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Remote Sensing and GIS Based Land Capability Classification of the Soils Adjacent to El-Manzala Lake

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THE CURRENT investigation was carried out to recognize and delineate the different types of landforms in the studied area and use of spatial analysis to assess the capability for cultivation of some soils adjacent to El Manzala Lake.

Keywords : Remote sensing, GIS , Land capability , Soils , El - Manzala Lake .

The studied area located in the North Eastern part of the Nile Delta it extended from longitudes 31° 45′ 00″ and 32° 11′ 00″ East and Latitudes 31° 05′ 00″ and 31° 32′ 00″ North it covers parts of Damita and Dakahlya Governorates with a total area of (2247.37 Km^2) including Land (1306.7 Km^2) ,Water bodies (921.62 Km^2) and Urban areas (19.05 Km^2).

Fluvio-marine deposits, alluvial lacostrine deposits and marine aeolian deposits are the main parent material in area. The water resources of the area mainly from the re-use of agricultural drainage water and some parts are irrigated from the surface water supplies.

According to the American Soil Taxonomy (USDA, 2006) and the given data by Climatologically Normal of Egypt (2006) of El Manzala station, the soil temperature regime is Thermic and the soil moisture regime is Torric.

Material and Methods

Pre-field work was started by training on soil survey methodology, collection of all existing data and information of topography, geology, land resource maps, digital elevation model and satellite image about the study area.

Topographic maps of the area under investigation of scale 1:50000 and landsat ETM image (path 176/row 39) taken during the year (2003) were used in this study for physiographic mapping.

A semi detailed survey are made throughout the investigated area in order to discover precise soil patterns as well as the land types and the characteristic landscape based on the profiles study and satellite image interpretation.

The interview forms were completed and detailed macro-morphological description was recorded using FAO Guidelines (1990). For carrying out this study, fourteen soil profiles representing the geomorphic units have been described morphologically, and representatives soil samples (43) have been collected and used for physical, chemical and fertility studies.

Digital elevation model (DEM) of the study area have been generated from the vector contour lines, the elevation points, which recorded during the field survey by (GPS) were also used to enhance the digital elevation model of the area , Arc- GIS 9.2 software used for this function. Landsat ETM (path176/row39) image (2003) and digital elevation model (DEM) was used in ERDAS Imagine 8.7 software to produce the physiographic map of the study area (Dobos *et al.*, 2002).

Results and Discussion

From the physiographic point of view, this landscape includes the following units:

- Flood plain (river terraces, river levees, basins, swales and isolated hills).
- Lacostrine plain (fish ponds, dried fish ponds; dry and wet sabkhas: swamps and dried lake bed: and sand dunes.
- Marine plain(sand sheet and hummocks)

Based on the landsat ETM, digital elevation model (DEM) and field check, the physiography of the studied area has been identified and mapped (Table 1).

The soil map of the studied area were produced depend on the given data, *Arc-GIS 9.2* software was used for this function. The studied soils were classified according to the American Soil Taxonomy System (2006).

The given data indicated that the most of the area is dominated by the *Torrifluvents* great group as the 64 % of the studied profiles, 21% of which are classified as *Vertic Torrifluvents* these soils are mainly found in the flood plain. 7% of the studied profiles are located in the great group of *Argids*. The soil profiles which represent the marine deposits are classified as *Typic Torripsamments*, as they represent 15 % of the total profiles.the soil profiles which classified as *Typic Haplosalids* represent 14 % of the studied profiles.

The spatial analysis technique was used to evaluate the agricultural land capability in the studied area. The land surveying data, Digital Elevation Model (DEM) and satellite image were used in a Geographic Information System (GIS) to delineate the landforms of the area. The thematic layers of the attribute data were created in Arc-GIS 9.2 software using the spatial analyses function and then

these layers were matched together to produce the soil capability map of the studied area.

The obtained data indicate that the high capable soils (class II) represent 10.25 % of the total area; it is associated with the river terraces landforms. The moderate capable soils (class III) dominate the decantation and overflow basins in the flood plain representing 42.74 % of the total area. The low capable soils (class IV) are associated with the landforms adjacent to the El Manzala Lake in, representing 25.06 % of the area. The soils fluvio-marine deposits and decantation basins which adjacent to the lake have a very low capability class (class V) representing 21.95 % of the total area.

TABLE 1. Legend of the physiographic map of the studied area.

Landscape	Origin	Relief	Land forms	Mapping unit	Area km^2	Area %
Flood plain (F)	Alluvial deposits (1)	Flat to gently undulating (1)	High terraces	F111	156.38	6.96
			Moderately high terraces	F112	178.11	7.93
			Low terraces	F113	110.21	4.90
		Gently slope (2)	River levees	F121	6.01	0.27
			Overflow basins	F123	182.41	8.12
			Decantation basins	F124	108.68	4.84
Lacustrine plain (L)	Lacust-rine deposits (1)	Almost flat (1)	Dried lake bed	L116	21.32	0.95
Marine plain (M)	Aeolian deposits (1)	Almost flat (1)	Coastal sand sheet	M111	58.01	2.58
		Undulating (2)	Sand dunes	M212	11.25	0.50
Total land (Flood, Lacustrine and Marine plains)					**1306.7**	**58.14**
Water bodies (river, lake and sea)					921.62	41.01
Urban areas					19.03	.0.85
Total area					**2247.36**	**100**

Land capability classification

Base map

The main objective of soil capability assessment for agriculture is to predict future conditions after development has taken place. It is necessary to forecast the benefits to farmers and the national economy and whether these will be sustained. The current study deals with spatial analyses techniques to evaluate the agricultural land capability in the studied area. The landforms of the studied area were delineated by using the digital elevation model, Landsat ETM$^+$ and ground truth data of the studied area. The produced map, represents the landforms of the studied area, it was imported in a Geo-database and considered as a base map.

