Environmental Study for Rashid and Idko Districts, El Behira Governorate, Egypt by using Remote Sensing and Geographic Information System techniques

1- Land and Water Resources Assessment for Sustainable Agricultural Development

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ABSTRACT

The three main Nile Delta wetland ecosystems, Manzala, Burullus and Idko lagoons, are among the most ecologically important and productive habitats in Egypt. The study area located between 31º 10\ and 31 º30 \ N and 30 º 10\ and 30º 35\ E with total area about 104522 fed. The study area includes Idko and Rashid Districts, Behira Governorate, Egypt. Rashid district covers about 47312 fed., Idko district covers about 33503 fed., and Idko Lake covers about 23707 fed. Seventeen soil profiles were dug in Idko district and twenty six soil profiles were dug at Rashid district**.** Water samples were collected to characterize their chemical properties 42 irrigation water samples, 7 drainage water samples and 24 water table samples**.** The soil mapping units extracted from the overlay of the main soil properties layers in the GIS environment such as soil depth, soil salinity, total calcium carbonate and soil texture. 10 soil units found in the study area. According to the model prediction, most of the study area was classified as (C3 aw, kh), which indicated moderately capability with available water and hydraulic conductivity as limiting factor which covered an area about 41.37% of the total area mostly focused in Rashid district followed by (C3 t, aw), which indicated moderately capability with available water and texture class as limiting factor which covered an area about 34.53% of the total area mostly focused in the area in between the two districts and the area closed to Idko lake followed by (C4 aw, t, ece), which indicated low capability with available water, texture class and soil salinity as limiting factor concentrated in the coastal area at Rashid district and very closed to Idko lake at Idko district.

Key words: Idko Lake, GIS, RS, Land capability, land suitability, and Soil Units.

INTRODUCTION

Since 1980s, Egyptian agriculture has benefitted from articulating and implementing four agricultural development strategies, namely the 1980s Agricultural Development Strategy, 1990s Agricultural Development Strategy, the Agricultural Development Strategy towards 2017, and Sustainable Agricultural Development Strategy towards 2030 (SADS). Meanwhile, agricultural development efforts have also experienced major changes in the different fields of plant production, due to synergized expansion of agricultural areas, and improving productivity. These efforts have led to the increase the agricultural land from 5.87 m feddans1 to approximately 8.44 m feddans in 2007, as well as increasing cropped area from some 11.1 m feddans in 1980 to 15.18 m feddans at present. This period has also experienced major changes in the cropping pattern. Agricultural productivity per land unit has also been significantly increased. The horizontal and vertical improvement in cultivated and crop productivity led to notable success in meeting increased population needs and achieving an average growth rate development from 3 to 4% annually. The main objectives of SADS were 1) sustainable use of agricultural natural resources, 2) Improving Agricultural Productivity, 3) Increasing Competitiveness of the agricultural Products in Local and Foreign Markets, 4) Achieving Higher Rates of Food Security in Strategic Goods, 5) Improving Opportunities for Agricultural Investment, 6) Improving Livelihood of Rural Inhabitants, and 7) Investments Needed to Achieve the Strategy Objectives (Abul Naga 2009). The creation of land resources database is rather important in documenting the environmental themes. Such documentation leads to data harmonization and maximization of its value. It also allows an easy data processing, and updating. The land resources databases are rather useful in elaborating site selection for sustainable development projects, in addition to decision support makers and early warning for non-natural phenomena such as floods and locusts…. etc. Remote sensing, with its multi-concept approach, provides up-to-date information on different themes. Multi-dates images allow detecting changes occurring in different environmental conditions. Also, multi spectral satellite images reflect the environmental elements characterized by a variety of spectral signature. Moreover, GIS and its integrated functional nature with remote sensing technology, facilitate the creation and developing of land resources databases (Said et. al. 2012). A sustainable development of the agricultural sector in Egypt is constrained by several factors. Which include:

Scarce land and water resources: Egypt has a limited area of arable land suitable for crops (3.5 million ha). Added to this constraint are the pressure of urban encroachments, degradation of land quality by intensive agriculture, and the onslaught of the desert. Even more important is the water constraint, there is little potential for additional water and the demand is fast rising in both the agricultural and other sectors, particularly in industry and urban households.

Environmental degradation: Intensive agriculture based on limited land and less water resources has led to considerable deterioration of land water quality, which is exacerbated by the effects of high doses of fertilizers and pesticides, use of fossil fuels, and the increased industrial and urban waste contaminating the natural resource base.

Rapid population growth: Egypt's population more than 90 million is increasing at an annual rate of 1.69 percent. Its effects on the economy and society are pervasive and generally deleterious.

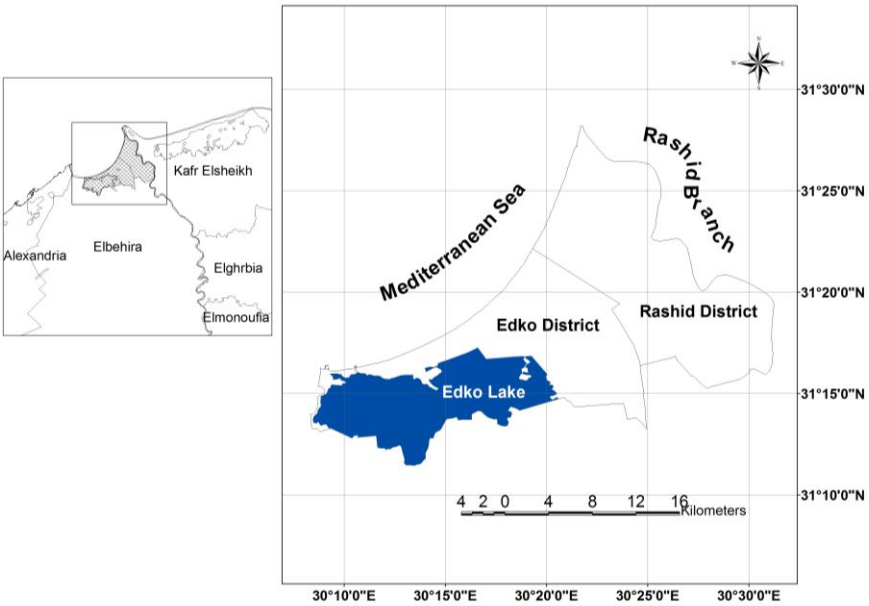
Institutional arrangements: The land tenure system, including farm fragmentation and land prices and rents have adverse effects on building farmers' organizations adoption of new technology, and efficient use of land and water resources.

Agricultural administration: The support infrastructure for agricultural education, research, and extension has lacked effectiveness because of poor coordination and absence of direct participation by the end-users farmers (Gehad A. 2003). The following represents the specific objectives of this study: 1- Characterize land and water resources of Idko and Rashid districts. 2- Evaluate soil capability and suitability for different land uses for the study area by using Applied Land Evaluation System (ALES) in GIS environment**.**

MATERIALS AND METHODS

1. Study Area:

1.1. General Description The study area is located between 31º 10\ and 31 º30 \ N and 30 º 10\ and 30º 35\ E with total area of 104522 fed. The study area includes Idko and Rashid Districts, Behira Governorate, Egypt. Rashid district covers about 47312 fed., Idko district covers about 33503 fed., and Idko Lake covers about 23707 fed. map (1). Idko district consists of three Sheikhs; the largest one is Idko where covers an area about 21102 fed. and has highest number of residents but the smallest one is El Maadya where covers an area of 4475 fed. and has a total population 19574 resident. Rashid district consists of 17 Sheikhs; the largest one is Rashid where covers an area about 11385 fed. and has total population 14256 residents on the other hand the smallest one is Edfina where covers an area of 332 fed. and has total population 2627 residents. There are significant relationship between the distribution of total population distribution and the area of each Sheikh.



Map 1: General location of the study area.

1.2. Study area characteristics: The coastal ecosystem includes: the agricultural land, clusters of palm trees, sand dunes residues scattered in the middle of the area, wide sandy beaches, the Rosetta Nile branch, River Nile basin, different classes of Lake Idko land cover, the urban environment expressed in a of a hierarchy of urban clusters varying in size starting from a vast number of villages and farms and towns to large urban conglomeration resembling the main cities of the governorate of the region. This is besides the interfering transportation network of roads, water system expressed in canals and drains, and various components of the infrastructure of the region (El Molla et., al. 2005).

2. Field and Laboratory work:

2.1. Fieldwork: The fieldwork aimed to characterize the land units for the study area. Grid system was designed to cover the study area the distance between each soil profile was 500 Km. Fourty-three soil profiles were dug in the field for an area about 104522 fed. Seventeen soil profiles were dug in Idko district and twenty six soil profiles were dug at Rashid district as shown in map (2). Soil profiles were described in the field according to FAO (2006). Different water samples (26 irrigation water samples, 19 drainage water samples and 22 water table samples) were collected from each soil profile site.

2-2. Laboratory analysis: soil samples were prepared to determine some soil chemical properties (Page et al., 1982), include the electric conductivity in dS/m, soluble cations and anions; and the soil reaction (pH) were measured in the suspension (1:2.5). Sodium adsorption ratio (SAR) was calculated (Richards 1954). In addition, total carbonates were determined by Collin's calcimeter. Furthermore, soil texture by hydrometer (FAO, 1970). Water samples were analyzed in order to characterize the water quality.

3. Satellite Image:

A window of Landsat 1 ETM+8 (Enhanced Thematic Mapper) image acquired in may. 2015 was selected to represent the study area as shown in map (3).

