*Egypt. J. Soil. Sci.* **46**, No.1, pp. 47- 67 (2006)

# Soil Mapping as A Base for Optimum Land Use and Crop Water Requirements in El-Nubariya Area West of Nile Delta, Egypt

**W.A.M. Abdel Kawy and R.R. Ali***
*Soils Science Department, Faculty of Agriculture, Cairo University and *Soils and Water Department, National Research Centre, Cairo, Egypt.*

THE MAIN objective of this study is to produce a geometrically corrected physiographic-siol map scale 1: 50.000 reduced to the attached map scale 1: 250.000 for the studied area as a base for optimum landuse and its crop water requirements in El-Nubaryia area. To fulfill this objective 10 soil profiles were chosen from 25 profiles to represent the different mapping unit. Morphological description was carried out and soil samples collected for physical and chemical analysis. Based on the aerial photo-interpretation and the geographic information system coupled with the field work and Laboratory analysis data, the physiographic soil map was produced. Three main land scape units in the study area can identify:

1. Marine Deposits: this landscape contain maryut table land and the penplain areas.
2. Eolian Deposits: These include the sand ripples of various elevations in the sand plain.
3. River terraces: as a sequence of old river terraces.

The main land qualities of the different mapping units and the crop requirement were rated and matched to obtain the current and potential land suitability using automated land Evaluation system "ALES". Then, the crop water Requirements for the selective crops was calculated using crop wat program.

**Keywords:** Soil mapping, Optimum land use, Consumptive use, El-Nubaryia area.

The policy of the horizontal expansion represents a very great importance for Egypt, since the rates of overpopulation increase annually with more than 2.1% which is considered to be one of the sustainable development impediments. No doubt that the overpopulation will consume the natural resources and damage the surrounding environment quickly and affect negatively the services and the job opportunities.

The policy of the desert immigration which is representing the majority of the Egyptian lands considered to be the core resolution to re-draw the population,

social and economic map of the Egypt, this will provide for each individual true job opportunity and a better standard of living and services.

El-Nubariya region is one of regions that enters in the horizontal expansion policy, this is an expansion for the alienation policy of small areas (ranges between 6-10 feddan) added to the areas that ranges between (10-20 feddan) this region differs from other newly reclaimed regions in Egypt which some of them located in the calcareous soils derived form the marine deposits, while this region has sandy texture and calcareous soils.

*Description of the studied area*

*Location*

The studied area incorporates an area of approximated 96819.14 feddans. It is bounded by longitudes 30° 00′ and 30° 25′ E and Latitudes 30° 30′ and 30° 45′ N, (Fig. 1).

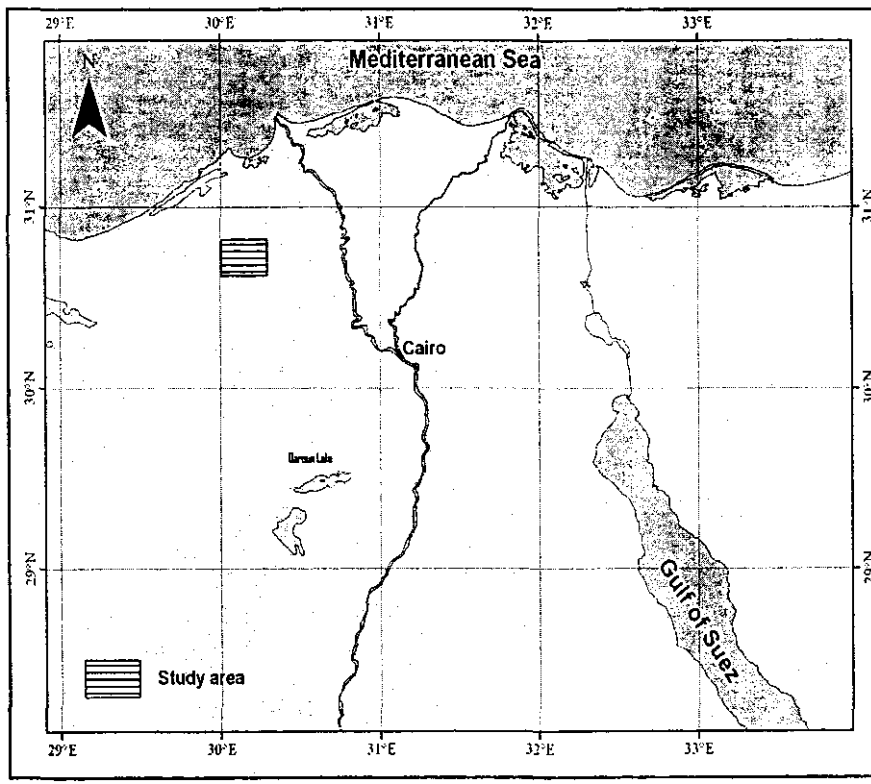



**Fig.1. Location map of the study area.**

*Climate*

According to Egyptian Meteorological Authority (1996) and Soil Taxonomy System (1999) the soil temperature regime of the studied area could be defined as Thermic and soil moisture regime as Torric.

*Geology*

Said (1993), reported that the studied area belongs to pleistocene sediments which is divided into the following:

1.Young Pleistocene terraces covered by sands and gravels.
2. Sand dunes area sand and sand accumulations.
3. Marine deposits.

## Material and Methods

*Aerial photo- interpretation*

Panchromatic aerial photographs scale (1: 40.000) which were taken during the year (1991) average consisting of 28 aerial photographs has been used for the present study. All photographs were analyzed stereoscopically and further division made using " the physiographic analysis " detailed by Vink (1963); Goosen (1967); Ligterink (1968); Bennema & Gelons (1969) and Zink & Valenzuala (1990). The main elements used are slope, relief, greytone, in addition to parceling and natural vegetation, so the physdographic map has been obtained.