Thematic layers

The attribute data of $CaCO_3$ content, texture class, soil depth, salinity, alkalinity, CEC and drainage condition (Table 2) were compiled into the units of the digitized geomorphologic map in a geographic information system. The incorporated attributes were used to obtain the thematic layers of spatial distribution of the above mentioned characteristics as shown in figures 1-7. The produced layers include information on the rating value, capability sub class, and distribution for each soil characteristics.

TABLE 2. Main land characteristics of the studied area .

Unit	Profile	Main land characteristics						
		Depth	Drainage	Texture	$CaCO_3$	Ec	CEC	ESP
F111	11	90	Moderate	C	3.52	4.43	53.96	17.47
F112	6	120	Well	C	3.41	5.55	50.17	21.5
F113	8	110	Well	C	1.95	3.71	47.80	15.82
F121	12	90	Moderate	CL	1.23	4.03	42.33	13.03
F123	3	90	Moderate	SiC	4.22	6.26	32.03	20.06
F124	5	60	Imperfect	C	6.2	14.05	51.20	28.51
L116	9	50	Poor	C	8.66	51.56	52.10	40.13
M111	13	120	Well	S	1.50	1.50	14.03	20.03
M212	14	90	Moderate	S	2.65	2.65	10.37	19.80

when planning for optimal land uses, also it benefits the existing land users in determining the most appropriate management practices.

The obtained data from the thematic layers indicate that the main limiting factors in the studied area are soil depth, drainage conditions, soil salinity, soil texture, $CaCO_3$ % and alkalinity. The limiting factors of $CaCO_3$ %, soil depth, drainage condition, salinity and alkalinity are associated with the lacusrtine plain, while the soil texture and CEC are the main limiting factors in the fluvio-marine plain. The limiting factors of the soil depth, drainage condition and soil salinity are dominating the soils of the flood plain. These results are of great importance as they show the distribution of the constraints of productivity all over the region. This is particularly important

Soil capability assessment

The attribute data of $CaCO_3$ content, soil depth, texture class, salinity, alkalinity, CEC and drainage condition were linked with the landform units of the area (Fig. 1, 2, 3, 4, 5, 6 and 7). The thematic layers of the attribute data were matched together to produce the soil capability map of the area (Map 1). The soil capability was divided to five .

Categories according the rating values (ranges from 0 to 1), whereby the soil capability tend to increase when the rating value is closed to 1. It became clear that the high capable soils (class II) represent 10.25 % of the total area; it is associated with the river .

Terraces landforms. The moderate capable soils (class III) dominate the decantation and overflow basins in the flood plain representing 42.74 % of the total area. The low capable soils (class IV) are associated with the landforms adjacent to the El Manzala Lake it, representing 25.06 % of the area. The soils fluvio-marine deposits and decantation basins which adjacent to the lake have a very low capability class (class V) representing 21.95 % of the total area.

One can recommend that the use of spatial analyses allows producing multi thematic layers of land characteristics, which offer a great source of data for the land use planners. Thew spatial distribution represents the correlation between the soil characteristics and landforms, with more detailed data, that can be use in extrapolation of soil characteristics in the different landforms.