3.1. Image Registration: Image registration is the first step to be carried out before proceeding to any further image processing. This step will assign coordinate systems to the image and linked it to its location on the ground. The ETM+ 8 image captured in May. 2015 was geometrically rectified to the digitized topographic maps using image-to-map procedure in ENVI 4.8 software (ENVI, 2008).

3.3. Resolution Merge: This dialog enables you to integrate imagery of different spatial resolutions (pixel size). Since higher resolution imagery is generally single band (ETM Panchromatic 15m data), while multispectral imagery generally has the lower resolutions (ETM 30m), these techniques are often used to produce high resolution, multispectral imagery. This improves the interpretability of the data by having high resolution information which is also in color. Resolution Merge offers three techniques: Multiplicative, Principal Components, and Brovey Transform (ERDAS 9.2, 2008).

3.4. Satellite Image Classification: Erdase imaging 9.2 was used to carry out the image classification. The following steps were used for image classification:

a- Subset of Study Area: This process cuts out (clip) the preferred study area from the image scene into a smaller more manageable file.

b- Unsupervised Classification: An unsupervised classification routine (CATEGORIZE) was used to create clusters of pixels with similar spectral characteristics in purpose of recognizing the main classes. Twenty spectral classes were created using bands 4, 3, and 2 as RGB to be input to the module. The obtained classes were regrouped into seven spectral classes. The trick then becomes one of trying to relate the different clusters to meaningful ground categories. This is done by visiting the study area.

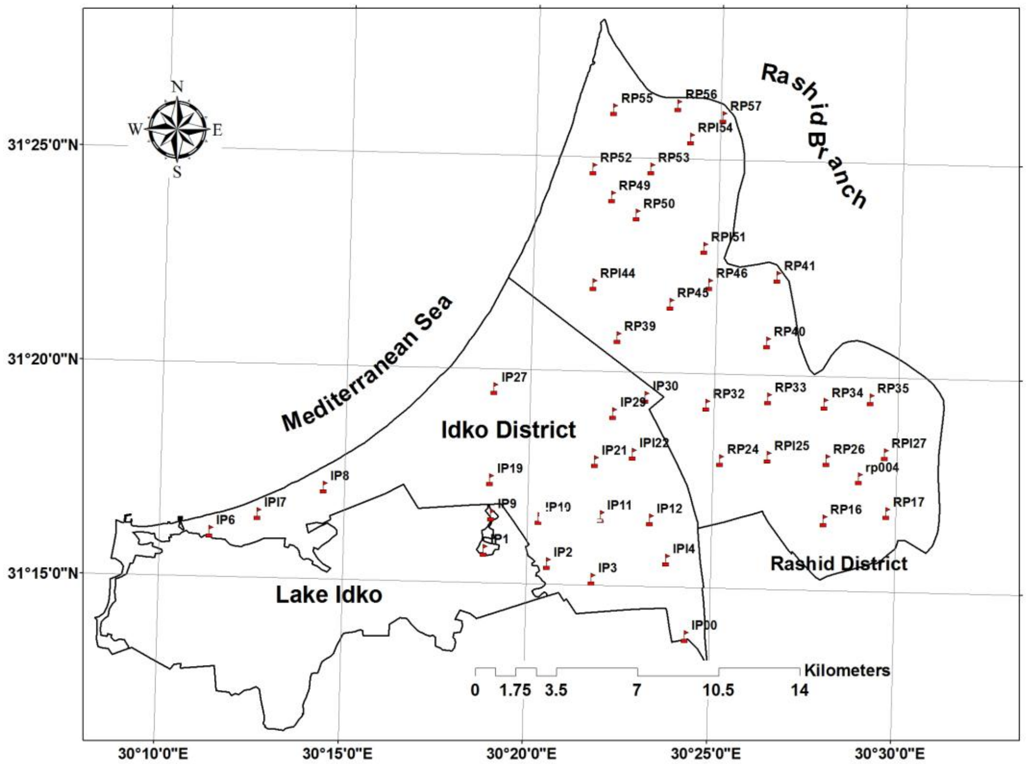
4. Topographic Maps

The study area is covered by five topographic map sheets at scale 1: 25000 produced by Egyptian General Survey Authority in 1982 named Abo Kir, Rashid, Edfina, Kafer El Dawer and Damanhour as shown in map (4). The ENVI software is used to convert the geographic coordinates (Lat-Long) system to Universal Transverse Mercator (UTM) coordinates (Easting-Northing) system.

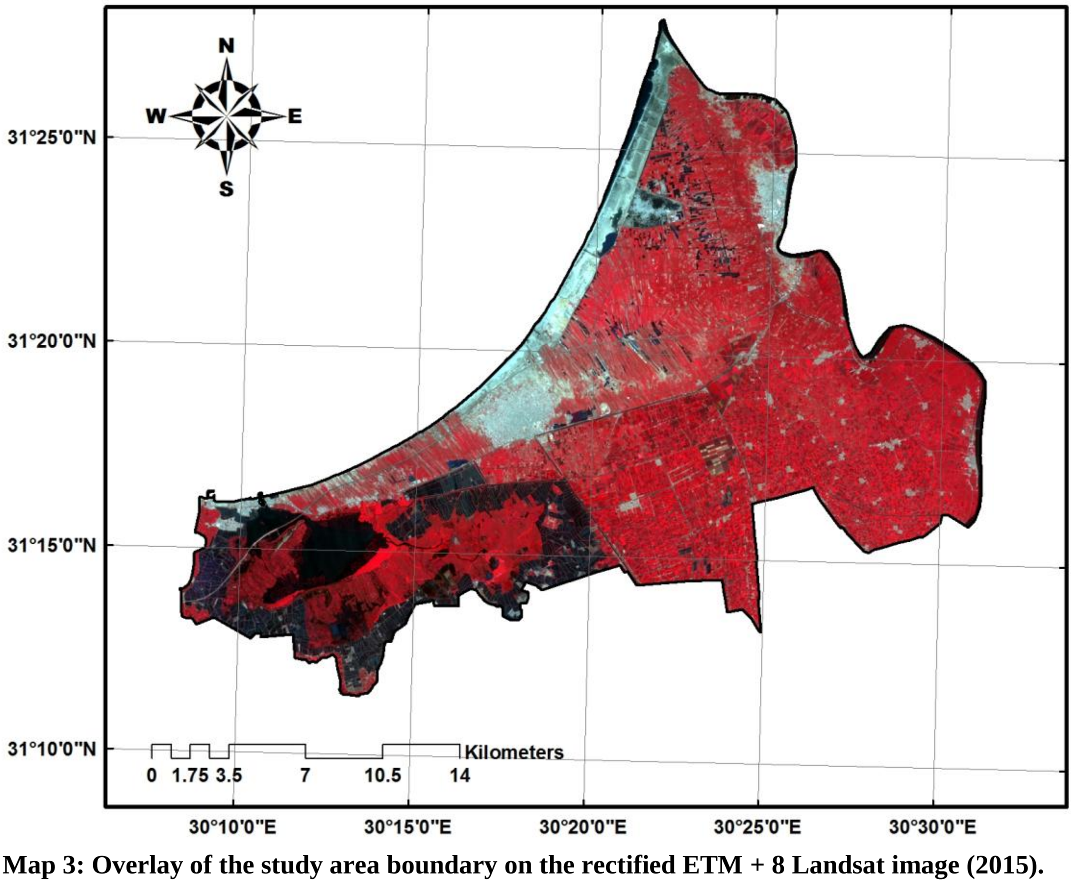
4.1. Generation of DEM: The digitized contour lines and spot heights were utilized by Contour Gridder extension to generate the Digital Elevation Model (DEM) within ArcGIS 10.3 environment. The Digital Elevation Model (DEM) is analyzed to generate the degree of slope classes and Aspect as shown in tables (1 and 2).

5. Descriptive statistical parameters: Minimum, maximum, mean, standard deviation and coefficient of variance were calculated using SPSS software Ver. 12 (2003).

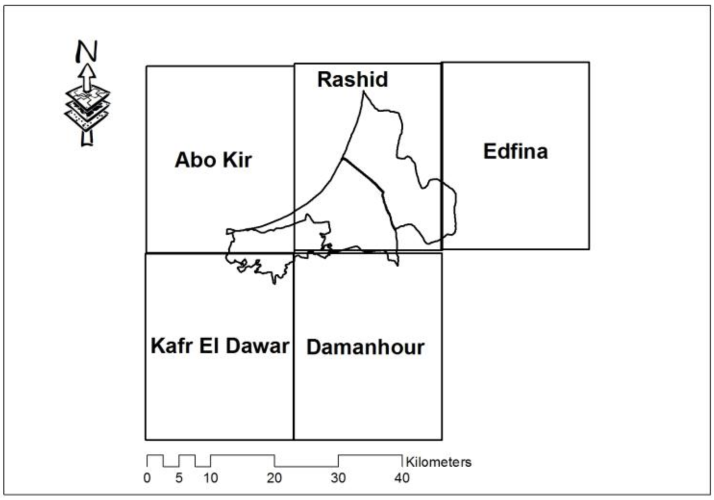
5.1. Building up Digital Georeference Database: Data input process is the operation of entering the spatial and non-spatial data into GIS using ArcGIS 10.3 software. Each soil observation was geo-referenced using the Global Position Systems (GPS) and digitized. The different soil attributes were coded, and new fields were added to the profile database file in Arc/View software. Surface interpolate grid were done for soil salinity, Soil depth, $CaCO_3$ % using module Arc Scripts in ArcGIS 10.3 (ESRI, 2014).



Map 2: Soil profiles distribution at Idko and Rashid districts.



Map 3: Overlay of the study area boundary on the rectified ETM + 8 Landsat image (2015).



