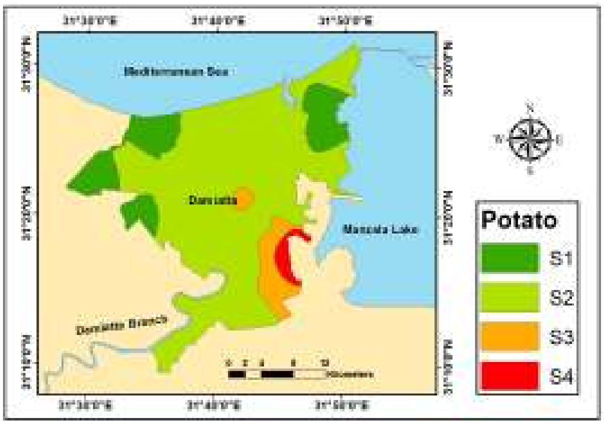

Fig. 19. Suitability of soils in the studied area for growing potato.

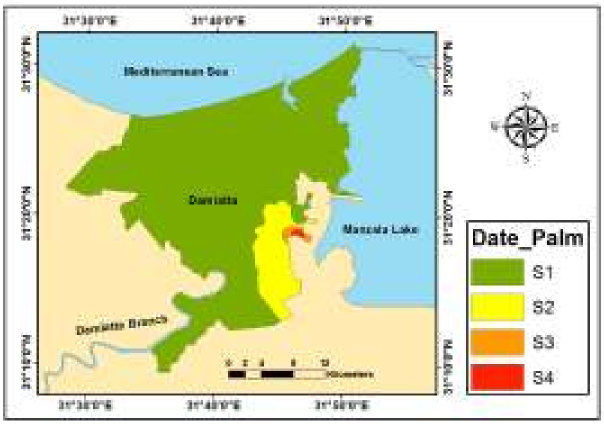

Fig. 20. Suitability of soils in the studied area for growing date palm.

CONCLUSION

Using GIS techniques provided a powerful tool for studying the spatial distribution of soil physical, chemical and fertility properties and producing land capability and suitability maps of Damietta governorate soils. Most of soil properties in the studied area were highly associated with the origin of their parent material. The soils developed on alluvial deposits in the middle and southern parts of the studied area were characterized by their higher values of clay content, saturation percentage (SP), organic matter (OM) and available NPK. On the other hand, soils developed on sand dunes and marine deposits at the Mediterranean coast had lower values for the same properties.

The soil physical index of the studied soils was fit in three classes (Excellent, good and fair) and the chemical index was excellent. Consequently, the soil index based on both physical and chemical properties ranged between excellent and good. On the contrary, soil fertility index was fit into two classes (poor and very poor). Quality of irrigation water in the studied area ranged between excellent and good. The environmental conditions of the studied area were good. The final land capability index was fit into two classes (fair and poor).

The suitability of the studied soils for growing the selected crops varied from very suitable to permanently unsuitable. The very suitable class represents the majority of the studied area. The restrictions for crop productivity in the studied area were mainly associated with soil salinity, sodicity, heavy soil-texture, poor drainage and soil depth. Most of these restrictions can be treated through the application of proper fertility and land management practices.

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تقييم خصوبة بعض أراضى محافظة دمياط – مصر بإستخدام نظم المعلومات الجغرافية

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لقد أدى تكثيف الإنتاجية الزراعية واستخدام المحاصيل ذات الإنتاجية العالية وفقدان الترسيبات النيلية بعد بناء السد العالي إلى انخفاض كبير في خصوبة التربة. ولذلك، هناك حاجة ماسة لتقييم خصوبة التربة للأراضى الرسوبية في دلتا النيل في مصر بالأضافة الى المناطق المستصلحة حديثا والمتطوره على الكثبان الرملية في الجزء الشمالي من دلتا النيل. لذلك يركز هذا العمل على دراسة التباين المكانى فى الخواص الفيزيائية والكيميائية وتقييم خصوبة التربة لأراضى محافظة دمياط باستخدام تقنيات نظم المعلومات الجغرافية. ولتحقيق ذلك، تم عمل ٣٠ قطاع أراضى ذات مرجعية جغرافية وموزعة عشوائيا فى منطقة الدراسة. وتم جمع عينات تربة على ثلاث أعماق (٠-٣٠، ٣٠-٦٠، و٦٠-٩٠ سم). وتم تحليل هذه العينات للتعرف على خصائصها الفيزيوكيميائية وخصوبتها. كما تم جمع عينات مياه من قنوات الري والصرف القريبة من كل قطاع أرضى. وتم تحليل هذه العينات للتعرف على معايير جودتها. وقد استخدم Ordinary Kriging (OK) فى أنتاج خرائط التوزيع المكانى للخصائص الفيزيائية والكيميائية للتربة في منطقة الدراسة. كما تم أيضا استخدام نموذج الـ ASLE لتقيم القدرة الإنتاجية للأرض وملاءمتها للإنتاج المحاصيل.دلت النتائج على أن التوزيع المكاني للخصائص الفيزيائية التى تم دراستها كان مرتبط ارتباطا وثيقا بمصدرمادة أصل التربة. حيث وجدت القيم العالية لمحتوى الطين والنسبة المئوية للتشبع الرطوبى (SP) والمادة العضوية (OM) والمسامية والعناصر الميسرة من النيتروجين والفوسفور والبوتاسيوم NPK فى الأراضى المتطورة على الرواسب النيلية بينما وجدت القيم المنخفضة فى الأراضى المتطورة على الكثبان الرملية والرواسب البحرية على طول ساحل البحر المتوسط. وتراوح مؤشر التربة للأراضى التى تم دراستها بين ممتاز وجيد وذلك بناءا على الخصائص الفيزيائية والكيميائية لها. كما وقع مؤشر خصوبة التربة فى فئتين فقيرة وفقيرة جدا. وكانت جودة المياه ممتازة وجيدة وكانت الظروف البيئية فى منطقة الدراسة جيدة. وأوضح المؤشر النهائى للقدرة الأنتاجية للأرض أن الأراضى التى تم دراستها تقع فى فئتين (معتدلة وفقيرة). وتراوحت صلاحية الأراضي للمحاصيل المختارة بين ملاءمة جدا الى غير ملاءمة بشكل دائم. وتمثل الفئة الأولى الغالبية العظمى من منطقة الدراسة. وارتبطت معظم المعوقات لإنتاجية المحاصيل بملوحة التربة وقلويتها و نعومة القوام وسوء الصرف وعمق التربة. ومع ذلك، فإن هذه المعوقات يمكن الحد منها من خلال استخدام الممارسات الملاءمة لخصوبة وإدارة الأراضي.