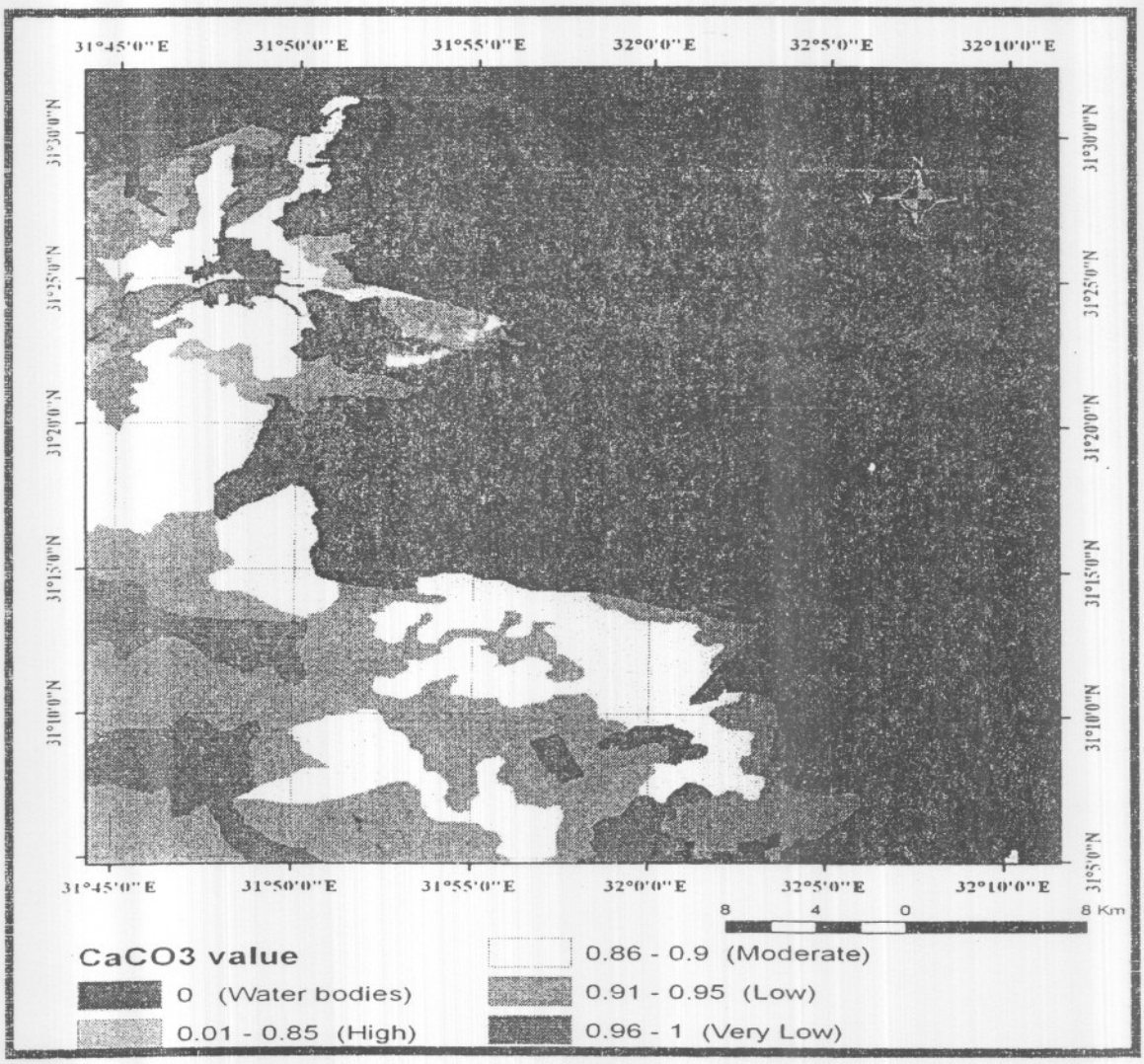


Fig. 1. Spatial distribution of $CaCO_3$ content in the studied area .

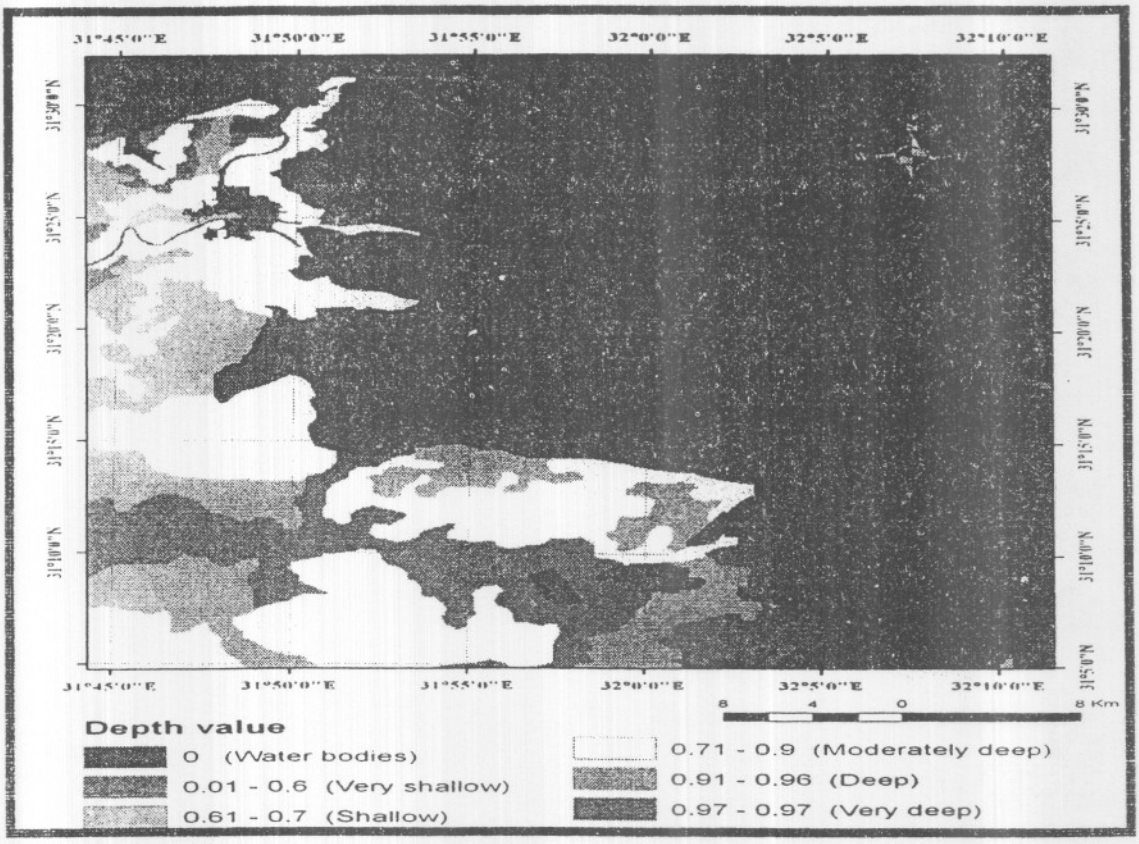


Fig. 2. Spatial distribution of soil depth in the studied area .