Map 4: Topographic map sheets cover study area.

Table 1: Slope classes according to the (FAO, 1990).

Type of class	Slope %
Flat	0 – 0.2%
Level	0.2 – 0.5%
Nearly Level	0.5 – 1.0%
Very Gently Slope	1 – 2%
Gently Slope	2 – 5%
Sloping	5 – 10%
Strongly sloping	10 – 15%
Moderately Sloping	15 – 30%
Steep	30 – 60%
Very Steep	> 60%

Table 2: Aspect classes and their Azimuth ranges.

Aspect class	Compass direction	Azimuth range (degree)
1	North	0.0 – 22.5 and 337.5 – 360.0
2	Northeast	22.5 – 67.5
3	East	67.5 – 112.5
4	Southeast	112.5 – 157.5
5	South	157.5 – 202.5
6	Southwest	202.5 – 247.5
7	West	247.5 – 292.5
8	Northwest	292.5 – 337.5

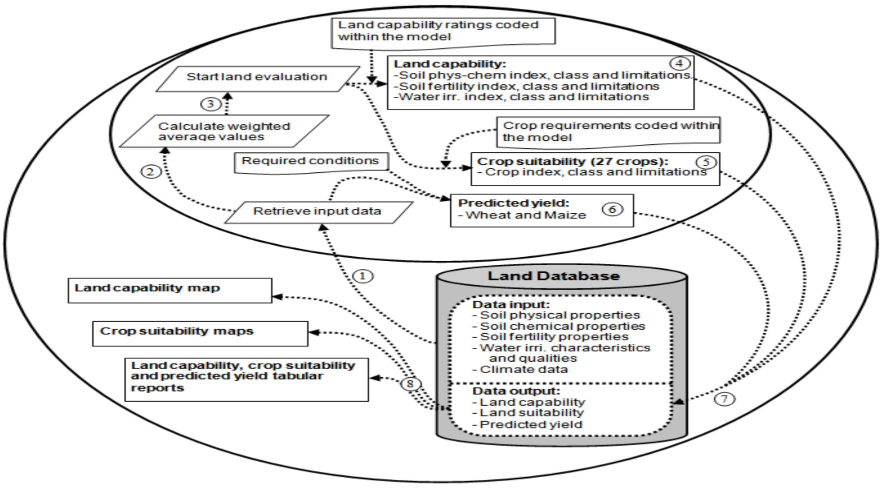


Fig. 1: The structure of ALES arid-GIS. The inner circle shows the model steps (the land evaluation processes) and the outer circle represents the GIS framework (ArcMap platform).

6. Land evaluation: Land capability and suitability evaluation have been done using ALES-Arid as shown in figure 1 (Abd El-Kawy et al., 2010).

RESULTS AND DISCUSSION

1. Statistical characterization of soil profiles attributes: Table (8) indicates the statistical parameters of the soil profiles for the different soil horizons samples for Rashid district the soil depth ranged from 70 cm to 185 cm with mean value about 115 cm. The coefficient of variation of the soil depth was 0.22 shows that the soil depth was less homogeneity in Rashid district. For the surface horizon the coefficient of variation shows that pH was less homogeneity 0.04 and ranged from 7.64 to 9.04 and this may be due to the high sand content in the surface horizon. Ec ranged from 0.53 to 10.50 dS/m. The highest homogeneity properties were sand%, clay%, SAR%, silt % and Ec dS/m 0.38, 0.66, 0.75, 0.76, and 0.98 respectively. Ec decrease with depth in the horizon no.2 and ranged from 0.69 to 3.72 dS/m. The highest homogeneity was sand%, Ec, SAR, clay% and silt% 0.47, 0.55, 0.68, 0.69 and 0.69 respectively. The same for the other horizons but the value of Ec decreased with the depth and ranged from 0.53 to 6.11 dS/m for the horizon no 3. For the horizon no 4 soil salinity ranged from 0.59 to 10.10 dS/m.

Table 8: characteristics and the main statistical parameters of soil profiles samples for Rashid district.

Properties	NO. of representive samples	Minimum	Maximum	Range	Median	Mean	St. D	Variance	C. V.
Horizon No1									
Depth	26	70.00	185.00	110.00	110.00	115.77	25.00	625.38	0.22
Ec, dS/m	26	0.53	10.50	9.97	1.73	2.35	2.32	5.37	0.98
pH	26	7.64	9.04	1.40	8.11	8.21	0.38	0.14	0.04
SAR	26	1.06	16.16	15.09	5.00	4.73	3.55	12.56	0.75
$CaCO_3$	26	0.00	8.62	8.62	1.66	1.84	2.39	5.71	1.30
Clay, %	26	8.00	55.00	47.00	30.00	24.23	16.08	258.50	0.66
Silt, %	26	0.00	22.00	22.00	9.88	9.35	7.53	56.83	0.76
Sand, %	26	10.00	92.00	82.00	62.02	60.43	23.69	561.55	0.38
Horizon No2									
Ec, dS/m	26	0.69	3.72	3.03	1.50	1.52	0.83	0.69	0.55
pH	26	7.55	8.85	1.30	8.21	8.12	0.39	0.15	0.05
SAR	26	1.29	14.97	13.68	6.71	5.46	3.71	13.77	0.68
$CaCO_3$	26	0.00	11.50	11.50	2.40	2.39	3.08	9.48	1.29
Clay, %	26	6.00	58.00	52.00	36.00	26.92	18.56	344.55	0.69
Silt, %	26	2.00	22.00	20.00	8.00	9.81	6.75	45.60	0.69
Sand, %	26	10.00	90.58	80.58	42.98	56.37	26.53	703.76	0.47
Horizon No3									
Ec, dS/m	26	0.53	6.11	5.58	1.74	3.81	1.35	1.82	0.77
pH	26	7.70	9.06	1.36	8.21	8.28	0.38	0.14	0.05
SAR	26	1.26	25.46	24.19	7.25	12.64	6.32	39.99	0.87
$CaCO_3$	26	0.00	18.85	18.85	2.39	3.75	4.06	16.46	1.69
Clay, %	26	8.00	49.00	41.00	27.27	31.07	18.80	353.49	0.69
Silt, %	26	2.00	27.00	25.00	9.65	8.76	7.12	50.72	0.74
Sand, %	26	10.00	90.00	80.00	59.08	57.41	25.93	672.51	0.44
Horizon No 4									
Ec, dS/m	20	0.59	10.10	9.51	2.45	4.34	2.41	5.81	0.98
pH	20	7.52	8.90	1.38	8.16	8.21	0.46	0.21	0.05
SAR	20	1.70	34.39	62.69	9.69	15.32	9.03	81.62	0.93
$CaCO_3$	20	0.00	7.36	7.36	1.84	2.15	1.85	3.42	1.00
Clay, %	20	8.00	58.00	50.00	33.75	36.77	20.40	416.41	0.61
Silt, %	20	2.00	19.00	17.00	9.60	9.40	5.31	28.15	0.55
Sand, %	20	10.00	90.00	80.00	51.74	50.31	25.31	640.34	0.49

For Idko district table (9) the soil depth ranged from 60 cm to 200 cm with mean value about 112 cm. The coefficient of variation of the soil depth was 0.25 shows that the soil depth was less homogeneity in Idko district. For the surface horizon the coefficient of variation shows that pH was less homogeneity 0.04 and ranged from 7.78 to 8.82 may be due to the high sand content in the surface horizon. Ec ranged from 0.45 to 12.72 dS/m. The highest homogeneity properties were sand%, silt%, SAR, clay% and Ec dS/m 0.48, 0.67, 0.69, 0.69 and 0.88 respectively. Ec increase with depth in the horizon no.2 ranged from 0.92 to 21.00 dS/m. The highest homogeneity was sand%, silt%, clay%, SAR and Ec, dS/m 0.54, 0.66, 0.72, 0.78 and 1.06 respectively. The same for the other horizons but the value of Ec increase with the depth ranged from 0.90 to 33.60 dS/m for the horizon no 3. For the horizon no 4 soil salinity ranged from 1.17 to 22.20 dS/m. In general the soil depth in Idko district was deeper than Rashid district the same for soil salinity in Idko district higher than Rashid district due to the absence of drainage system in Idko district and the irrigation from the lake Idko.