*Field work*

To fulfill the objective of this study 10 soil profiles were chosen from 25 profiles to represent the different soil unit. Morphological description was carried out following the guidelines edited by FAO (1990) and abbreviated as:

| Color | | Structure | | Consistency | | Stickiness | | Boundary | |
|---|---|---|---|---|---|---|---|---|---|
| VPB | Very pale brown | SG | Single grained | SO | Soft | NST | Nonsticky | D | Diffuse |
| BY | Brownish yellow | MW | Massive, weakly coherent | SHA | Slightly hard | SST | Slightly sticky | | Slope |
| BS | Brownish | MM | Massive, mod. coherent | HA | hard | Plasticity | | F | Flat |
| YE | Yellow | MG | Massive strongly coherent | Carbonates | | NPL | nonplastic | A | Almost flat |
| YB | Yellowish brown | Cementation | | MO | Mod. | SPL | Slightly plastic | G | Gently undulating |
| Texture: | | Y | Compacted | ST | strong | | | U | Undulating |
| S | Sandy | W | Weakly cemented | EX | Extremely | | | | |
| | | M | Mod. cemented | | | | | | |

*Laboratory analysis*

Disturbed soil samples were collected for laboratory analyses, which include the following:

- Dry sieving method, Richard's method (1954).
- $CaCO_3$, O.M & EC, Jackson (1967) and USDA (1991).
- Soil reaction pH, Richard (1954) and Klut (1986)
- Cation exchange, after Piper (1950) as modified by Gohar (1954).
- Exchangeable sodium according to Tucker (1971) modified method.
- Available N.P.K., after Jackson (1967) and Page *et al.* (1982).
- Soil color by Munssel Color Charts (1975).

*Integration of the data in a soil map*

- Soil Taxonomy (1999) were used to classify the different soil profiles.
- The soil correlation between the physiographic and taxonomic units, were designed in order to identify the major soil sets of the studied area, after Elberson & Catalan (1987).
- ARC- info program has been used as the main GIS software for this study.

*Land suitability*

Actual and potential suitability calculated by using the Automated Land Evaluation System (ALES) depending on soil rating after Sideruis (1984 & 1989).

*Crop water requirement*

The crop water requirements calculated by using crop wat program to calculate $ET_O$ using penmon-monteith method, After Allen (1998). The climatic data of west Nubariya area, after Climatological Normals for Egypt (2000) was used.

## Results and Discussion

*Visual interpretation of conventional aerial photographs*

The most important elements used and palyed the decisive role in the photo-interpretation of the studied area are relief, slope and gray tone elements.

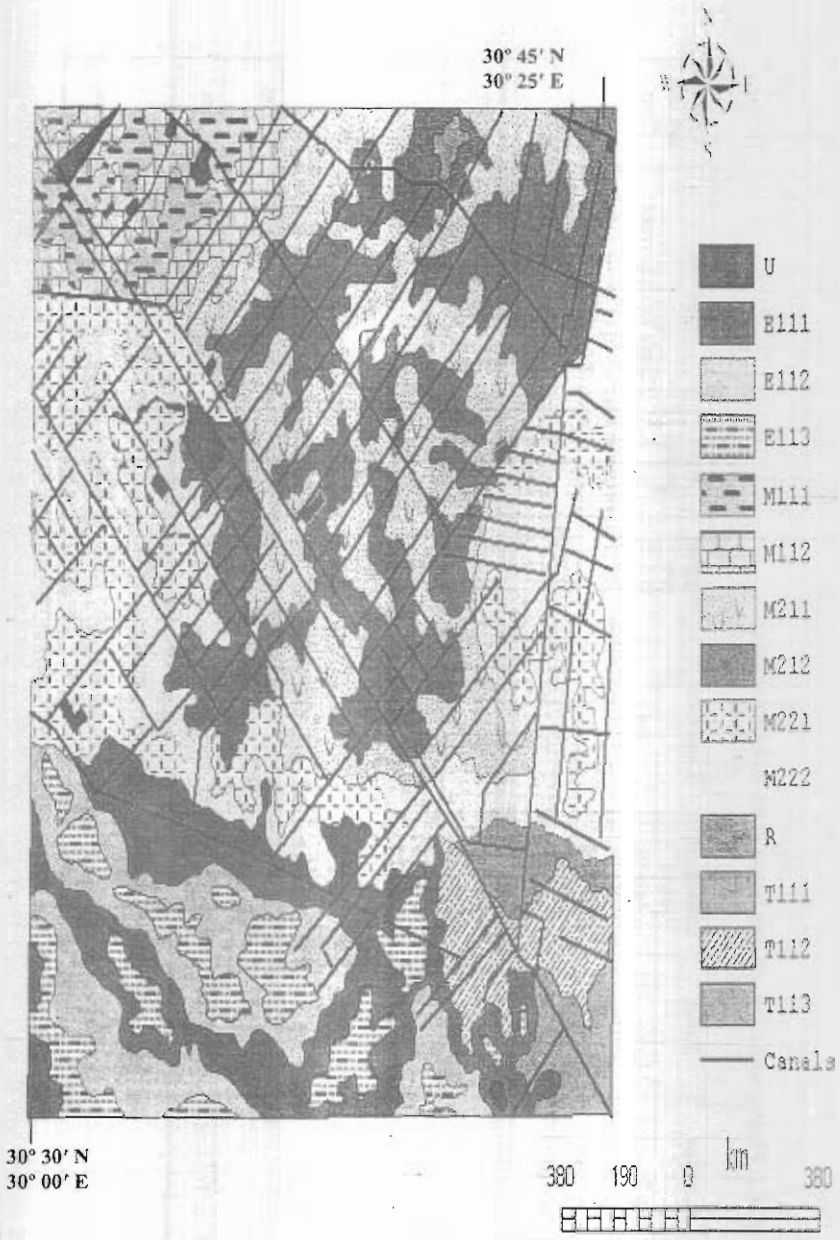
Geomorhpology is assumed to be one of the driving soil forming factors and soil mapping criteria, concepts provided by this discipline can converiently be used for soil data structuring.

The combination of the geomorphic approach as a hierarchic classification system of geoforms using the existing body of knowledge in geomorphology, with the photo-interpretation map and field observations improved the results and allow us to use the computer-assistance procedures.

The soil map legend of the investigated area is shown in Table 1 and the physiography and soils map is shown in Map 1.