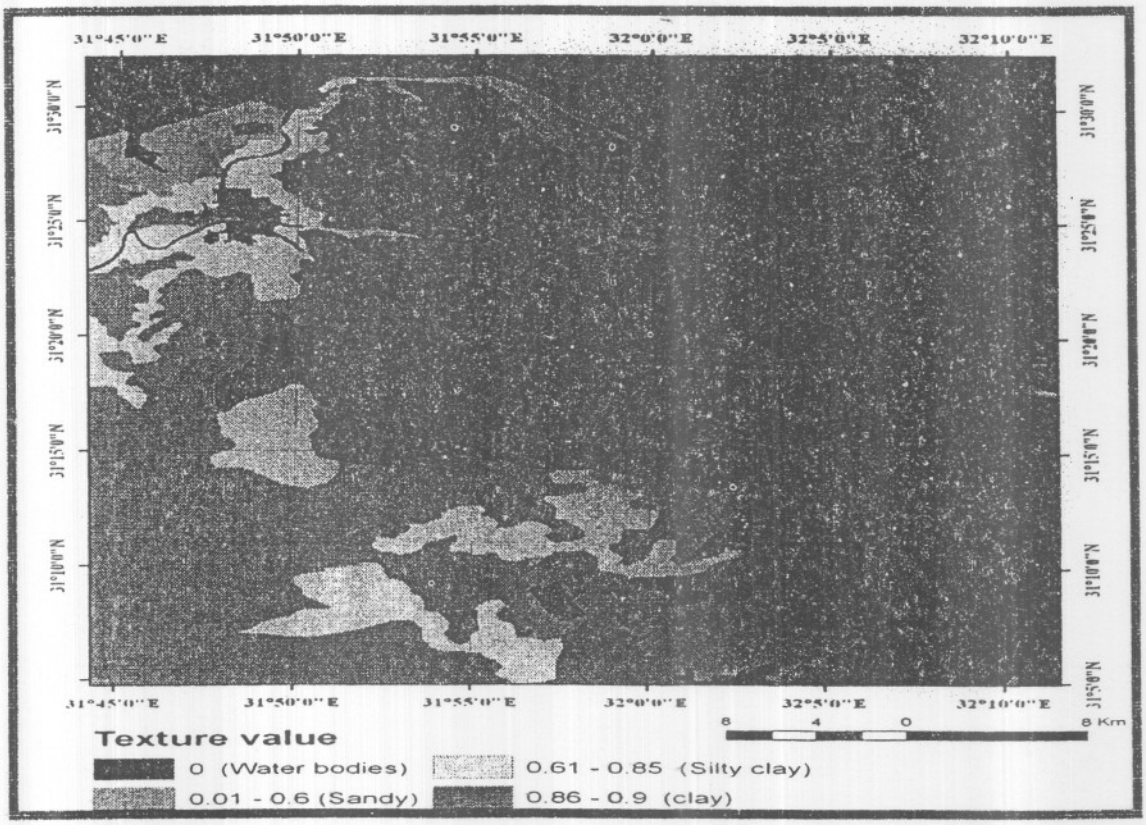


Fig. 3. Spatial distribution of soil texture in the studied area .