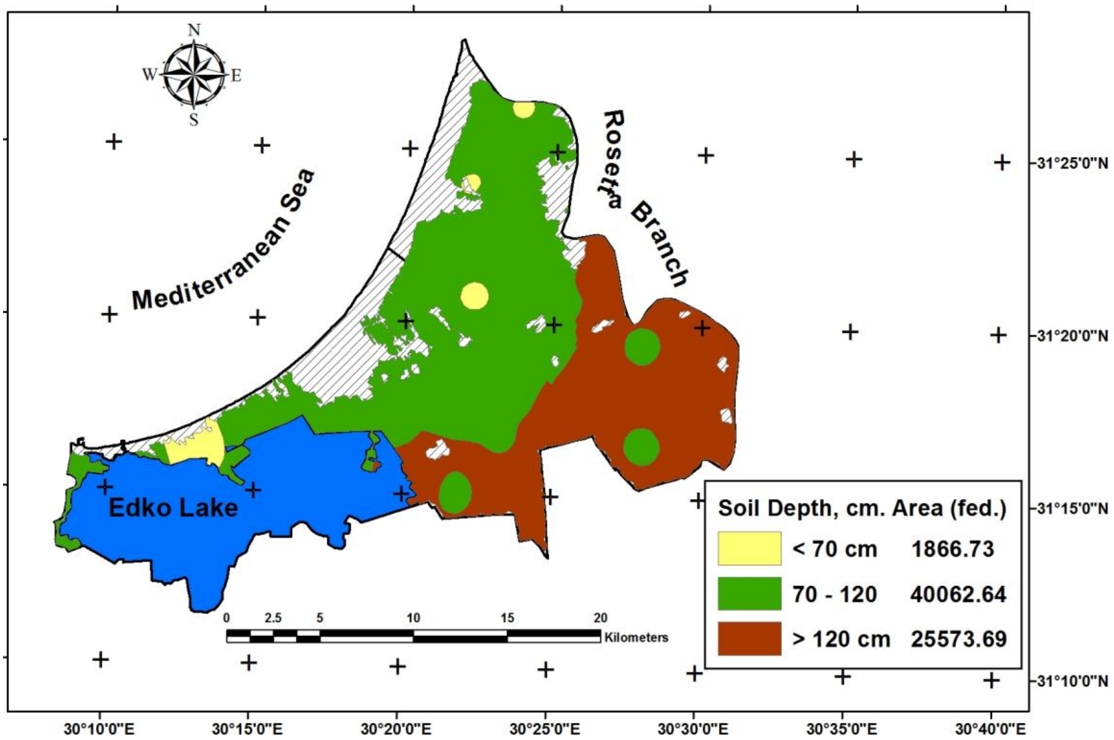
1.1. Soil mapping units: The soil mapping units of the study area were extracted from the overlay of the main soil properties layers in the GIS environment such as soil depth (map 5), soil salinity (map 6), total calcium carbonate (map 7) and soil texture (map 8). 10 soil units found in the study area as shown in map (9) and table (11) shows the area and percentage of each soil unit in the study area.

Table 9: characteristics and the main statistical parameters of soil profiles samples for Idko district.

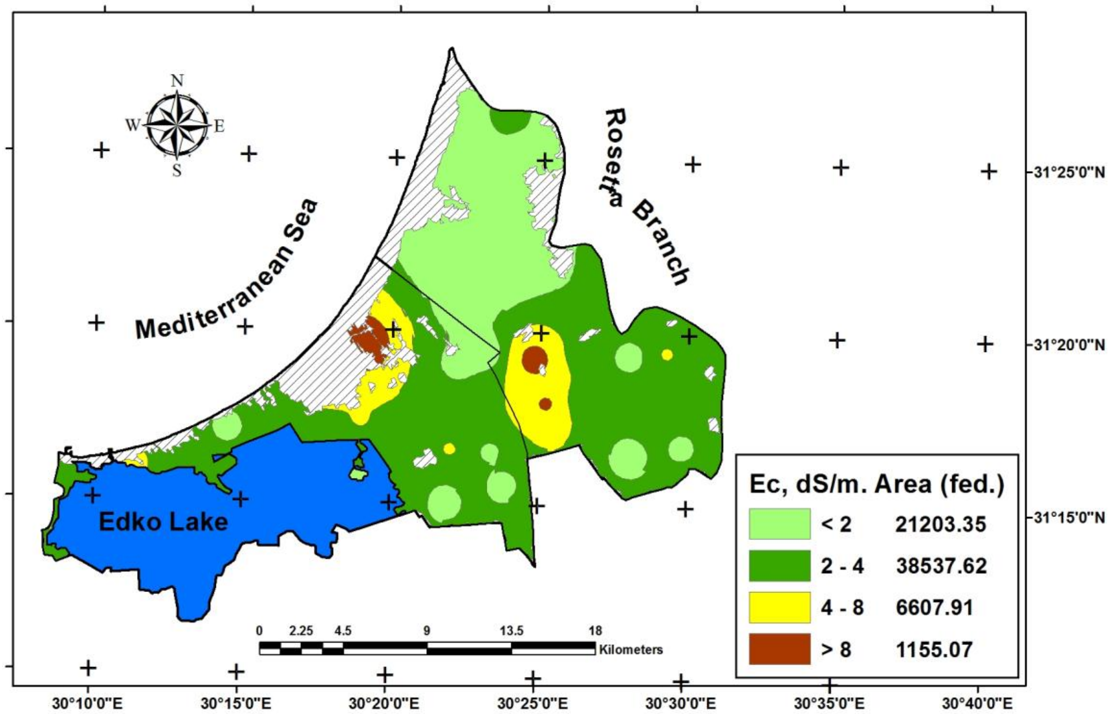
Properties	NO. of representive samples	Minimum	Maximum	Range	Median	Mean	St. D	Variance	C. V.
Horizon No1									
Depth	17	60.00	200.00	140.00	110.00	112.94	28.45	809.56	0.25
Ec, dS/m	17	0.45	12.72	12.72	1.73	3.11	2.76	7.63	0.88
pH	17	7.78	8.82	1.04	8.16	8.19	0.29	0.08	0.04
SAR	17	1.79	28.99	27.19	5.00	9.28	6.36	40.87	0.69
$CaCO_3$	17	0.55	36.11	35.56	1.66	6.58	9.20	84.69	1.39
Clay, %	17	5.00	57.00	52.00	30.00	32.68	22.50	506.26	0.69
Silt, %	17	0.00	19.00	17.00	8.00	8.53	5.74	32.89	0.67
Sand, %	17	28.68	91.48	62.80	50.13	57.99	27.63	763.35	0.48
Horizon No2									
Ec, dS/m	17	0.92	21.00	20.08	1.50	4.68	4.96	24.56	1.06
pH	17	7.66	8.52	0.86	8.21	8.13	0.30	0.09	0.04
SAR	17	4.30	48.11	43.81	6.71	14.55	11.31	127.92	0.78
$CaCO_3$	17	1.10	26.66	25.56	2.40	6.14	7.03	49.47	1.15
Clay, %	17	4.00	63.00	59.00	36.00	36.18	25.91	671.40	0.72
Silt, %	17	0.00	19.00	19.00	8.00	7.12	4.69	21.99	0.66
Sand, %	17	23.18	92.48	69.30	42.98	55.95	29.35	861.18	0.54
Horizon No3									
Ec, dS/m	16	0.90	33.60	32.70	1.45	7.17	8.21	67.36	1.14
pH	16	7.48	9.00	1.52	8.31	8.27	0.45	0.20	0.05
SAR	16	4.62	48.24	43.62	6.76	21.36	13.68	192.18	0.65
$CaCO_3$	16	0.55	36.11	35.56	1.28	5.96	9.36	87.53	1.57
Clay, %	16	4.00	60.00	56.00	39.50	37.25	24.04	577.93	0.64
Silt, %	16	0.00	16.00	16.00	8.00	7.31	5.04	25.43	0.69
Sand, %	16	28.68	95.23	66.55	41.88	54.70	28.41	807.09	0.52
Horizon No 4									
Ec, dS/m	10	1.17	22.20	21.03	2.04	8.11	7.16	51.27	0.88
pH	10	7.93	8.73	0.80	8.26	8.30	0.27	0.07	0.03
SAR	10	4.11	59.69	55.58	9.71	26.56	18.74	353.21	0.71
$CaCO_3$	10	0.50	5.00	4.50	2.04	2.77	1.54	2.32	0.55
Clay, %	10	8.00	60.00	52.00	42.80	36.77	23.71	561.95	0.55
Silt, %	10	5.00	13.00	8.00	9.00	9.40	3.53	12.44	0.39
Sand, %	10	28.68	86.43	57.75	47.44	50.31	26.44	699.21	0.56

Table 10: The area and percentage of the soil depth in Idko and Rashid districts.

Depth, cm	Area, %
Moderate < 70 cm	2.77
Deep 70 – 120 cm	59.35
Very Deep > 120 cm	37.88

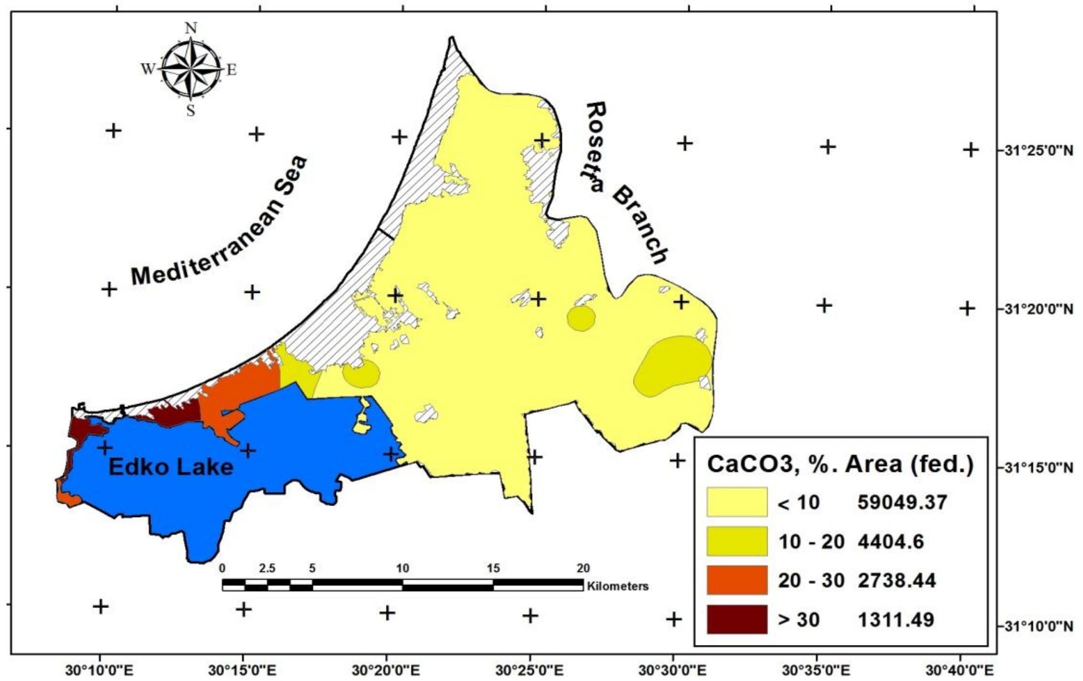


Map5: Soil depth distribution of Idko and Rashid districts.

