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RESTRICTIONS OF BORDERING IDKO LAKE LOW SOIL PRODUCTIVITY, NORTH NILE DELTA.

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ABSTRACT

Most of agricultural lands in the Northern parts of Egypt are relatively low productive soil; particularly the soils adjacent to the Northern Lakes. This study aims to define soil limitations for sustainable productivity in some of these soils as well as to assess the suitability of natural resources in EL- Behaira Governorate for agricultural purposes.

Ten representative soil profiles were selected, morphologically described and analyzed. Also, their soil texture and soil salinity & alkalinity were assessed for the suitability of the studied area. Results indicated that the studied soil profiles were classified as *Sodic Haplotorrerts, Typic Torripsamments, Sodic Endoaquerts, and Typic Fluvoaquerts.*

The studied soils are categorized into three suitability classes (i.e., *moderate* S_2, *marginally* S_3 and not *suitable* N_1) and five subclasses i.e S_3 *(Wbn),* N_1 *(Wbn),* S_3 *(Wabn),* S_3 *(Wn)* and S_2 *(Wbn)*. Results indicated that the main soil limitations are wetness (W), Soil depth (b), texture (a) and Salinity & alkalinity (n) with different intensity degrees. Land improvement should be executed to achieve the potential suitability, i.e. highly, moderately and marginally suitable classes.

Keywords: Low soil productivity, Morphological data, Soil suitability.

INTRODUCTION

Agriculture policy of Egypt includes both reclamation of the barren extension areas and improvement the production of the old cultivated lands. The Northern part of the Nile delta close to the Mediterranean Sea contains five wide salty lakes occupying a vast area constitute about 600000 feddans (1 feddan = 4200m^2). The area is low and alluvial soils of fluviomarine. Soil formation of the fluviomarrine flats is influenced by both the Nile and the sea. At an early stage, the coast line was presumably closed with a continuous ridge of marine and separating a huge in land lake from the sea.

The Rosetta Nile branch (East of Alexandria) and some of the main agricultural drains discharges into the Mediterranean Sea through some of these lakes. These lakes could be considered as transitional sinks for the majority of anthropogenic wastes of Egypt (Awad and Youssef, 2002). Moreover, saline shallow ground water has been considered one of the reasons for the deterioration of the soils adjacent to Idko and Mariut Lakes in the Northern part of the Nile Delta along the Mediterranean coast. According to Abo El–Izz (2000) and Said (2000), the terrestrial of Nile Delta essentially has been occupied by formation of the Quaternary and Holocene epochs. Shata et al. (1978) reported that the geological history of the North Nile Delta was formed in the latter part of the Miocene and the beginning of Pliocene periods. The quaternary formations were formed during Pleistocene and Holocene epochs and cover a large part of Egypt, while alluvial deposits composed of very fine materials with little sand and upper part is about 9.8 meters in thickness fluvio–marine deposit dominates in the surface of the plain to the north and is particularly noted at the southern edge, of the north lakes. Aeolian plain deposits are mainly loose quartzitic sand making forms such as sand dunes (Shifting Sand, hummocks and sheets. Aeolian deposits are seen in areas at the North coastal plain.

Climatic data (1992-2002) indicated that the maximum and minimum air temperatures of the studied area are 30°C and 9.0°C, respectively. Precipitation is limited about 65mm during the rainy season in December and January. Maximum relative humidity occurred during October - January. The evaporation rate increases at summer months with a value of 146mm/year. The wind speed reaches 6.8km/hr during March- April (Egyptian Meteorological Authority, 2002). According to Soil Survey staff (2010), both soil temperature and moisture regime of the studied area could be defined as thermic and torric, respectively. Shata *et al.,* (1978) reported that three geomorphic units of the Delta can be distinguished namely: (i) alluvial plain (Recent Nile Alluvium), (ii) the fluvio – marine plain and (iii) the desert plain. Mustafa (1993) showed that the results of paleontolgoical study of shells and snails spread in the soils around Idko Lake indicated the presence of different spices of marine, Lacustrine, alluvial, and terrestrial and plant shells. He reported that these soils were developed from a mixture of alluvium (River Nile), marine (Mediterranean) and Lacustrine (Idko Lake) deposits.