**TABLE 1. Physiographic and soil map legend of the investigated area.**

| Landscape | Relief | Lithology/ origin | Land form | Mapping unit | Rep. profile | Soil sets | Type of soil sets |
|---|---|---|---|---|---|---|---|
| Marine Deposits ( M) | Maryut table land ($M_1$) | Undulating to gently undulating ($M_{11}$) | Top | $M_{111}$ | 1 | Typic Torripsamment | Cons |
| | | | Gently slope | $M_{112}$ | 3 | Typic Paleorthids | Assoc. |
| | Pen plain (M2) | Rolling to undulating ($M_{21}$) | Top | $M_{211}$ | 5 | Typic Torripsamment | Cons. |
| | | | Gently slope | $M_{212}$ | 9 | Typic Calciorthids | Assoc. |
| | | Rocky area | Complex. | R | - | - | - |
| Aeolian Deposits (E) | Plain ($E_1$) | Sand Ripples ($E_{11}$) | Relatively high | $E_{111}$ | 11 | Typic Torripsamment | Cons. |
| | | | Moderately high | $E_{122}$ | 14 | | |
| | | | Relatively low | $E_{113}$ | 16 | Typic Paleorthids | Assoc. |
| River Terraces (T) | Old River Terraces ($T_1$) | Sequence of old River Terraces ($T_{11}$) | Relatively high | $T_{111}$ | 19 | Typic Torripsamment | Cons. |
| | | | Relatively high | $T_{112}$ | 21 | | |
| | | | Relatively low | $T_{113}$ | 25 | Typic Calciorthids | Assoc. |




**Map.1. Physiography and soils map of the studied area.**

*Soil classification*

According to the recent American Soil Taxonomy (1999), laboratory analyses and field work the studied soils could be classified as:

$M_1$, Typic Torripsamments (consociation).
$M_1$ Typic Paleorthids (association).
$M_2$, Typic Torripsamments (consociation).
$M_2$, Typic Calciorthids (association).
$E_1$, Typic Torripsamments (consociation).
$E_1$, Typic Paleorthids (association).
$T_1$, Typic Torripsamments (consociation).
$T_1$, Typic Calciorthids (association).
The physiographic-soil sets are shown in Table 1.

*Soil characterization*

The present geomorphic-pedological study, which based on aerial photographs interpretation, field observation and analytical data are shown in Table 2 and 3.

*Soils of Maryut table land ($M_1$)*

These soils are occurred in the top and gently slope $M_{111}$ , $M_{112}$, of the undeulating to gently undulating area in maryut table land. It was represented by profiles (1 & 3). The texture is sandy and the structure is single grains to Massive. The consistence is loose, non-sticky, non plastic. There are few scattered broken shells at the first horizon. The compaction at the second horizon is slightly. There are common medium pores. The effervescence with HCl is (moderate to strong). The natural of boundary is diffuse boundary. EC varies between (0.3-0.81) dS/m, pH value (7.3-7.6), Organic matter ranges between 0.21 and 0.73 % and calcium cardonate varies between (19.43- 40.26) %. The macro nutrients analysis indicates that; available nitrogen is (0.3-0.4) ppm; available phosphorus is (0.8-1.1) ppm; available potassium is (6.3- 7.3) ppm.

*Soil of penplain ($M_2$)*

These soils are found in mapping units ($M_{221}$, $M_{212}$ & R) represented by profiles (5 & 9). There is a limited Rocky area in the penplain. The texture of these soils is sandy and the structure is single grains to massive. The consistence is loose, non-sticky, and non-plastic. There are few scattered broken shells at the first horizon. The compaction at the second horizon is slightly. There are few medium pores. The effervescence with HCl is moderate to strong. The natural of boundary is diffuse boundary. EC varies between (0.23 – 0.84) dS/m; pH value (7.2–7.4); Organic matter ranges between 0.19 and 0.82% and calcium carbonate varies between (6.74–38.61) %. The macro nutrients analysis indicates that; available Nitrogen is (0.2- 0.4) ppm; available phosphorus is (0.7- 0.9) ppm; available potassium is (4.6- 6.2) ppm.

**TABLE 2. Summary of soils morphological features at the studied area.**

| Mapping unit | Rep. Profile No. | Depth in cm | Slope | Color | | Texture class | Structure | Consistency | Stickiness | Plasticity | Carbonates | Boundary | Cementation | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Dry | Moist | | | | | | | | | |
| $M_1$ | 1 | 0-20 | G | BY | BY | S | MG | HA | SST | SPL | MO | D | M | shells |
| | | 20-90 | | BY | BS | S | MM | SHA | SST | SPL | MO | D | M | - |
| | | 90-120 | | BY | BY | S | MM | SHA | NST | NPL | MO | D | M | - |
| | 3 | 0-20 | G | YE | YE | S | SG | SHA | NST | NPL | ST | D | W | - |
| | | 20-60 | | YE | BY | S | SG | SHA | NST | NPL | EX | D | M | - |
| | | +60 | | Petrocalcic horizon –discontinuous hard pan. | | | | | | | | | | |
| $M_2$ | 5 | 0-15 | F | YB | BY | S | MM | SHA | NST | NPL | MO | D | W | - |
| | | 15-70 | | YE | BY | S | MW | SO | NST | NPL | MO | D | W | Shells |
| | | 70-110 | | YB | BY | S | MW | SO | NST | NPL | MO | D | W | - |
| | 9 | 0-15 | U | BY | BS | S | SG | HA | NST | NPL | ST | D | Y | - |
| | | 15-70 | | BY | BY | S | MW | HA | NST | NPL | EX | D | Y | Shells |
| | | 70-100 | | BY | BS | S | SG | HA | NST | NPL | ST | D | Y | - |

All abbreviation are used according to FAO (1990) & ISRIC (1991).

**TABLE 2. Contd.**

| Mapping unit | Rep. Profile No. | Depth in cm | Slope | Color | | Texture class | Structure | Consistency | Stickiness | Plasticity | Carbonates | Boundary | Cementation | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Dry | Moist | | | | | | | | | |
| $E_1$ | 14 | 0-25 | A | Y | YB | S | SG | LO | NST | NPL | SL | D | Y | shells |
| | | 25-60 | | Y | BY | S | SG | LO | NST | NPL | SL | D | Y | Shells |
| | | 60-100 | | VPB | BY | S | SG | LO | NST | NPL | SL | D | Y | - |
| | 16 | 0-15 | G | BY | BY | S | SG | LO | NST | NPL | ST | D | W | - |
| | | 15-70 | | BY | BY | S | SG | SHA | NST | NPL | EX | D | M | - |
| | | +70 | | Petrocalcic horizon –discontinuous hard pan. | | | | | | | | | | |
| $T_1$ | 21 | 0-30 | G | Y | YB | S | SG | LO | NST | NPL | SL | D | Y | - |
| | | 30-75 | | YB | BY | S | SG | LO | NST | NPL | SL | D | Y | Shells |
| | | 70-115 | | Y | Y | S | SG | LO | NST | NPL | SL | D | Y | Shells |
| | 25 | 0-20 | G | BY | Y | S | SG | HA | NST | NPL | ST | D | Y | Shells |
| | | 20-60 | | Y | Y | S | MW | HA | NST | NPL | EX | D | Y | - |
| | | 60-90 | | BY | BY | S | SG | HA | NST | NPL | ST | D | Y | - |

All abbreviation are used according to FAO (1990) & ISRIC (1991).