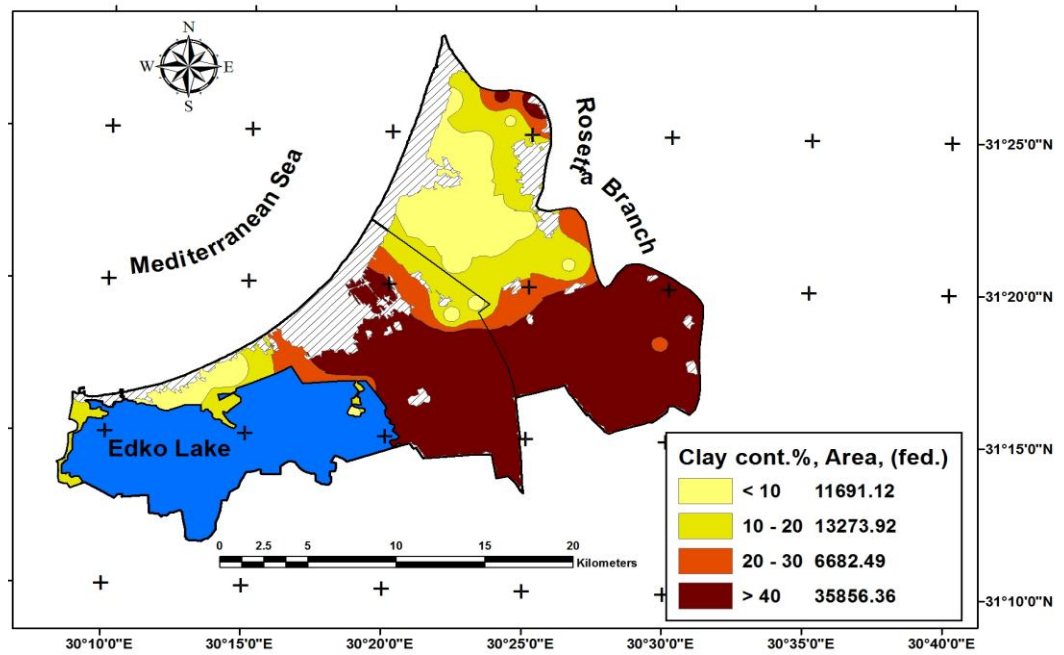


Map 6: Soil salinity distribution of Idko and Rashid districts.

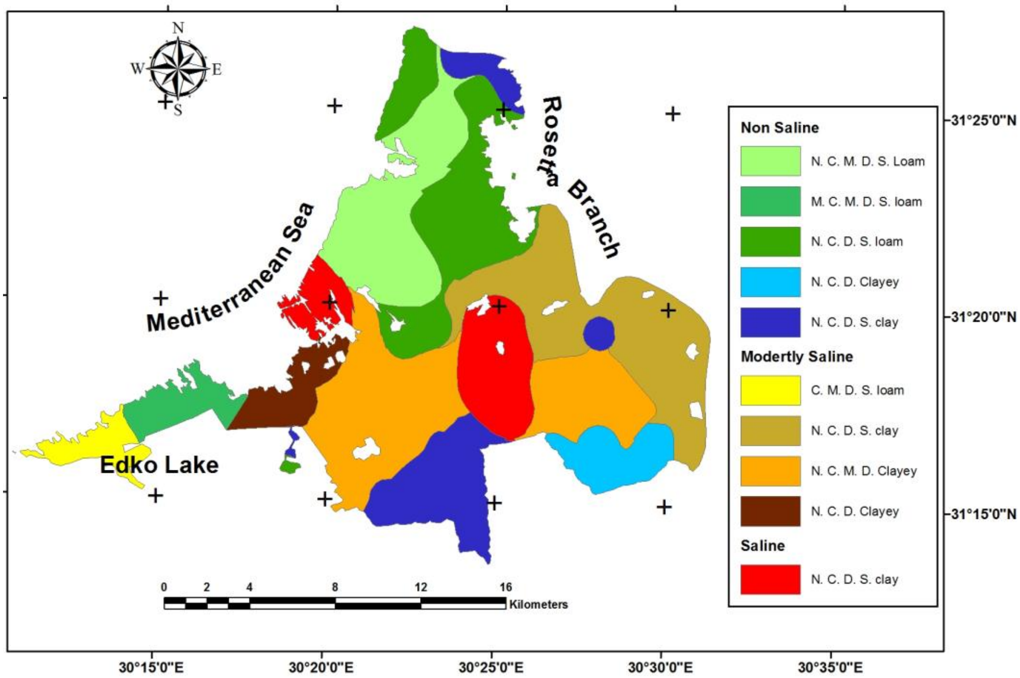
It is clear that soil salinity is variable and ranged from > 2 to < 8 dS/m, where the dominant soil salinity was 4 - 8 dS/m covered an area about of 57.09% of the total mostly focused in the southern part of the study area. Followed by < 2 dS/m class covered an area about of 31.41% of the total area mostly focused in the northeastern part of the study area which is irrigated from the Nile River directly as shown in map (6). Total calcium carbonate ranged from <2% to >30% and classified according to FAO, 1990 into four classes as shown in map (7) the dominant class was > 10% which covered an area about 87.47% of the total area mostly focused in the eastern part of the study area and increasingly in the western direction near Lake Idko followed by 10 – 20% which covered an area about 6.52% of the studied area. This may be due to the proximity of this land along Lake Idko and the quality of land used for backfilling. By studying the clay content in Idko and Rashid districts its clear that the southern part of the study area have heavy clay content texture as shown in map (8).



Map 7: Soil calcium carbonate distribution of Idko and Rashid districts.



Map 8: Clay content distribution of Idko and Rashid districts.



N = Non, C = Calcareous , M = Moderately, D = Deep, S = Sand

Map 9: Soil mapping units distribution in the study area.

Table 11: The area and percentage of soil units.

Soil unit	Area, fed.	Area, %
Non Saline		
N. C. M. D. S. loam	8553.22	12.67
M. C. M. D. S. loam	2343.91	3.47
N. C. D. S. Loam	2625.13	3.89
N. C. D. Clayey	9783.76	14.49
N. C. D. S. clay	2946.98	4.36
Moderately Saline		
C. M. D. S. loam	11742.73	17.40
N. C. D. S. clay	6164.88	9.13
N. C. M. D. clayey	7070.69	10.47
N. C. D. clayey	13772.25	20.40
Saline		
N. C. D. S. clay	2498.37	3.70

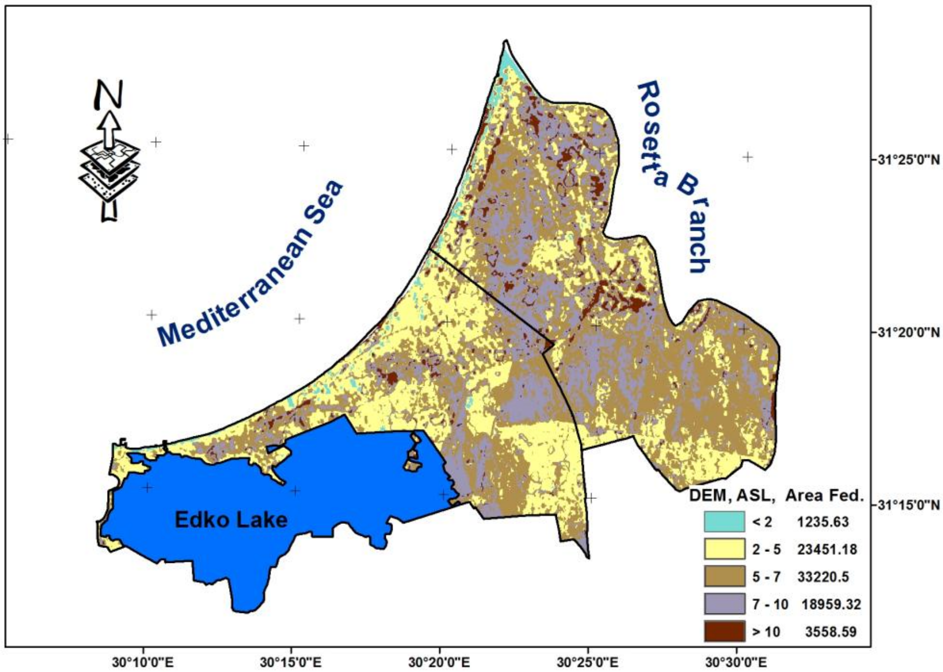
The clay content percentage ranged from < 10% to >30% and classified according to FAO, 1990 into four classes. The dominant class was > 40% which covered an area about 53.12% of the total area mostly focused in the southern part of the study area and decrease in the northern direction near the coast line followed by 10 – 20% which covered an area about 19.67% of the studied area. This may be due to the texture and quality of land used for backfilling in the north part of the study area.

1. 2. Terrain components:

a) Digital Elevation Model (DEM): The analysis of DEM indicated that the elevations ranged between > 2 m A.S.L. to < 10 m A.S.L. The main elevation from 5 m A.S.L. 7 m A.S.L. covers an area about of 33220.50 fed. mostly focused in eastern part of the study area followed by the elevation 2 m A.S.L. to 5 m A.S.L. compress an area about 23451.18 mostly focused in the western and middle parts of the study area especially in Idko district as shown in map (10) and Table (12).