The texture of the soil located around Idko Lake is changing from sandy to clayey. The value of electric conductivity, EC_e, in the saturation extract ranged between 2.60 and 60.90 dsm^{-1}. CEC and ESP ranged between 6 and 53meq/100g soil and between 9 and 46 respectively (Nashed 1991). Ali et al. (2008) in their study on the area located between Idko-Rasheed, the North Nile Delta using remote sensing and GIS found that the area included three landscapes, i.e. flood plain (805.3 km^2), Lacustrine plain (288.98km^2) and Marine plain (169.3km^2). The main subgroups of the soils of these landscapes are Typic Torrifluvents (46.6%). Typic Torripsamments (20%), Typic Haploargds (20%) and Typic Haplosalids (13.4%) Soil capability of the area were carried out upon the factors of soil depth (D), available moisture content (AM), texture class (T). $CaCO_3$ content (K), cation exchange capacity (CEC), exchangeable sodium percentage (ESP), soil salinity (EC) and drainage condition (DC). Results indicate that the most limiting factors in the soils of marine and Lacustraine plains are soil texture, cation exchange capacity and available moisture content. The soil capability in the alluvial plain is limited by soil salinity, exchangeable sodium percentage, and drainage condition and soil depth, (Sys *et al.,* 1991).

The current work aims to study the restriction of soil productivity for soils adjacent to Idko Lake as wells as their land capability that could be a base for proper agricultural utilization and its sustainable agriculture on the long- term.

MATERIALS AND METHODS

The area under investigation is located in the North Nile Delta adjacent to the Idko Lake in El- Beheria governorate. The study area covered almost 210000 feddans extended from 30°03" 12.9" to 30°25"3.6" East and from 31°05"07.7 to 31°18" 44.0" North as shown in Fig (1).

For carrying out this study according to Shata *et al.,* (1978) and the semi detailed survey are made throughout the unites tigated are in order to discover precise soil patterns as well as the land types and the characteristic landscapes based on the profile study. Ten soil profiles were chosen and described morphologically, FAO Guidelines (2006), and representative soil samples were collected. Soil color in both wet and dry conditions was determined using Munsell soil color charts. The collected soil samples were air dried, crushed and sieved through a 2mm sieve, then the obtained fine earth samples (<2mm) were kept for Laboratory analyses. Soil samples were mechanically analyzed according to the international method Page (1950) using hexa–methaphosphate a dispersing agent. The following analyses were carried out using the "soil survey" Laboratory methods manual (USDA. 2004): Calcium carbonate, Gypsum, organic matter and electrical conductivity (EC) was determined conduct metrically; soil reaction (pH) was determined in soil paste action exchange capacity (CEC) and the exchangeable sodium percentage (ESP) were determined. The American soil Taxonomy (USDA, 2010) was used to classify the studied soils of the investigated area to the sub great group level.

Soil limitations as well as land suitability evaluation for irrigated agriculture were obtained by using the parametric systems undertaken by Sys *et al.,* (1991). The main soil parameters used in this system are climate, soil depth, soil texture, gravel %, $CaCO_3$ percentage, Gypsum %, Salinity (EC_e), alkinity (ESP) slope pattern and drainage conditions.