**TABLE 3. Main physical & chemical characteristics of the representative soil profile.**

| Mapping unit | Rep. Profile No. | Depth in cm | Particle size distribution % | | | | | | | Texture class | pH | O.M % | $CaCO_3$ % | ECex (1:1) dS/m | CEC meq./ 100 gm Soil | ESP % | Available macro nutrients (ppm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | >2mm | 2-1 | 1-0.5 | 0.5-0.25 | 0.25-0.125 | 0.125-0.053 | <0.053 | | | | | | | | N | P | K |
| $M_1$ | 1 | 0-20 | 2.0 | 7.1 | 22.3 | 23.6 | 27.9 | 6.7 | 10.4 | Sandy | 7.5 | 0.73 | 20.41 | 0.81 | 3.2 | 9.3 | 0.3 | 0.8 | 6.3 |
| | | 20-90 | 1.6 | 6.3 | 26.1 | 26.2 | 28.2 | 5.2 | 6.4 | Sandy | 7.3 | 0.26 | 17.82 | 0.43 | 3.0 | 8.4 | - | - | - |
| | | 90-120 | 0.5 | 6.2 | 25.3 | 25.1 | 31.7 | 5.1 | 6.1 | Sandy | 7.3 | 0.17 | 19.43 | 0.30 | 3.4 | 8.1 | - | - | - |
| | 3 | 0-20 | 0.7 | 5.4 | 24.0 | 27.3 | 29.3 | 6.1 | 7.2 | Sandy | 7.5 | 0.64 | 31.51 | 1.40 | 4.3 | 9.2 | 0.4 | 1.1 | 7.2 |
| | | 20-60 | 1.4 | 5.1 | 26.6 | 31.1 | 24.2 | 5.1 | 6.5 | Sandy | 7.6 | 0.21 | 40.26 | 0.52 | 6.1 | 10.1 | - | - | - |
| | | + 60 | Petrocalcic horizon-discontinous hard pan. | | | | | | | | | | | | | | | | |
| $M_2$ | 5 | 0-15 | 0.8 | 16.2 | 17.4 | 18.6 | 33.6 | 6.1 | 7.3 | Sandy | 7.2 | 0.82 | 14.31 | 0.51 | 2.9 | 7.4 | 0.2 | 0.9 | 4.6 |
| | | 15-70 | 0.9 | 17.4 | 27.8 | 17.2 | 25.4 | 4.2 | 7.1 | Sandy | 7.4 | 0.34 | 9.26 | 0.42 | 2.4 | 6.9 | - | - | - |
| | | 70-110 | 1.4 | 19.2 | 30.1 | 20.4 | 22.1 | 2.7 | 4.1 | Sandy | 7.2 | 0.16 | 6.74 | 0.23 | 2.5 | 7.1 | - | - | - |
| | 9 | 0-15 | 0.7 | 16.7 | 25.7 | 20.1 | 21.6 | 7.2 | 8.0 | Sandy | 7.3 | 0.51 | 25.31 | 0.84 | 4.6 | 8.4 | 0.4 | 0.7 | 6.2 |
| | | 15-70 | 0.6 | 7.1 | 34.3 | 21.4 | 22.1 | 6.3 | 8.2 | Sandy | 7.4 | 0.36 | 38.61 | 0.61 | 5.1 | 8.1 | - | - | - |
| | | 70-100 | 0.4 | 6.2 | 29.5 | 25.1 | 21.1 | 6.0 | 11.7 | Sandy | 7.3 | 0.19 | 20.83 | 0.46 | 6.4 | 9.3 | - | - | - |

**TABLE 3. Contd.**

| Mapping unit | Rep. Profile No. | Depth in cm | Particle size distribution % | | | | | | | Texture class | pH | O.M % | $CaCO_3$ % | ECex (1:1) dS/m | CEC meq./ 100 gm Soil | ESP % | Available macro nutrients (ppm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | >2mm | 2-1 | 1-0.5 | 0.5-0.25 | 0.25-0.125 | 0.125-0.053 | < 0.053 | | | | | | | | N | P | K |
| $E_1$ | 14 | 0-25 | 2.6 | 11.8 | 29.3 | 21.4 | 22.4 | 3.2 | 9.3 | Sandy | 7.3 | 0.79 | 8.72 | 0.71 | 3.6 | 6.5 | 0.2 | 0.7 | 5.2 |
| | | 25-60 | 1.6 | 10.9 | 27.9 | 20.4 | 26.3 | 5.5 | 7.4 | Sandy | 7.1 | 0.29 | 9.17 | 0.53 | 3.1 | 6.5 | - | - | - |
| | | 60-100 | 1.4 | 10.3 | 20.2 | 19.6 | 32.8 | 6.4 | 9.3 | Sandy | 7.5 | 0.20 | 9.34 | 0.40 | 2.4 | 6.3 | - | - | - |
| | 16 | 0-15 | 1.1 | 15.2 | 20.6 | 30.6 | 21.4 | 5.0 | 6.1 | Sandy | 7.4 | 0.62 | 35.72 | 1.3 | 4.2 | 7.5 | 0.3 | 0.9 | 6.1 |
| | | 15-70 | 1.4 | 21.8 | 19.7 | 21.7 | 21.1 | 7.1 | 7.2 | Sandy | 7.5 | 0.43 | 45.16 | 0.8 | 4.8 | 6.9 | - | - | - |
| | | +70 | Petrocalcic horizon-discontinous hard pan. | | | | | | | | | | | | | | | | |
| $T_1$ | 21 | 0-30 | 1.5 | 11.7 | 17.3 | 24.2 | 25.6 | 9.3 | 10.4 | Sandy | 7.2 | 0.64 | 5.31 | 0.62 | 3.7 | 7.4 | 0.2 | 0.8 | 7.1 |
| | | 30-75 | 1.8 | 15.4 | 20.4 | 23.8 | 28.6 | 4.0 | 6.0 | Sandy | 7.3 | 0.19 | 3.42 | 0.4o | 3.1 | 7.1 | - | - | - |
| | | 75-115 | 2.3 | 15.1 | 21.1 | 23.6 | 32.9 | 7.9 | 6.1 | Sandy | 7.6 | 0.10 | 3.21 | 0.38 | 2.8 | 7.0 | - | - | - |
| | 25 | 0-20 | 1.2 | 10.2 | 17.2 | 32.5 | 20.1 | 10.1 | 8.7 | Sandy | 7.3 | 0.72 | 21.2 | 0.81 | 3.8 | 6.2 | 0.3 | 0.9 | 6.7 |
| | | 20-60 | 1.4 | 15.1 | 20.3 | 35.6 | 21.6 | 6.0 | 5.8 | Sandy | 7.4 | 0.28 | 36.4 | 0.63 | 4.1 | 7.8 | - | - | - |
| | | 60-90 | 2.2 | 13.5 | 19.9 | 28.2 | 10.7 | 19.3 | 6.2 | Sandy | 7.5 | 0.16 | 19.1 | 0.31 | 3.2 | 9.1 | - | - | - |