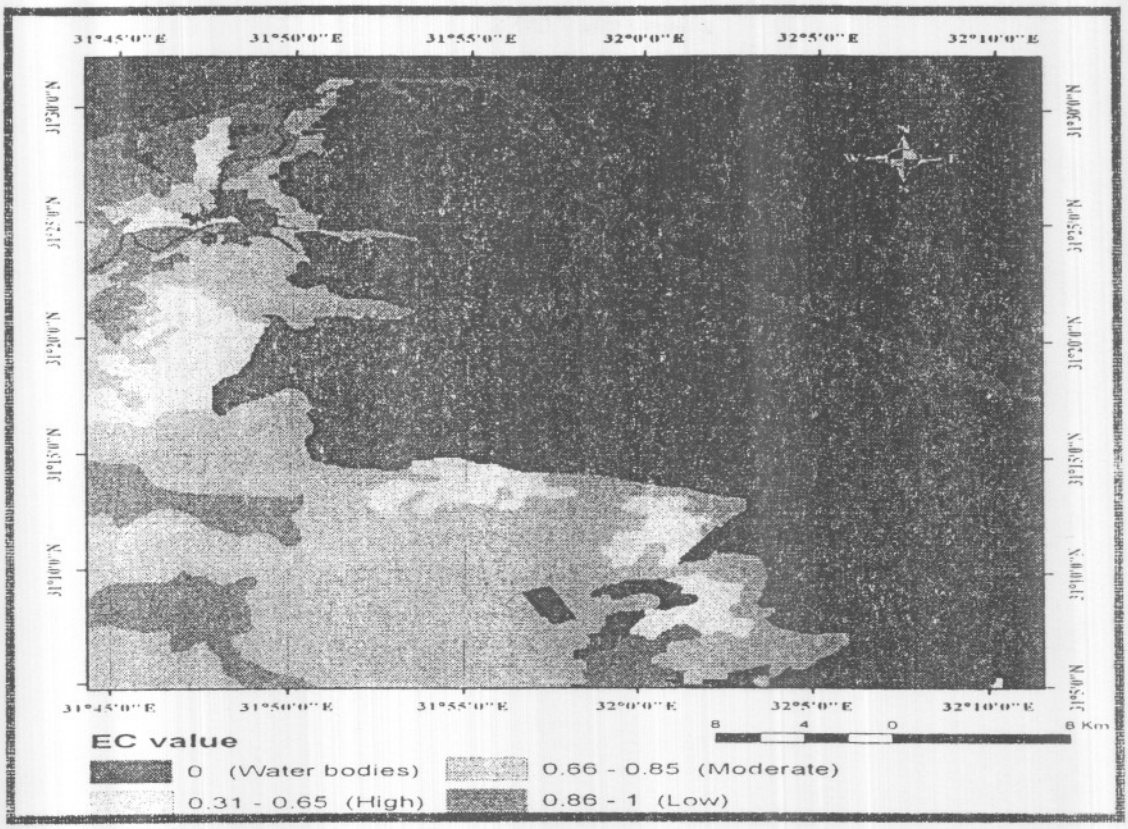


Fig. 4. Spatial distribution of soil salinity in the studied area .

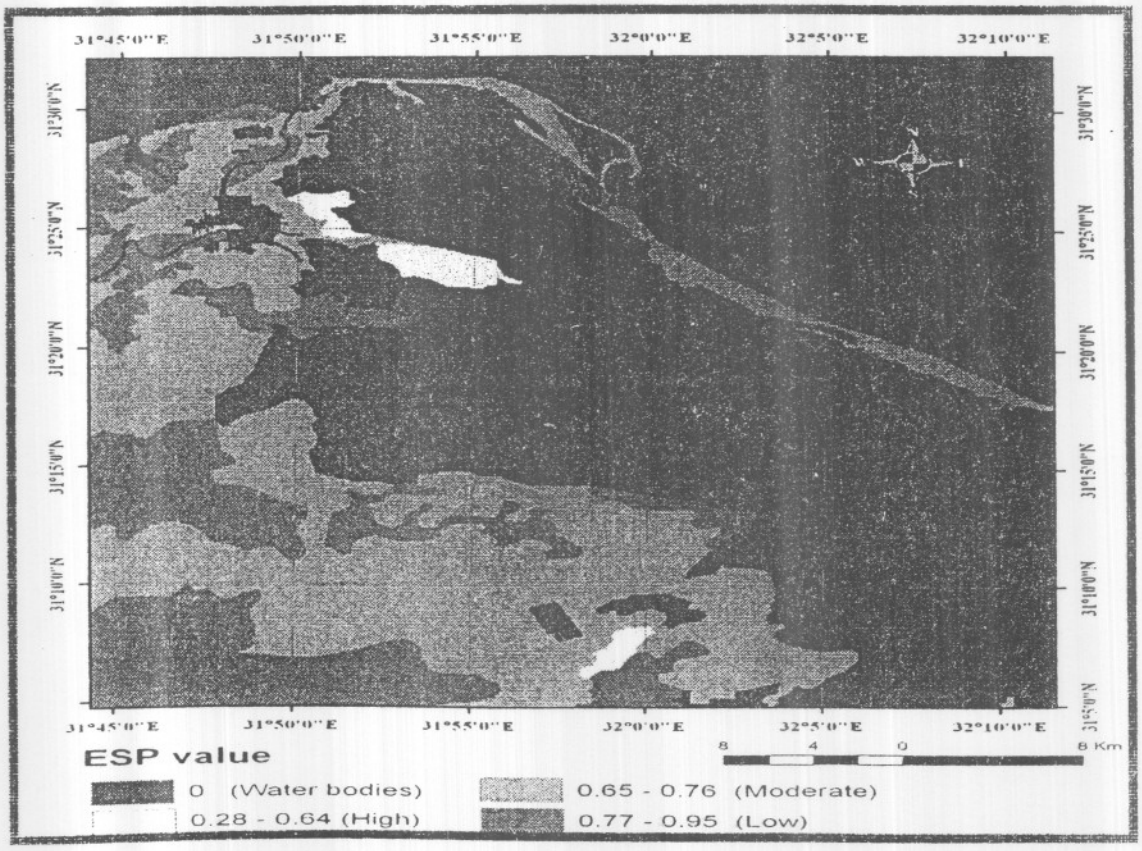


Fig. 5. Spatial distribution of soil alkalinity in the studied area .