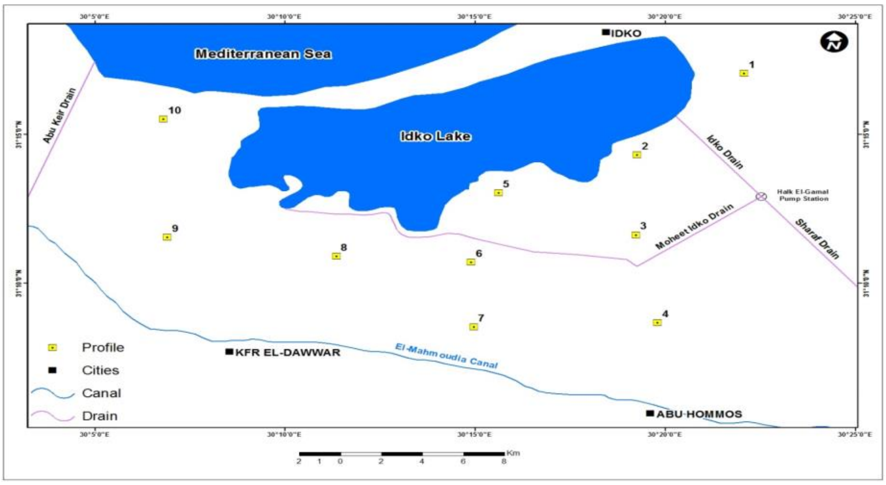

Figure 1.Location of the studied soil profiles

The study area extends from 30° 03' 12.9" to 30° 25' 3.6" East and from 31° 05' 07.7" to 31° 18' 44.0" North.

Profile No.	Longitude	Latitude
1	30° 22' 4.285" E	31° 17' 3.641" N
2	30° 19' 15.769" E	31° 14' 18.815" N
3	30° 19' 13.308" E	31° 11' 37.679" N
4	30° 19' 47.750" E	31° 8' 40.553" N
5	30° 15' 36.820" E	31° 13' 2.552" N
6	30° 14' 53.769" E	31° 10' 42.327" N
7	30° 14' 57.459" E	31° 8' 31.942" N
8	30° 11' 20.971" E	31° 10' 54.627" N
9	30° 6' 54.051" E	31° 11' 32.759" N
10	30° 6' 47.901" E	31° 15' 31.388" N

RESULTS AND DISCUSSION

Soil identification:

The morphological soil profile description is recorded in Table (1). Data shows that the slope of soil surface is almost flat. In dry state, color varies from very dark grayish brown (10YR2/2) to yellow (10YR8/6), while in moist state, it ranges between very dark brown (10YR2/2) and yellow (10YR7/6). Soil texture ranges from mostly clay to sand and soil structure is described as single grain, sub- angular blocky or massive. The soil consistency varies from loss to firm, where as the stickiness and plasticity differ from non sticky to very sticky and non plastic to very plastic, respectively. $CaCO_3$ content as concluded from effervescence with HCl showed moderate to very few carbonates through soil profile layers.

The effective soil depth varies widely from moderately deep to deep and coincides well with water table depth. Soil boundary among layers is detected as clear smooth or diffuse smooth boundary. The investigated area has cracks at the surface of about 10cm wide and extending down to more than 50cm. Also, the morphological description shows well developed slickensides. The slickenside developed through the entire thickness of the studied soils profiles 1, 4, 5, 6, 7, 8 and 9. Gilgai phenomenon was recognized in strong form in the clay textured soils as shown in the morphological description.

1

Physical – Chemical Properties

Data of the physical and chemical properties of the studied soil profiles are shown in table (2). The electric conductivity values EC_e ranges from 2.60 to 60.90 dsm^{-1} indicating that the investigated area vary from non to highly saline soils. It is noticed that, the EC_e values increase from south to north direction towards IdKo Lake; it may be attributed to seepage from the salty Idko Lake into adjacent area which relatively buildup shallow ground water level. pH values ranges from 8.10 to 8.96 indicating slight alkalinity. Organic matter content is generally low and varies from 0.15 to 2.70%.

Low organic matter contents are common in arid and semi-arid regions, since the high temperature and dry climate encourage the decomposition of organic matter. Calcium carbonate content ranges between 1.90 and 10.3%, the lowest value are detected in the subsurface layer of profile 1, where as the highest value is found in the top layer of profile 10. Generally, $CaCo_3$ distribution shows a relatively regular distribution pattern through the studied profile layers Gypsum content is mainly less than 2.5%.