*Soils of plain (E1)*

These soils are found in mapping units ($E_{111}$, $E_{112}$ & $E_{113}$) represented by profiles (11, 14 &16). There is a limited area which has discontinuous hardpan (petrocalcic horizon). The texture is sandy, the structure is single grains. The consistence is loose, non-sticky, non plastic. There are few scattered broken shells at the first and second horizon. The compination at the second horizon is lightly. There are few medium pores. The effervescence with HCl (slight to strong). The natural of boundary is diffuse boundary. EC varies between 0.4 and 1.3 dS /m; pH value (7.1–7.5); organic matter ranges from 0.20 to 0.79 %. The macro nutrients analysis indicate that; available Nitrogen is (0.2- 0.3) ppm; available phosphorus is (0.7 – 0.9) ppm; available potassium is (5.2 – 6.1) ppm.

*Soils of old River terraces (T1)*

These soil are found in maping units ($T_{112}$ & $T_{113}$) Represented by profiles (19, 21 & 25). The Texture is sandy; the structure is single grains to massive. The consistence is loose, non-sticky, non second horizon. The compaction at the second horizon is slightly. There are few medium pores. The effervescence with HCl is slight to strong. The natural of boundary is diffuse boundary. EC varies between (0.31–0.81) dS/m; pH value (7.2–7.6); organic matter ranges from 0.10 to 0.72 and calcium carbonate varies between 3.12–36.4%. The macro nutrients analysis indicates that; available nitrogen is (0.2–0.3) ppm; available phosphorus is (0.8–0.9) ppm ; available potassium is (6.7 – 7.1) ppm.

*Land suitability*

Actual and potential suitability deals with land qualities coupled with crop requirements calculated by using the Automated Land Evaluation System (ALES) depending on soil rating after Siderius (1984 & 1989). Land quality rating of soil mapping units are shown in Table 4. The selections of the most promising crops to be evaluated according to its suitabilities for the investigated area build according the following parameters.

Sustaining the natural resources, national strategic and economic, Based on these factors, fairly traditional crops are proposed for the studied area. The main crops selected are (clover, wheat, beans, sugar beet, onion, maize, sunflower, tomato, potato, groundnut, pea, lentil, barley, sesame and carrot).

*Crop water requirements*

The crop water requirements were calculated by using crop wat program. The $ET_0$ was estimated using (penman-monteith) method, after Allen (1998), as shown in Table 5. The crop water requirements of clover, wheat, beans, sugar beet, onion, maize, sunflower, tomato, potato, groundnut, pea, lentil, barley, sesame, and carrots are (683.5mm, 490.4 mm, 328.2 mm, 556.65mm, 339.9 mm, 668.5mm, 619.5mm, 765.7mm, 377.5mm, 467.5mm, 176.4mm, 173.1mm, 237.06 mm, 445.3mm and 218.1mm.), respectively.

**TABLE 4. Land quality rating of soil mapping units.**

| Land Qualities | Suitability classes | | | | |
|---|---|---|---|---|---|
| | $M_1$, KCBG | $M_2$, KCBG | $E_1$, KCBG | $T_1$, KCBG | R, FFAK |
| *Availability of foothold of Roots (d) 1* | 1 | 1 | 1 | 1 | 5 |
| *Availability of foothold of Roots (d) 2* | 1 | 1 | 1 | 1 | 5 |
| * Availability of Water (m) | 4 | 4 | 4 | 4 | 5 |
| * Availability of Nutrients (n) | 5 | 5 | 5 | 5 | 5 |
| * Erosion Hazard (e) | 4 | 4 | 4 | 4 | 5 |
| * Limitations | m,n,e | m,n,e | m,n,e | m,n,e | d,m,n,e |

1*: for fruits
2*: for crop and vegetables

* The suitability classes are defined as follows:

1 Highly suitable
2 Moderately suitable
3 Marginally suitable
4 Currently not suitable
5 Not suitable most of the time

Notes:

- DCBG: Typic Torripsamment, After FAO (1990)
- FFAK: Typic Petrocalcids, After FAO (1990)
- $M_1$ = Maryut table land
- $M_2$ = penplain
- $E_1$ = plain
- $T_1$ = old River terraces
- R= Rocky area.

