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

M.A. Abd El-Rahman*, M.A. Hussain**, R.R. Ali* and E. F. Abd El-Salam*
*Soils and Water Use Department, National Research Centre and**Soils and Water Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

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° 01’ 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 Km²) including Land (1306.7 Km²), Water bodies (921.62 Km²) and Urban areas (19.05 Km²).

Fluvio-marine deposits, alluvial lacustrine 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 Torri fluvents great group as the 64 % of the studied profiles, 21% of which are classified as Vertic Torri fluvents 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.

<table>
<thead>
<tr>
<th>Landscape</th>
<th>Origin</th>
<th>Relief</th>
<th>Land forms</th>
<th>Mapping unit</th>
<th>Area km²</th>
<th>Area %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood plain (F)</td>
<td>Alluvial deposits (1)</td>
<td>Flat to gently undulating (1)</td>
<td>High terraces</td>
<td>F111</td>
<td>156.38</td>
<td>6.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderately high terraces</td>
<td>F112</td>
<td>178.11</td>
<td>7.93</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Low terraces</td>
<td>F113</td>
<td>110.21</td>
<td>4.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gently slope (2)</td>
<td>River levees</td>
<td>F121</td>
<td>6.01</td>
<td>0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Overflow basins</td>
<td>F123</td>
<td>182.41</td>
<td>8.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Decantation basins</td>
<td>F124</td>
<td>108.68</td>
<td>4.84</td>
</tr>
<tr>
<td>Lacustrine plain (L)</td>
<td>Lacustrine deposits (1)</td>
<td>Almost flat (1)</td>
<td>Dried lake bed</td>
<td>L116</td>
<td>21.32</td>
<td>0.95</td>
</tr>
<tr>
<td>Marine plain (M)</td>
<td>Aeolian deposits (1)</td>
<td>Almost flat (1)</td>
<td>Coastal sand sheet</td>
<td>M111</td>
<td>58.01</td>
<td>2.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undulating (2)</td>
<td>Sand dunes</td>
<td>M212</td>
<td>11.25</td>
<td>0.50</td>
</tr>
<tr>
<td>Total land (Flood, Lacustrine and Marine plains)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1306.7</td>
<td>58.14</td>
</tr>
<tr>
<td>Water bodies (river, lake and sea)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>921.62</td>
<td>41.01</td>
</tr>
<tr>
<td>Urban areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.03</td>
<td>0.85</td>
</tr>
<tr>
<td>Total area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2247.36</td>
<td>100</td>
</tr>
</tbody>
</table>

**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.**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Profile</th>
<th>Main land characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Depth</td>
</tr>
<tr>
<td>F111</td>
<td>11</td>
<td>90</td>
</tr>
<tr>
<td>F112</td>
<td>6</td>
<td>120</td>
</tr>
<tr>
<td>F113</td>
<td>8</td>
<td>110</td>
</tr>
<tr>
<td>F121</td>
<td>12</td>
<td>90</td>
</tr>
<tr>
<td>F123</td>
<td>3</td>
<td>90</td>
</tr>
<tr>
<td>F124</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>L116</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>M111</td>
<td>13</td>
<td>120</td>
</tr>
<tr>
<td>M212</td>
<td>14</td>
<td>90</td>
</tr>
</tbody>
</table>

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, representing 25.06% of the area. The soils fluvio-marine deposits and decantation basins 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. The spatial distribution represents the correlation between the soil characteristics and landforms, with more detailed data, that can be used in extrapolation of soil characteristics in the different landforms.

Fig. 1. Spatial distribution of CaCO₃ 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


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تهدف هذه الدراسة إلى تمييز وتحديد أنواع المخلتفة من الأراضي وتحديد قدرتها
الإنتاجية ومدى ملاءمتها لزراعة بعض المحاصيل في بعض الأراضي المشابهة.
تغطي منطقة الدراسة بين خطوط طول 31° 32° E و 32° 33° E و شمال وجنوب تغطي
أجزاء من محافظات النطاقية ودبياط وتبلغ مساحتها الكلية 2247 كم² تشتمل
على 1320 كم² مساحة الأرضي والتابعة مساحة مائية
الراضي المغمورة بالمياه وكذلك 1905 كم² للمناطق المكشدة.

مادة الأصل الرئيسيه في المنطقة تشمل أكثر من واحده وهي: تربيات
النهرية بحرية، تربيات نهرية بحرية و تربيات هوية.

تُعتبر مياه الصرف الزراعي هي المصدر الرئيسي لمياه الري في منطقة
الدراسة وبعض المساحات تروي مياه الري السطحية من النزاعات.

The American Soil Taxonomy
وحسب النظام الأمريكي
(USDA, 2006)
و بالإضافة إلى بيانات هيئة الأرصاد الجوية المصرية (2006)
والخاصه بمحطة أرصاد المنزلة، وجد أن درجة حرارة الري تقع في الرتبة
Torrüic ورطوبة الريتية تقع في الرتبة Thermic

قبل البدء في العمل الحقيقى تم تجميع البيانات المتاحة عن منطقة الدراسة
ومعلومات الصخور الخالصة بالطبع و$('.اخص') و خرائط الموارد الأرضية
ETM ونموذج الارتفاع الرقمي (DEM) وصورة الارتفاع الرقمي (DEM)
لمتى الدراسة. تم عمل حصر نصف تفصيلي لكل منطقة الدراسة بغض
الإمستكشاف المطلق لأنواع الأرضي وصفات الموقع و المستمر على دراسة
القطع الاراضي وتصنيف صور التضارس التضارس. كما تم استعمال الأشكال
(landforms) التي تم معيينتها مع تسجيل الوصف الفروكي باستخدام دليل
منطقة الغطاء الزراعية (1990) وأختير 14 قطاعا أرضيا تمثل الوحدات
الجيومورفولوجية مع وصفها مورفولوجيا و تجميع 43 عيني لتحليله بالعمل
وإجراء الدراسات الطبيعية والكمبيوترية عليها.

(DEM) Digital Elevation Model
وتم استنباط نموذج الارتفاع الرقمي
بالاسترشاد بالخطوط الكهروتريه و تم تحديد نقاط الارتفاع أثناء الحصر المثل
(DEM) باستخدام جهاز GPS وأختير أيضا لتحقيق نموذج الارتفاع الرقمي
كما تم الاستعانة برامج Arc-GIS 9.2 من أجل هذا العمل.

وعمل خريطة الريبة منطقة الدراسة تم الاستعانه بالبيانات المتوافره
Arc-GIS 9.0
The American Soil Taxonomy (2006) identified American soils by region. The results show that 24% of the land is classified as Torrifluvents great group Vertic Torrifluvents and 21% is Argids great group psamment Torri Cy. A total of 15% of the land is classified as Haplosalids Typic. Spatial analysis using FAO Guidelines (1985) and GIS technology was used to conduct a comprehensive analysis of the land. The results showed that the land is suitable for agriculture, with a good water table and suitable soil conditions. The results are presented in a detailed report.