Soil textures vary from clay to sand texture in the different layers of the studied profiles and demonstrate the alternative pattern of sedimentations. These widely variations are more related to the soil origin, intensity of geochemical weathering, vertical or horizontal depositional pattern, and nature of both depositional media and mechanism of transportation. Cation exchange capacity values show a wide range (6 to 53 C mole/kg). The lowest values are detected in soil profile 3, while the highest value characterized the soils profile 7 differences in clay, silt and organic matter contents. Exchangeable sodium percentage (ESP) varied from 9 and 46 such wide variation reflect the dominance of alkalization process which may cause deterioration in some soil chemical properties.

This phenomenon seems to dominate most of the studied profiles except soil profile No’s 2, 3 and 10 where ESP values were less than 15.

2

Soil classification

Based on morphological features, soil physical and chemical properties, soil temperature and moisture requiem and based on USDA (2010**)**; the studied soils could be classified as, Sodic Haplotorrerts, Typic Fluvoaquerts, Typic Torripsamments and Sodic Endoaquerts. The investigated soil profiles can be grouped as shown in table (3).

Table (3). Soil classification

Soil Order	**Sub Order**	**Soil Characteristics**	**Profiles No.**	**Classification (Sub-group)**
Vertisols	Torrerts	Clay content > 30%, Cracks on soil surface of width > 5cm and down to60 cm depth and slickenside EC_e,<15dSm^{-1} , ESP>15 and $CaCO_3$ content<5%	1,4,6,8 and 9	Sodic Haplotorrerts
	Aquerts	Water table less than 100 cm	5 and 7	Sodic Endoaquerts
Entisols	Psamments	Loamy fine sand or sand in all layers EC_e,<10dSm^{-1} $CaCO_3$ content<5% Soil depth >80cm.	3	Typic Torripsamments
	Aquerts	Sandy clay loam in the sub and deepest layer; clay content <30%. Soil profiles are wet since water table depth at about 70 cm.	2 and 10	Typic Fluvoaquerts

Land evaluation for irrigated agriculture:

The current suitability of the studied soils was estimated by matching between the present soil characteristics and their ratings using the parametric system outlines by Sys and Verheye (1978) and Sys et al. (1991) as shown in table (4). Suitability indices and their classes of the studied soils reveal three suitable classes, i.e. moderately suitable S_2, marginally suitable S_3 and non suitable N1, besides five subclasses, e.i S_3 (w,s_2,n), N_1(w,s_2,n), S_3(w,s_1,s_2,n)-S_3 (Wn) and S_2 (w,s_2,n) were recognized in the investigated area. The soil of these subclasses suffering from some soil properties as soil limitations, i.e. soil texture (S_1), wetness (w), soil depth (S_2) and salinity & alkalinity (n) with different intensity degrees, i.e<90 (slight), < 90-60 (moderate) <60- 40 (severe)and <40 (very severe). The subclasses of these soils have a limitation in agriculture widely due to unfavorable soil conditions for better cropping and utilization. The obtained values of suitability indices show that the profile 8 could be evaluated as moderately suitable (S_2), with slight intensity of logging soil depth and moderate intensity salinity and alkalinity. On the other hand of profile 2 is evaluated as not suitable (N_1) for irrigated agriculture- soils. Profile 1,3,4,5,6,7,9 and 10 are evaluated as marginally suitable (S_3), the soils of these profiles have suitability index ranged from 20.8 to 45.5. In general, the studied soil profiles have severe and moderate intensity of salinity & alkalinity as well as slight and moderate intensity for both soil depth and logging limitations.