**TABLE 5. Crop water requirements for suitable crops in the studied area.**

| Month | ETo mm/10days | Clover (210 days) | | | Wheat (180 days) | | | Beans (130 days) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month |
| Jan. | 26 | 1.00 | 26.0 | 78.0 | 0.90 | 23.4 | 78.0 | 1.10 | 28.6 | 85.8 |
| | 26 | 1.00 | 26.0 | | 1.00 | 26.0 | | 1.10 | 28.6 | |
| | 26 | 1.00 | 26.0 | | 1.10 | 28.6 | | 1.10 | 28.6 | |
| Feb. | 29 | 1.00 | 29.0 | 87.0 | 1.10 | 31.9 | 95.7 | 0.90 | 26.1 | 46.4 |
| | 29 | 1.00 | 29.0 | | 1.10 | 31.9 | | 0.70 | 20.3 | |
| | 29 | 1.00 | 29.0 | | 1.10 | 31.9 | | | | |
| Mar. | 41 | 0.9 | 36.9 | 110.7 | 1.10 | 45.1 | 127.1 | | | |
| | 41 | 0.9 | 36.9 | | 1.10 | 45.1 | | | | |
| | 41 | 0.9 | 36.9 | | 1.10 | 36.9 | | | | |
| Apr. | 56 | 0.9 | 50.4 | 151.2 | 0.70 | 39.2 | 84.0 | | | |
| | 56 | 0.9 | 50.4 | | 0.50 | 28.0 | | | | |
| | 56 | 0.9 | 50.4 | | 0.30 | 16.8 | | | | |
| May | 68 | | | | | | | | | |
| | 68 | | | | | | | | | |
| | 68 | | | | | | | | | |
| June | 77 | | | | | | | | | |
| | 77 | | | | | | | | | |
| | 77 | | | | | | | | | |
| July | 75 | | | | | | | | | |
| | 75 | | | | | | | | | |
| | 75 | | | | | | | | | |
| Aug. | 72 | | | | | | | | | |
| | 72 | | | | | | | | | |
| | 72 | | | | | | | | | |
| Sep. | 64 | | | | | | | | | |
| | 64 | | | | | | | | | |
| | 64 | | | | | | | | | |
| Oct. | 48 | 0.50 | 24.0 | 86.4 | | | | | | 48.0 |
| | 48 | 0.60 | 28.8 | | | | | 0.50 | 24.0 | |
| | 48 | 0.70 | 33.6 | | | | | 0.50 | 24.0 | |
| Nov. | 34 | 0.80 | 27.2 | 97.0 | 0.50 | 17.0 | 51.0 | 0.50 | 17.0 | 66.3 |
| | 34 | 0.90 | 30.6 | | 0.50 | 17.0 | | 0.65 | 22.1 | |
| | 34 | 1.00 | 34.0 | | 0.50 | 17.0 | | 0.80 | 27.2 | |
| Dec. | 26 | 1.00 | 26.0 | 78.0 | 0.60 | 15.6 | 54.6 | 0.95 | 24.7 | 81.9 |
| | 26 | 1.00 | 26.0 | | 0.70 | 18.2 | | 1.10 | 28.6 | |
| | 26 | 1.00 | 26.0 | | 0.80 | 20.8 | | 1.10 | 28.6 | |
| Total ET crop (mm) | | 683.5 | | | 490.4 | | | 328.2 | | |

* KC → Crop Coefficient * ETo → Evapotranspiration * ET crop → consumptive use.

**TABLE 5. Contd.**

| Month | ETo mm/10days | Sugar Beet (200 days) | | | Onions ( 140 days ) | | | Maize ( 110 days ) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month |
| Jan. | 26 | 1.10 | 28.6 | 85.8 | 0.95 | 24.7 | 74.1 | | | |
| | 26 | 1.10 | 28.6 | | 0.95 | 24.7 | | | | |
| | 26 | 1.10 | 28.6 | | 0.95 | 24.7 | | | | |
| Feb. | 29 | 1.10 | 31.9 | 95.7 | 0.80 | 23.2 | 43.5 | | | |
| | 29 | 1.10 | 31.9 | | 0.70 | 20.3 | | | | |
| | 29 | 1.10 | 31.9 | | | | | | | |
| Mar. | 41 | 0.85 | 34.85 | 104.55 | | | | | | |
| | 41 | 0.85 | 34.85 | | | | | | | |
| | 41 | 0.85 | 34.85 | | | | | | | |
| Apr. | 56 | 0.60 | 33.6 | 67.2 | | | | | | |
| | 56 | 0.60 | 33.6 | | | | | | | |
| | 56 | | | | | | | | | |
| May | 68 | | | | | | | | | |
| | 68 | | | | | | | | | |
| | 68 | | | | | | | | | |
| June | 77 | | | | | | | 0.40 | 30.8 | 123.2 |
| | 77 | | | | | | | 0.50 | 38.5 | |
| | 77 | | | | | | | 0.70 | 53.9 | |
| July | 75 | | | | | | | 0.90 | 67.5 | 232.5 |
| | 75 | | | | | | | 1.10 | 82.5 | |
| | 75 | | | | | | | 1.10 | 82.5 | |
| Aug. | 72 | | | | | | | 1.10 | 79.2 | 223.2 |
| | 72 | | | | | | | 1.10 | 79.2 | |
| | 72 | | | | | | | 0.90 | 64.8 | |
| Sep. | 64 | | | | | | | 0.70 | 44.8 | 89.6 |
| | 64 | | | | | | | 0.70 | 44.8 | |
| | 64 | | | | | | | | | |
| Oct. | 48 | 0.50 | 24.0 | 72.0 | 0.50 | 24.0 | 72.0 | | | |
| | 48 | 0.50 | 24.0 | | 0.50 | 24.0 | | | | |
| | 48 | 0.50 | 24.0 | | 0.50 | 24.0 | | | | |
| Nov. | 34 | 0.50 | 17.0 | 61.2 | 0.62 | 21.1 | 76.2 | | | |
| | 34 | 0.60 | 20.4 | | 0.75 | 25.5 | | | | |
| | 34 | 0.70 | 23.8 | | 0.87 | 29.6 | | | | |
| Dec. | 26 | 0.80 | 20.8 | 70.2 | 0.95 | 24.7 | 74.1 | | | |
| | 26 | 0.90 | 23.4 | | 0.95 | 24.7 | | | | |
| | 26 | 1.0 | 26.0 | | 0.95 | 24.7 | | | | |
| Total ET crop (mm) | | 556.65 | | | 339.9 | | | 668.5 | | |

* KC → Crop Coefficient. * ETo → Evapotranspiration. * ET crop → consumptive use.

**TABLE 5. Contd.**

| Month | ETo mm/10days | Sunflower ( 100 days ) | | | Tomato (120 days ) | | | Potato (150 days ) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month |
| Jan. | 26 | | | | | | | | | |
| | 26 | | | | | | | | | |
| | 26 | | | | | | | | | |
| Feb. | 29 | | | | | | | | | |
| | 29 | | | | | | | | | |
| | 29 | | | | | | | | | |
| Mar. | 41 | | | | | | | | | |
| | 41 | | | | | | | | | |
| | 41 | | | | | | | | | |
| Apr. | 56 | | | | | | | | | |
| | 56 | | | | | | | | | |
| | 56 | | | | | | | | | |
| May | 68 | 0.40 | 27.2 | | | | | | | |
| | 68 | 0.50 | 34.0 | 108.8 | 0.40 | 27.2 | 54.4 | | | |
| | 68 | 0.70 | 47.6 | | 0.40 | 27.2 | | | | |
| June | 77 | 0.90 | 69.3 | | 0.55 | 42.4 | | | | |
| | 77 | 1.10 | 84.7 | 238.7 | 0.73 | 56.2 | 167.90 | | | |
| | 77 | 1.10 | 84.7 | | 0.90 | 69.3 | | | | |
| July | 75 | 1.10 | 82.5 | | 1.05 | 78.8 | | | | |
| | 75 | 1.10 | 82.5 | 228.8 | 1.15 | 85.3 | 251.4 | | | |
| | 75 | 0.85 | 63.8 | | 1.15 | 86.3 | | | | |
| Aug. | 72 | 0.60 | 43.2 | | 1.15 | 82.8 | | 0.15 | 10.8 | |
| | 72 | | | 43.2 | 1.15 | 82.8 | 237.6 | 0.15 | 10.8 | 32.4 |
| | 72 | | | | 1.00 | 72.0 | | 0.15 | 10.8 | |
| Sep. | 64 | | | | 0.85 | 54.4 | | 0.5 | 32.0 | |
| | 64 | | | | | | 54.4 | 0.5 | 32.0 | 96.0 |
| | 64 | | | | | | | 0.5 | 32.0 | |
| Oct. | 48 | | | | | | | 0.60 | 28.8 | |
| | 48 | | | | | | | 0.60 | 28.8 | 88.8 |
| | 48 | | | | | | | 0.65 | 31.2 | |
| Nov. | 34 | | | | | | | 1.10 | 37.4 | |
| | 34 | | | | | | | 1.10 | 37.4 | 112.2 |
| | 34 | | | | | | | 1.10 | 37.4 | |
| Dec. | 26 | | | | | | | 0.65 | 16.9 | |
| | 26 | | | | | | | 0.60 | 15.6 | 48.1 |
| | 26 | | | | | | | 0.60 | 15.6 | |
| Total ET crop (mm) | | 619.5 | | | 765.7 | | | 377.5 | | |