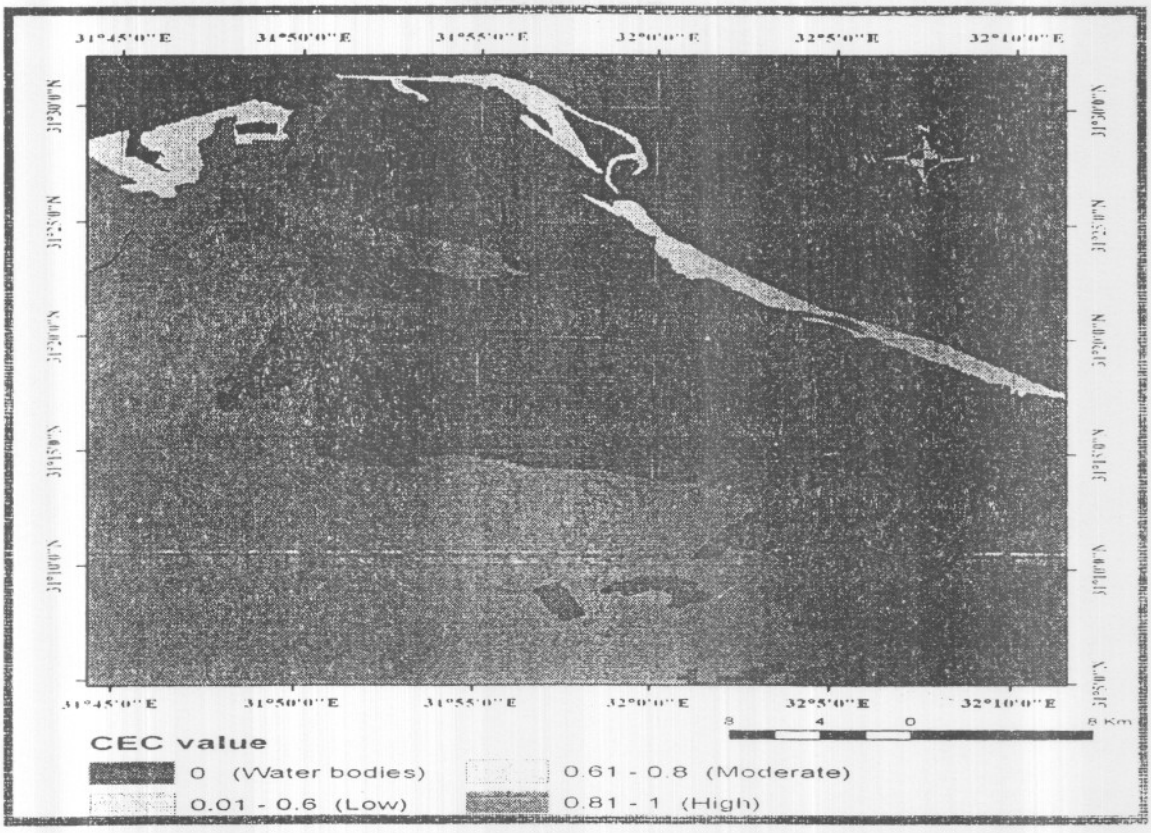


Fig. 6. Spatial distribution of CEC in the studied area .