Table 12: DEM classes, area percentage of Idko and Rashid districts.

Elevation, m A.S.L.	Area, fed.
< 2	1235.63
2 – 5	23451.18
5 – 7	33220.50
7 – 10	18959.32
> 10	3558.59



Map 10: Digital Elevation Model (DEM) of Idko and Rashid districts.

b) Slope: It's clear that the dominant slope class is 1-3% covering an area 49.6% of the total area of the study area followed by slope class > 3% covered an area about 26.8% as shown in Table (13).

Table 13: Slope classes and area percentage of Idko and Rashid districts.

Slope class	Area, %
0 – 1	24.32
1 – 3	49.60
> 3	26.08

c) Aspect: Table (14) indicates the percentage of each aspect class in Idko and Rashid districts. It is noticeable that the south facing directions (S, SE, and SW) is the dominant aspect representing 26.26% of the total area.

Table 14: Direction and area percentage of aspect of Idko and Rashid districts.

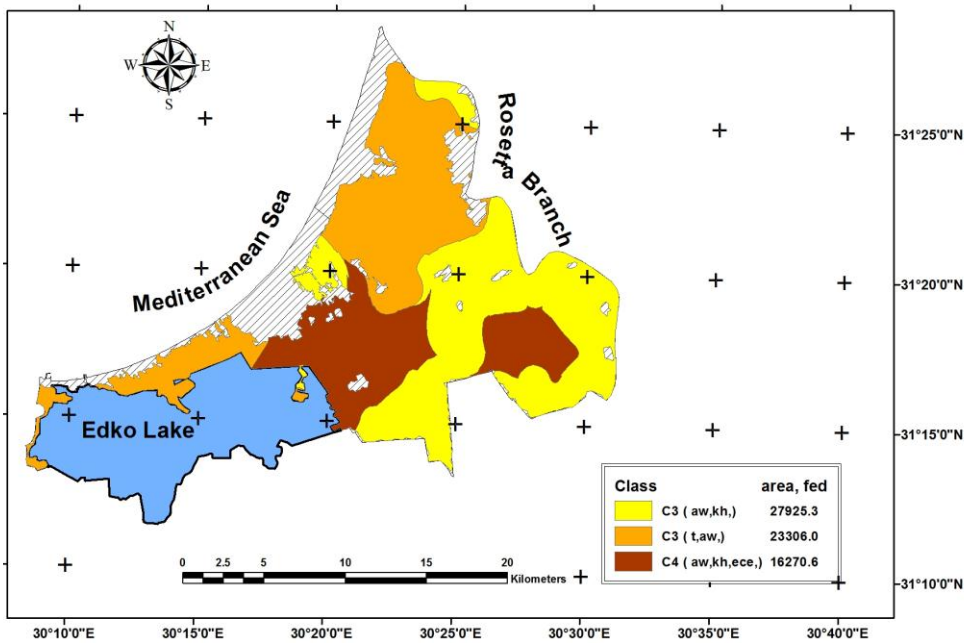
Direction	Area, %	Direction	Area, %
Flat	3.56	South East	9.15
North	8.86	South	8.97
North East	7.88	South West	8.14
East	10.44	West	10.34
		North West	8.91

1.3. Land capability classes: The ALES Model (Applied Land Evaluation System) provides prediction for general land use capability for a broad series of possible uses. According to the model prediction, most of the study area was classified as (C3 aw, kh), which indicated moderately capability with available water and hydraulic conductivity as limiting factor which covered an area about 41.37% of the total area mostly focused in Rashid district, followed by (C3 t, aw), which indicated moderately capability with available water and texture class as limiting factor which covered an area about 34.53% of the total area mostly focused in the area in between the two districts and the area closed to Idko lake, followed by (C4 aw, t, ece), which indicated low capability with available water, texture class and soil salinity as limiting factor concentrated in the coastal area at Rashid district and very closed to Idko lake at Idko district. Map (11) and table (15) show the distribution of each land use capability class in the study area.

Table 15: The area and percentage of land use capability classes in Idko and Rashid districts.

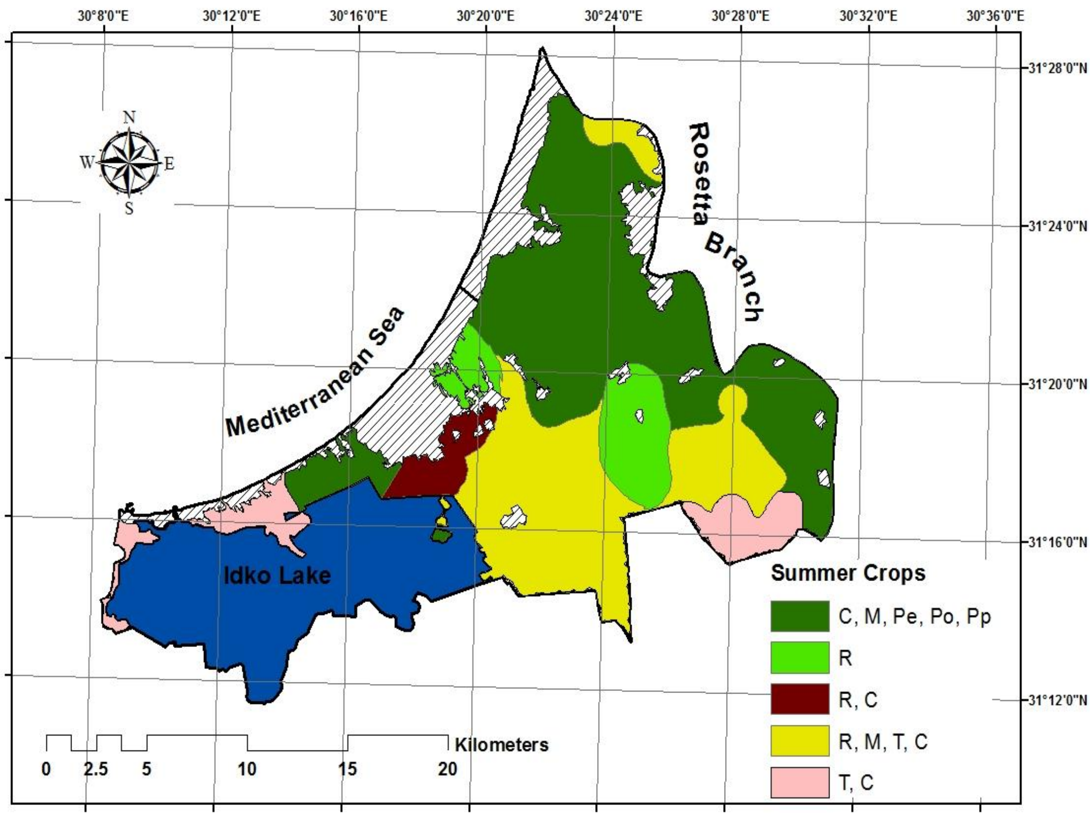
Land capability class	Area, %
C3 aw, kh	41.37
C3 aw, t	34.53
C4 aw, t, ece	24.10

Where: C3 Moderate, C4 Low.
Limiting Factor: aw available water, kh hydraulic conductivity,
T texture class, ece soil salinity



Map 11: Land capability classes of Idko and Rashid districts.

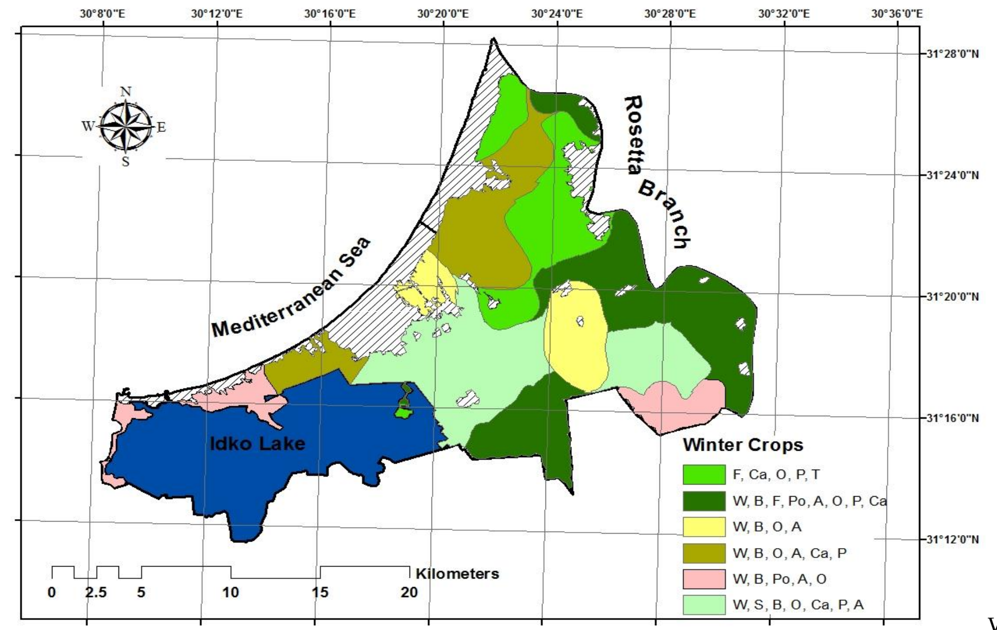
1.4. Land suitability classes for specific uses: The ALES model was used to predict soil suitability for some common crops cultivated in the study area including: wheat, maize, alfalfa, cotton, fababean, onion, rice, tomato, date palm, banana, citrus, fig and watermelon. Finally maps (12, 13 and 14) show the distribution and suggested cultivated crops for each soil units in the study area.