* KC → Crop Coefficient * ETo → Evapotranspiration * ET crop → consumptive use.

**TABLE 5. Contd.**

| Month | ETo mm/10days | Groundnut ( 120 days ) | | | Pea ( 120 days ) | | | Lentil (110 days) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month |
| Jan. | 26 | | | | 0.25 | 6.5 | 19.5 | 0.20 | 5.2 | 15.6 |
| | 26 | | | | 0.25 | 6.5 | | 0.20 | 5.2 | |
| | 26 | | | | 0.25 | 6.5 | | 0.20 | 5.2 | |
| Feb. | 29 | | | | | | | | | |
| | 29 | | | | | | | | | |
| | 29 | | | | | | | | | |
| Mar. | 41 | 0.15 | 6.15 | 18.4 | | | | | | |
| | 41 | 0.15 | 6.15 | | | | | | | |
| | 41 | 0.15 | 6.15 | | | | | | | |
| Apr. | 56 | 0.65 | 36.4 | 109.2 | | | | | | |
| | 56 | 0.65 | 36.4 | | | | | | | |
| | 56 | 0.65 | 36.4 | | | | | | | |
| May | 68 | 1.10 | 74.8 | 224.4 | | | | | | |
| | 68 | 1.10 | 74.8 | | | | | | | |
| | 68 | 1.10 | 74.8 | | | | | | | |
| June | 77 | 0.5 | 38.5 | 115.5 | | | | | | |
| | 77 | 0.5 | 38.5 | | | | | | | |
| | 77 | 0.5 | 38.5 | | | | | | | |
| July | 75 | | | | | | | | | |
| | 75 | | | | | | | | | |
| | 75 | | | | | | | | | |
| Aug. | 72 | | | | | | | | | |
| | 72 | | | | | | | | | |
| | 72 | | | | | | | | | |
| Sep. | 64 | | | | | | | | | |
| | 64 | | | | | | | | | |
| | 64 | | | | | | | | | |
| Oct. | 48 | | | | 0.15 | 7.2 | 21.6 | | | 14.4 |
| | 48 | | | | 0.15 | 7.2 | | 0.15 | 7.2 | |
| | 48 | | | | 0.15 | 7.2 | | 0.15 | 7.2 | |
| Nov. | 34 | | | | 0.60 | 20.4 | 61.2 | 0.60 | 20.4 | 61.2 |
| | 34 | | | | 0.60 | 20.4 | | 0.60 | 20.4 | |
| | 34 | | | | 0.60 | 20.4 | | 0.60 | 20.4 | |
| Dec. | 26 | | | | 0.95 | 24.7 | 74.1 | 1.05 | 27.3 | 81.9 |
| | 26 | | | | 0.95 | 24.7 | | 1.05 | 27.3 | |
| | 26 | | | | 0.95 | 24.7 | | 1.05 | 27.3 | |
| Total ET crop (mm) | | 467.5 | | | 176.4 | | | 173.1 | | |

* KC → Crop Coefficient * ETo → Evapotranspiration * ET crop → consumptive use.

**TABLE 5. Contd.**

| Month | ETo mm/10days | Barley ( 130 days ) | | | Sesame (120 days ) | | | Carrots ( 120 days) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month | KC | ET crop mm/10 day | ET crop mm/month |
| Jan | 26 | 0.2 | 5.2 | 10.4 | | | | 0.85 | 22.1 | 66.3 |
| | 26 | 0.2 | 5.2 | | | | | 0.85 | 22.1 | |
| | 26 | | | | | | | 0.85 | 22.1 | |
| Feb. | 29 | | | | | | | | | |
| | 29 | | | | | | | | | |
| | 29 | | | | | | | | | |
| Mar. | 41 | | | | | | | | | |
| | 41 | | | | | | | | | |
| | 41 | | | | | | | | | |
| Apr. | 56 | | | | 0.15 | 8.4 | 25.2 | | | |
| | 56 | | | | 0.15 | 8.4 | | | | |
| | 56 | | | | 0.15 | 8.4 | | | | |
| May | 68 | | | | 0.65 | 44.2 | 132.6 | | | |
| | 68 | | | | 0.65 | 44.2 | | | | |
| | 68 | | | | 0.65 | 44.2 | | | | |
| June | 77 | | | | 1.05 | 80.8 | 242.5 | | | |
| | 77 | | | | 1.05 | 80.8 | | | | |
| | 77 | | | | 1.05 | 80.8 | | | | |
| July | 75 | | | | 0.2 | 15.0 | 45.0 | | | |
| | 75 | | | | 0.2 | 15.0 | | | | |
| | 75 | | | | 0.2 | 15.0 | | | | |
| Aug. | 72 | | | | | | | | | |
| | 72 | | | | | | | | | |
| | 72 | | | | | | | | | |
| Sep. | 64 | | | 19.2 | | | | | | |
| | 64 | 0.15 | 9.6 | | | | | | | |
| | 64 | 0.15 | 9.6 | | | | | | | |
| Oct. | 48 | 0.5 | 24.0 | 72.0 | | | | 0.15 | 7.2 | 21.6 |
| | 48 | 0.5 | 24.0 | | | | | 0.15 | 7.2 | |
| | 48 | 0.5 | 24.0 | | | | | 0.15 | 7.2 | |
| Nov. | 34 | 0.65 | 22.1 | 66.3 | | | | 0.55 | 18.7 | 65.1 |
| | 34 | 0.65 | 22.1 | | | | | 0.55 | 18.7 | |
| | 34 | 0.65 | 22.1 | | | | | 0.55 | 18.7 | |
| Dec. | 26 | 1.02 | 26.5 | 79.56 | | | | 0.95 | 24.7 | 74.1 |
| | 26 | 1.02 | 26.5 | | | | | 0.95 | 24.7 | |
| | 26 | 1.02 | 26.5 | | | | | 0.95 | 24.7 | |
| Total ET crop (mm) | | 237.06 | | | 445.3 | | | 218.1 | | |

* KC → Crop Coefficient * ETo → Evapotranspiration * ET crop → consumptive use.