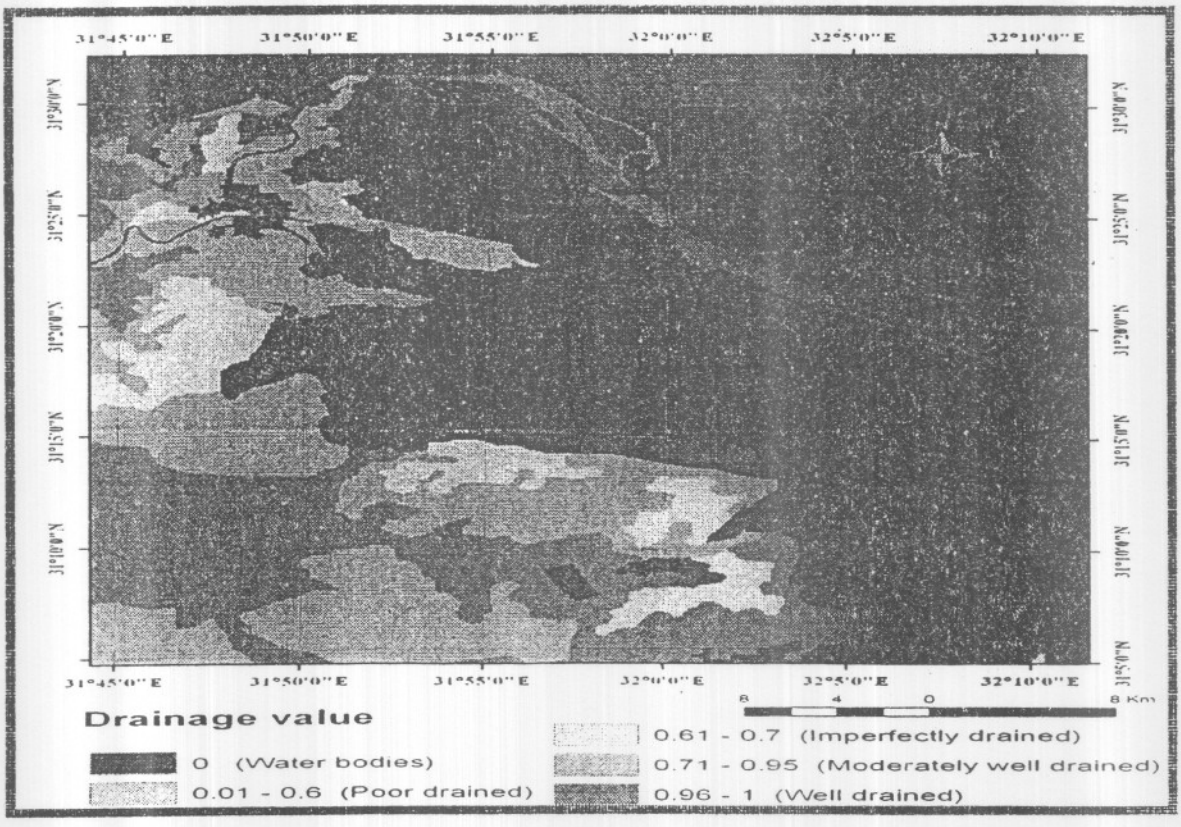
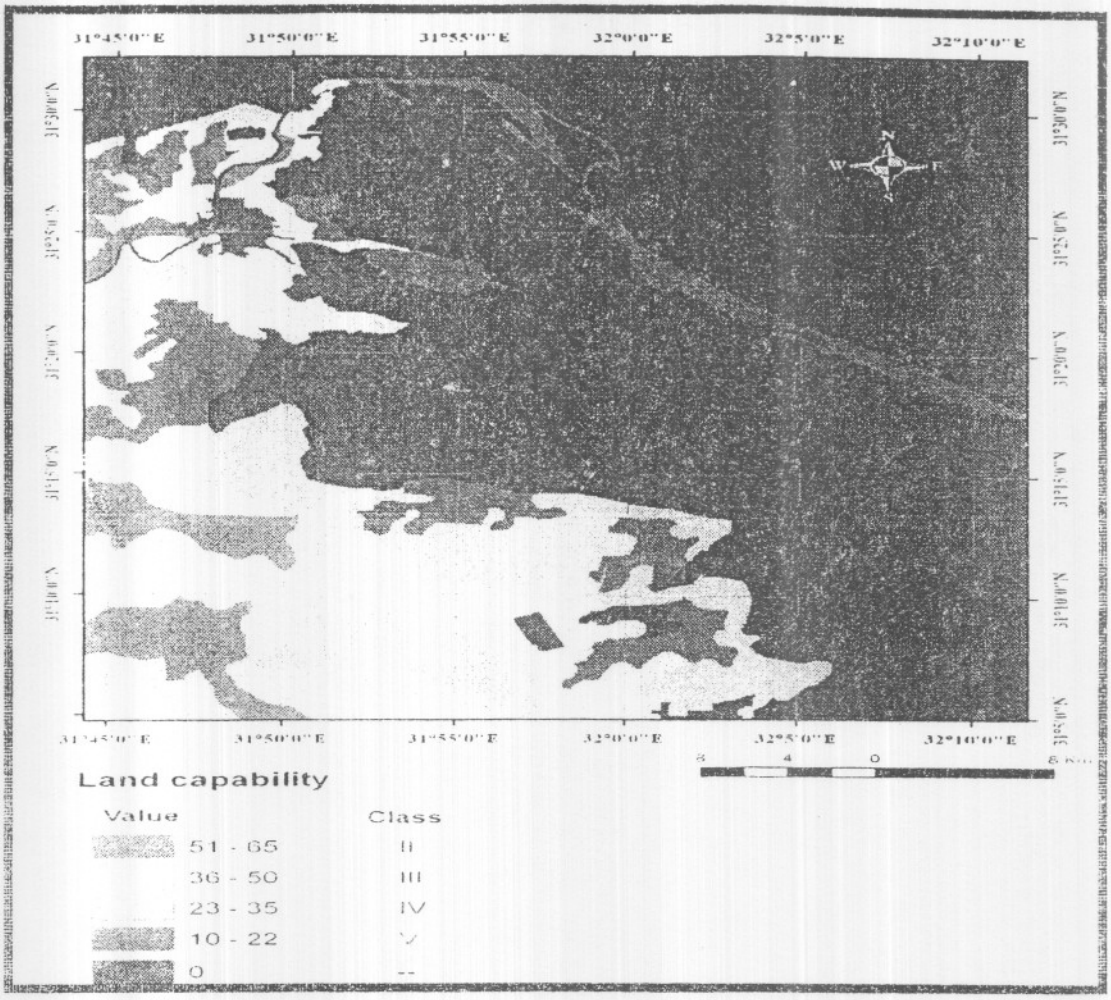


Fig. 7. Spatial distribution of drainage condition in the studied area .



Map . 1. Land capability classes of the studied area .

Reference

Climatologically Normal of Egypt(2006).

Dobos, E.; Norman, B.; Bruee, W.; Luca, M.; Chris, J. and Erika, M. (2002) "*The Use of DEM and Satellite Images for Regional Scale Soil Database*", 17th, World Congress of Soil Science (WCSS), 14-21 August 2002, Bangkok, Thailand.

FAO (1990) *"Guidelines for Soil Description"*, 53p., FAO, Rome,

USDA(2006) *"Keys to Soil Taxonomy"*, 10th United State Department of Agriculture, Natural Resources Conservation, Service (NRCS).

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إستخدام تقنية الإستشعار من البعد و نظم المعلومات الجغرافية فى تقسيم القدرة الانتاجية للأراضى المجاورة لبحيرة المنزلة

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تهدف هذه الدراسه إلى تمييز وتحديد الأنواع المختلفه من الأراضى وتحديد قدرتها الإنتاجيه ومدى ملاءمتها لزراعة بعض المحاصيل فى بعض الأراضى المتاخمة.