Potential Land Suitability

Regarding suitability of the studies soils, data reveal that the soils are affected mainly by drainage conditions, soil depth, soil fertility, as well as salinity and alkalinity. Land improvement is required to correct or to reduce the severity of limitations exiting in the studies area, such as:

(i) Improving the internal and external drainage by preparing system of beds and furrows for cultivation. Moukhtar et al (2012) indicated that drainage have an attractive effect on lowering the water table, for the most part under narrow spacing between drains combined with mole lines and hydraulic connection. Increasing downward water movement after irrigation gives the chance for the effective root zone to dry, shrink and form water pathways.

(ii) Leaching of soil salinity to get rid of soluble salts outside of the area.

(iii) Adding soil amendments (Gypsum) to reduce the ESP values and increase soil aggregates.

(iv) Continuous application of organic manure to improve soil physical–chemical properties and fertility status.

Potential Land Suitability:

The potential land suitability data are shown in table (4). These adaptations can be described by applying the previous improvement practices, and in turn potential suitability of the studies soils indicates the existing of three suitability classes, i.e. highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S_3). However, soil suitability sub-classes of soil profile No (5, 6, 7, 8 and 9) improved from marginally suitable (s_3) to highly suitable (s_1) as well as soils of profile (2) and (4) improved from none and marginally suitable (N1 w_{bn}) and (S_3 w_{ban}) to moderately suitable (s_2s_1). Soils of profile (3) improved from marginally suitable S3 w, s1, s2, n to marginally suitable (s_3s_1) where suitability index changed from 37.80 to 42.08. The later subclass represents the soils of profiles (3 and 4) with severe to moderate intensity of soil texture (relatively coarse) as soil limitations. The severity of soil texture (sand) can be corrected in these subclasses by application of organic and inorganic soil amendments as well as drip irrigation system to soil moisture content at favorable conditions for grown plants.

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معوقات إنتاجية الأراضي المتاخمة لبحيرة إدكو شمال دلتا النيل

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تقع معظم الأراضي الزراعية المنخفضة في الإنتاجية بالحزام الشمالي بمصر وهي أراضي واعدة وقابلة للزيادة في الإنتاجية، وأحد هذه المناطق الأراضي المتاخمة لبحيرة ادكو بمحافظة البحيرة وتهدف هذه الدراسة لتحديد معوقات الإنتاجية علاوة على تقييم القدرة الملائمة للمصادر الطبيعية للأراضي الزراعية في هذه المنطقة.

فقد تم أخذ عشرة قطاعات أرضية ممثلة للمنطقة مع وصف القطاعات مورفولوجياً وأخذ عينات أرضية طبقاً للاختلاف في الصفات المورفولوجية، وأجريت عليها التحليلات الطبيعية والكيميائية وطبقا للتقسيم الأمريكي (2010) قسمت الأراضي إلى تحت المجاميع الأرضية التالية:

Sodic Haplotorrerts, Sodic Endoaquerts, *Typic Torripsamments* and *Typic Fluvoaquerts*.

وتبعاً للنظام الكمي لنظام التقييم بواسطة Sys & Verheye (1978) فإن درجات الصلاحية الحالية للأراضي تحت الدراسة يمكن تحديدها في ثلاث درجات وهي متوسطة الصلاحية (S_2) وهامشية الصلاحية (S_3) وعديمة الصلاحية (N_1) للزراعات المروية، بجانب خمسة تحت درجة وهي S_3 (wabn) ، N_1 (wbn)، S_3 (wbn)، S_2 (wbn)، S_3 (wn) وهذه الأراضي تعاني من بعض المعوقات للإنتاجية متمثلة في قوام التربة والصرف الحقلي بجانب الملوحة والقلوية للتربة وذلك بدرجات متباينة في شدتها. وفي حالة إجراء عمليات تحسين لهذه الأراضي من خلال تحسين حالة الصرف الحقلي وغسيل الأملاح ومعالجة القلوية فإن الصلاحية الكامنة سوف ترتفع بالإضافة إلى إختيار المحاصيل الأكثر ملائمة لظروف المنطقة.

قام بتحكيم البحث

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