Where: C=Cotton, M=Maize, Pe=Peanut, Po=Potato, Pp=Pepper, R=Rice, T=Tomato

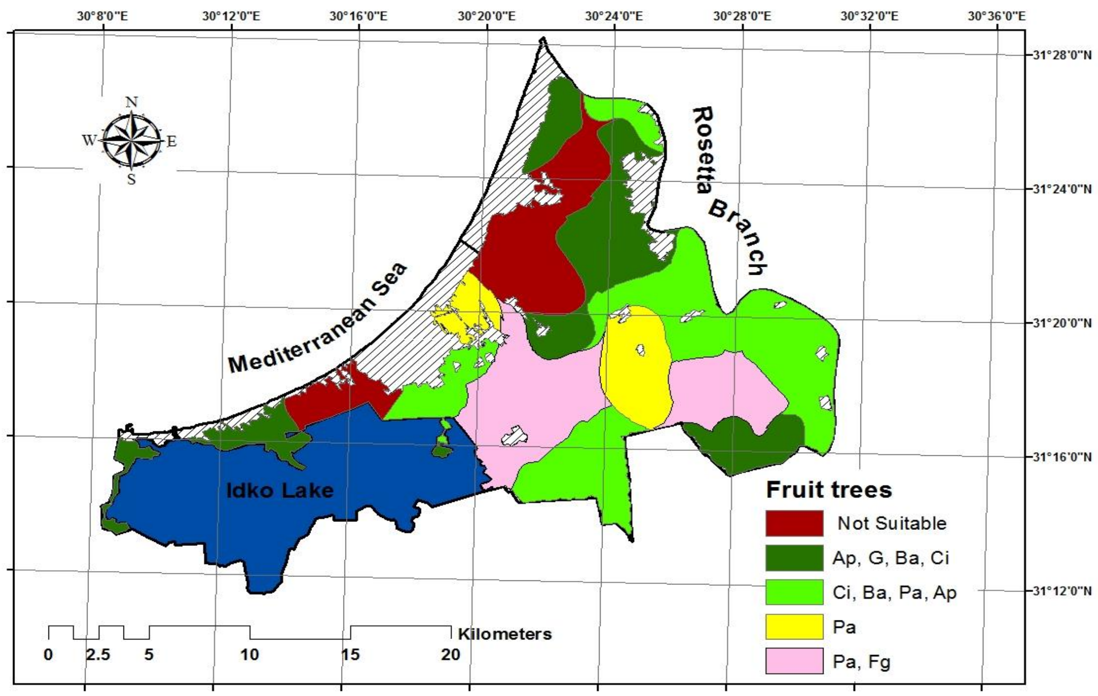
Map 12: Suitability of summer crops in Idko and Rashid districts.

2. Statistical characterization of water samples: Table (16) indicates the statistical parameters of the water samples for Idko and Rashid districts. Twenty six irrigation water samples, nineteen drainage water samples and twenty two water table samples. For irrigation water samples its clear that the lower value of water salinity found in irrigation water samples ranged from 0.56 to 2.63 dS/m, gradually increase in water table samples ranged from 0.74 to 12.54 dS/m and the highest values found in drainage water samples ranged from 0.58 to 112.30 dS/m. The result's show that the Residual Sodium Carbonate (RSC) values are suitable for irrigation ranged from -4.00 to 0.8, -10 to 1.00 and -33.00 to -1.00 for irrigation, water table and drainage water samples respectively.



Where: F=Fababean, Ca=Cabbage, O=Onion, P=Pea, T=Tomato, W=Wheat, B=Barley, A=Alfalfa, S=Sugerbeet.

Map 13: Suitability of winter crops in Idko and Rashid districts.



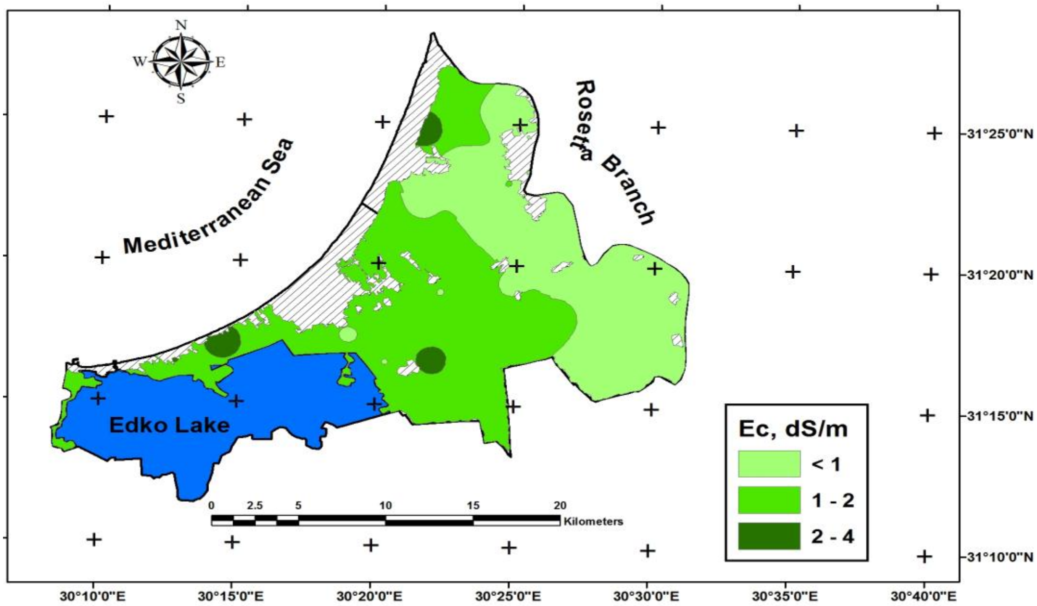
Where: Ap=Apple, G=Grape, Ba=Banana, Ci=Citrus, Pa=Pear, Fg=Fig.

Map 14: Suitability of fruit trees in Idko and Rashid districts.

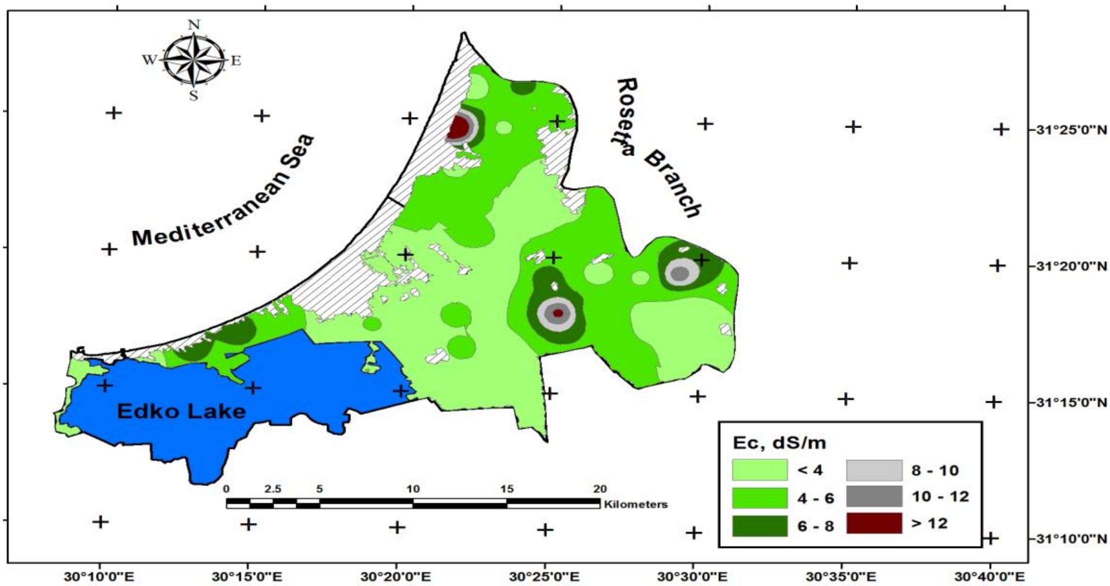
The coefficient of variation of the shows the highest homogeneity parameteries were SO_4, Cl, Na and EC 1.03, 0.84, 0.75, and 0.50 respectively for irrigation water samples. For water table samples the highest homogeneity parameteries were CO_3, Cl, Na, Mg and EC 2.19, 2.02, 2.08, 2.02 and 1.17 respectively. For drainage water samples the highest homogeneity parameteries were CO_3, EC, K and Cl 3.87, 2.30, 1.29 and 0.87 respectively.

Map (15) shows the distribution of irrigation water salinity in Idko and Rashid district which ranged from < 1 to 4 dS/m. It's clear that the lower value of irrigation water salinity found in the eastern part of Rashid district which irrigated from the Nile water and gradually increased in the west direction.