تقع منطقة الدراسه بين خطى طول ٣١° ٠٥ ٠٠ و ٣١° ٣٢ ٠٠ شرقا وخطى عرض ٣١° ٤٥ ٠٠ و ٣٢° ١١ ٠٠ شمالا.وهى تغطى أجزاء من محافظتى الدقهلية ودمياط وتبلغ مساحتها الكليه ٢٢٤٧,٣٧ كم٢ تشتمل على ١٣٠٦,٧٠ كم٢ مساحة الاراضى و ٩٢١,٦٢ كم٢ مسطحات مائية والاراضى المغمورة بالمياة وكذلك ١٩,٠٥ كم٢ للمناطق السكنية .

مادة الأصل الرئيسيه فى المنطقه تشمل أكثر من واحده وهى: ترسيبات نهريه بحريه، ترسيبات نهريه بحيرية و ترسيبات هوائية .

تعتبر مياه الصرف الزراعى هى المصدر الرئيسى لمياه الرى فى منطقة الدراسه وبعض المساحات تروى بمياه الرى السطحى من الترع والقنوات.

وحسب النظام الأمريكى **The American Soil Taxonomy (USDA, 2006)** وبالإضافه إلى بيانات هيئة الأرصاد الجويه المصريه (٢٠٠٦) والخاصه بمحطة أرصاد المنزلة، وجد أن درجة حرارة التربه تقع فى الرتبه *Thermic* ورطوبة التربه تقع فى الرتبه *Torric*.

قبل البدء فى العمل الحقلى تم تجميع البيانات المتاحه عن منطقة الدراسه و المعلومات الخاصه بالطبوغرافيه و الجيولوجيا وخرائط الموارد الأرضيه و نموذج الإرتفاع الرقمى (DEM) وصورة القمر الصناعى لاندسات ETM لمنطقة الدراسه. تم عمل حصر نصف تفصيلى لكل منطقة الدراسه بغرض الإستكشاف المتقن لأنواع الأراضى وصفات الموقع و المعتمده على دراسة القطاعات الأرضيه وتفسير صور القمر الصناعى. كما تم استكمال الأشكال (landforms) التى تم معاينتها مع تسجيل الوصف المورفولوجى باستخدام دليل منظمة الغذاء والزراعه (1990) FAO وأختير ١٤ قطاعا أرضيا تمثل الوحدات الجيومورفولوجيه مع وصفها مورفولوجيا وتجميع ٤٣ عينه لتحليلها بالمعمل وإجراء الدراسات الطبيعيه والكيميائيه عليها.

وتم استنباط نموذج الإرتفاع الرقمى (DEM) Digital Elevation Model بالإسترشاد بالخطوط الكنتوريه وتم تحديد نقاط الإرتفاع أثناء الحصر الحقلى باستخدام جهاز GPS والذى أستخدم أيضاً لتحقيق نموذج الإرتفاع الرقمى(DEM) كما تم الإستعانه ببرنامج Arc-GIS 9.2 من أجل هذا العمل .

ولعمل خريطة التربه لمنطقة الدراسه تم الإستعانه بالبيانات المتوافره و برنامج Arc-GIS 9.0 .

وحسب النظام الأمريكى The American Soil Taxonomy (2006) تم تقسيم أراضى منطقه الدراسه . وتشير النتائج إلى أن معظم المنطقه تسودها *Torrifluvents great group* وتمثل ٦٤٪ من القطاعات الأرضيه التى تمت دراستها و ٢١٪ من هذه القطاعات تتبع تحت المجموعه *Vertic Torrifluvents* والتى تقع فى السهل الفيضى و ٧٪ تتبع *Argids great group* أما الباقى من القطاعات التى تمثل الترسيبات البحرية فهى تقع ضمن *psamments Torri* وتمثل ١٥٪ اما الاراضى التى تتبع تحت المجموعه *Haplosalids Typic* فهى تمثل ١٤٪ من اجمالى القطاعات المدروسة.

تم تقسيم القدره الانتاجية للاراضى بمنطقة الدراسه باستخدام FAO Guidelines (1985) وقد استخدمت تقنيات التحليل المكانى Spatial analysis لانتاج خرائط المعلومات الخاصة بالصفات الارضية داخل نظام المعلومات الجغرافى GIS وتبين النتائج المتحصل عليها أن معظم العوامل المحدده فى كل من أراضى السهل البحرى والبحيرى فى منطقة الدراسه هى قوام التربه وعمق القطاع الارضى و السعه التبادليه الكاتيونيه والمحتوى من كربونات الكالسيوم والملوحة والقلوية . اما فى السهل الفيضى فان اهم العوامل المحددة هى ملوحة التربه و حالة الصرف وعمق التربه .

وتم التوصل إلى أن درجات قدرة الأرض الإنتاجيه فى منطقة الدراسه هى أربعة درجات (الثانيه II ، الثالثه III ، الرابعه IV والخامسه V) وتم حساب مساحات هذه الدرجات ووصفها مع عمل خريطة القدره الإنتاجيه. حيث اشارت النتائج الى ان اراضى الدرجة الثانية والثالثة والرابعه والخامسة تمثل ١٠,٢٥و ٤٢,٧٤ و ٢٥,٠٦ و٢١,٩٥٪ من اجمالى المساحة الكلية على الترتيب.