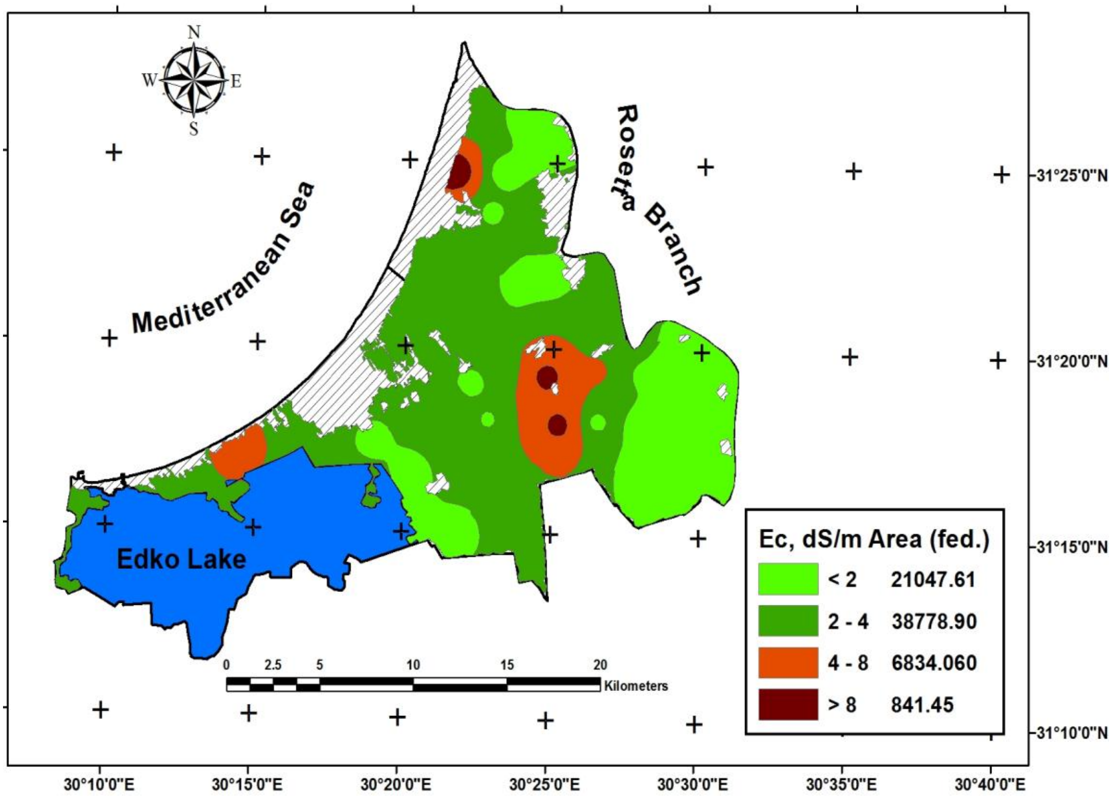
Map (16) shows the distribution of drainage water salinity in Idko and Rashid district which ranged from < 4 to > 12 dS/m. It's clear that the lower value of drainage water salinity found in the middle part of each districts may be due to the soil salinity, clay content distribution and Digital Elevation Model in this part of the study area and increase in some spots closed to the sea cost and Idko lake. Map (17) shows the distribution of water table salinity in Idko and Rashid districts which ranged from < 2 to > 8 dS/m which take the same trend of drainage water salinity. Map (18) shows the relationship between water table salinity, drainge water salinity and soil salinity in Idko and Rashid Districts.



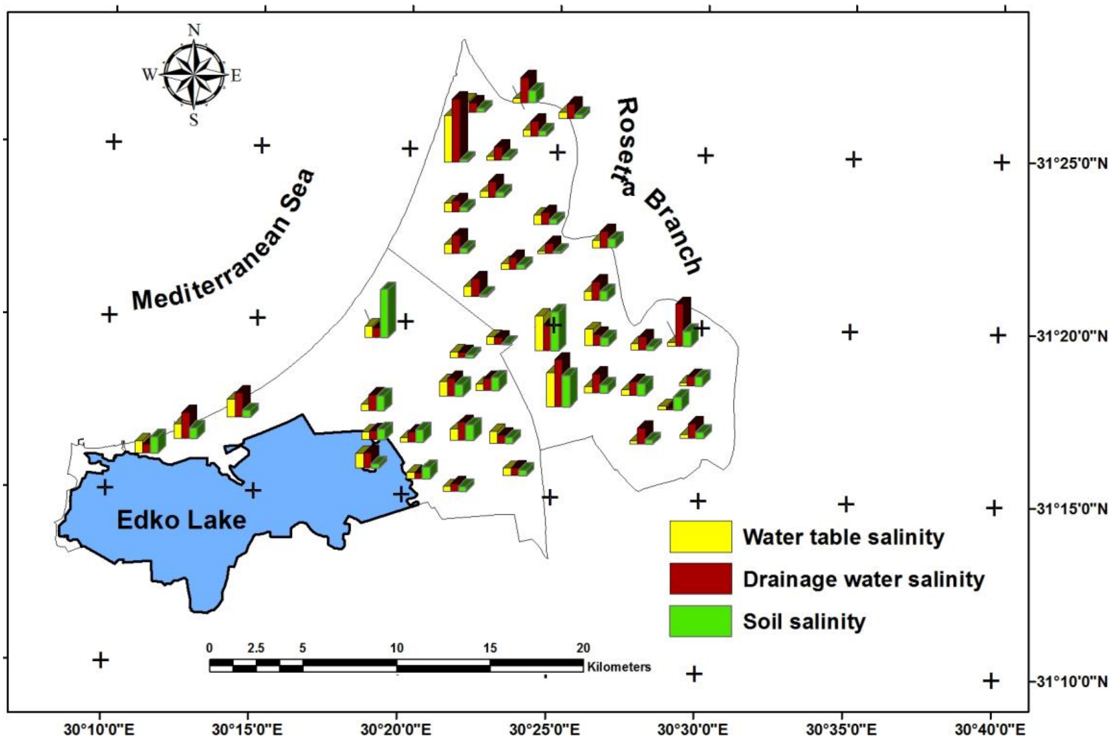
Map 15: Irrigation water salinity distribution in Idko and Rashid districts.



Map 16: Drainage water salinity distribution in Idko and Rashid districts.



Map 17: Water table salinity distribution in Idko and Rashid districts.



Map 18: Relationship between water table salinity, Drainage water salinity and soil salinity in Idko and Rashid districts.

CONCLUSION

The difference between management-dependent soil properties and stable or inherent soil properties is not absolute. Soil properties vary at temporal scales ranging from seconds to centuries and at spatial scales ranging from millimeters to hundreds of kilometers. Over a sufficient time period, practices that affect dynamic soil properties will also affect stable soil properties, and stable soil properties will change. It is very important to create soil databases and land information systems, including soil types, soil fertility, terrain, current land use status, climate, slope, vegetation cover, soil erosion, land unit map. The database system will be created on the GIS software, allowing users to access, edit, up-to-date, overlay and analysis to create a new map which meets the requirements of the current problem. Application of other information sources like remote sensing images, Global Positioning System (GPS), etc should be encourage because it will help on bringing real time change in land use and management strategy. Further study should be carried out to construct a complete and official database with close links among different information sources of natural environment, economy conditions, infrastructure, and the society, which achieved sustainable agricultural development.

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الملخص العربى

دراسه بيئيه لمركزى رشيد وادكو، محافظه البحيره، مصر باستخدام نظم المعلومات الجغرافيه وتقنيات الاستشعار عن بعد

١- تقييم الموارد الارضيه والمائيه للتنميه الزراعيه المستدامه

محمد اسماعيل، هيثم عبد الطيف يحيى، ايهاب محرم محمد مرسى

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من اهم ثلاث بحيرات موجوده فى جمهوريه مصر العربيه هى بحيره المنزله وبحيره البرلس وبحيره ادكو من الناحيه البيئيه والانتاجيه. تقع منطقه الدراسه بين 31º 10\ and 31 º30 \ N and 30 º 10\ and 30º 35\ E باجمالى مساحه ١٠٤٥٢٢ فدان وتشمل مركزى رشيد وادكو، محافظه البحيره، جمهوريه مصر العربيه. ويغطى مركز رشيد مساحه تقدر بحوالى ٤٧٣١٢ فدان ومركز ادكو مساحه تقدر بحوالى ٣٣٥٠٣ فدان اما بحيره ادكو فتغطى مساحه تقدر بحوالى ٢٣٧٠٧ فدان. تم عمل ٢٦ قطاع ارضى وجسه بمركز رشيد و١٧ قطاع ارضى وجسه بمركز ادكو بهدف التعرف على خصائص التربه بكلتا المركزين.

تم جمع ٤٢ عينه مياه رى وكذلك ٧ عينات من مياه الصرف و ٢٤ عينه مياه ارضيه للتعرف على الخواص الكيميائيه لعينات المياه وتقييمها لاغراض الرى الزراعى. من خلال بيئه نظم المعلومات الجغرافيه تم تركيب كلا من خرائط توزيع ملوحه التربه وعمق القطاع الارضى ونسبه كربونات الكالسيوم الكليه وقوام التربه للحصول على Soil Mapping Units الممثله لمنطقه الدراسه ومنها تم الحصول على ١٠ وحدات خرائطيه لمنطقه الدراسه. وفقا للنتائج المتحصل عليها من نموذج تقويم الاراضى وجد ان منطقه الدراسه تقع فى C3 aw, kh والتى تدل على اراضى منطقه الدراسه متوسطه القدره الانتاجيه مع وجود عوائق مثل الماء المتاح والتوصيل الهيدروليكى وتمثل مساحه تقدر بحوالى ٤١,٣٧% تتركز معظمها فى مركز رشيد يتبعها C3 t, aw والتى تدل على ان اراضى المنطقه متوسطه القدره الانتاجيه مع وجود عوائق مثل قوام التربه والماء المتاح وتمثل مساحه تقدر بحوالى ٣٤,٥٣% من اجمالى مساحه المنطقه المدروسه وتتركز فى المنطقه الواقعه بين المركزين والمناطق المتاخمه لبحيره ادكو ثمC4 aw, t, ece والتى تدل على اراضى منخفضه القدره الانتاجيه مع وجود عوائق تتمثل فى ملوحه التربه والماء المتاح وقوام التربه وتتركز فى المناطق الساحليه والمناطق المتاخمه لبحيره ادكو.