## Conclusion

A number of factors were considered in selecting cropping patterns suitable for cultivation in the studied area, these include:
- Physical: water, soils, climate, and topography.
- Financial: financial returns, risks and labor requirements.
- Socio-Economic: economic returns, food production and employment.
- Traditional: past experience and practice.

Based on these factors, fairly traditional crops ad rotations are proposed for the study area. The main crops selected are:
- Summer crops & vegetables: maize, sunflower, tomato, and sesame. the water requirements of these crops range between (467.5 – 765.7) mm per season.
- Winter crops & vegetables: clover, wheat, beans, sugar beet, onions, potato, groundnut, pea, lentil, barley and carrots, these crops has a water requirements ranges of (173.1– 683.5) mm/ season.

## Reference

**Allen (1998)** "*Crop Evapotranspiration Guidelines*" for computing crop water requirements. FAO, Irrigation and drainage, paper No. 65. Rome

**Bennema, J. and Gelons, M.F. (1969)** "*Aerial Photo Interpretation For Soil Survery*", lecture note, ITC course photo-interpretation in soil surveying, ITC., Enschede , the NetherLands.

**Climatological Normals for Egypt (2000)** The normals for west Nubariya station, (1960– 2000) Minsistry of Civil Aviation , Meterological Authority, Cairo, Egypt.

**Egyptian Metrological Authority (1996)** "*Climatic Atlas of Egypt*", Published, Arab Republic of Egypt, Ministry of Transport.

**Elberson, G.W.W. and Catlan, R. (1987)** "*Protable Computers In Physiographic Soil Survey*", proc intemat soil sci., cong, Humburg.

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

**Goher, A.A.L. (1954)** The influence of exchangeable cations on the physical properties of Egyptian soils. *M.Sc. Thesis*, Soil Sci Dept., Fac. of Agric., Cairo Univ., U.A.R.

**Goosen, D. (1967)** Aerial photo- interpretaion in soil survey, FAO. *Soil Bull.* (6), FAO, Rome.

**Isric (1991)** FAO –Soil – Database, version 2.0, FAO publication, Rome.

**Jackson, M.L. (1967)** "*Soil Chemical Analyses*", Prentice- Hall Inc. Engle – wood cliffs, N.S. Constable & Co. ltd, Landon.

**Klut, A. (1986)** "*Methods of Soil Analysis (Part–1) Physical and Mineralogical Methods*", 2nd ed., Amer. Soc. of Agron. Madisom, Wisconing, USA.

**Ligterink, G.H. (1968)** Elmentary photogrammetry for Interpretation course. Gen. 1. ITC, Delft, the Nether lands.

**Page, A.I., Miller, R.H. and Keeney, D.R. (1982)** "*Methods of Soil Analysis ( Part 2) – Chemical and Microbiological Properties*", 2nd ed., Amer. Soc. of Agron., Madison, Wisconsing, U.S.A.

**Piper, C.S. (1950)** Soil and Plant Analyses, A monograph form the wait Agric. Research institute, Univ. Of Adelaide, Australia.

**Richard, L.A. (1954)** " *Diagnosis and Improvement of Saline and Alkali Soils*", No. 60, U.S Dept. of Agric., HandBook.

**Rossiter, D.G. and Van Wambeke, A.R. (1995)** Automated land Evaluation system (ALES), software. Version 4.1. Cornell university., Dept of soils. Crop and Atmospheric Sci Ithaca , NY.

**Said, R. (1993)** " *The River Nile Geology and Hydrology and Utilization*", 320 p., oxford, Britain Pergmon press.

**Sideruis, W. (1984)** Rating of Soil derived land qualities .

**Sideruis, W. (1989)** Selective Reading in Land Evaluation, lecture Notes, ITC, Enschede, Netherlands

**Soil Survey Staff (1975)** "*Soil Munssel Color Chorts*", U.S.D.A., soil conserve, Washington, D.C.

**Soil Survey Staff (1999)** "*Soil Taxonomy*", A basic system of soil classification for making and interpreting surveys, 2nd ed., Agriculture Hand book No. 436, U.S.D.A., Nat. Res. Cons. Service.

**Tucker, B.M. (1971)** Basic Exchangeable Cations in Soils, Soil Tech. Pup., No. 8, **5**, 706. Aust. And G.RES.

**USDA (1991)** Soil survey laboratory Methods Manual, Soil Investigation Report, No. 42, version N.1.0, OCT. 1991, 603 p.

**Vink, A.B.A. (1963)** Aerial Photographs And Soil Sciences, UNESCO Report. Paris

**Zink, J.A. and Valenzuala (1990)** Soil geographic database, Vol. **3**, ITC., Ensched, the Netherlands.

( *Received* 2 / 2006;
*accepted* 5 / 2006)

# عمل خرائط التربة كأساس لتحديد الاستخدام الأمثل والاحتياجات المائية للمحاصيل بمنطقة النوبارية غرب الدلتا ــ مصر

**وائل أحمد محمد عبد القوي و رأفت رمضان على***
قسم الأراضي ــ كلية الزراعة ــ جامعة القاهرة و*قسم الأراضى واستغلال المياة – المركز القومى للبحوث– القاهرة – مصر .

الهدف الرئيسي من هذه الدراسة هو عمل خريطة فيزوجرافية أرضية مصححة بمقياس ١: ٥٠,٠٠٠ تصغر إلى الخريطة الملحقة مقياس ١: ٢٥٠,٠٠٠ كأساس لتصنيف صلاحية الارض للزراعة بالمحاصيل وتقدير الاحتياجات المائية لهذه المحاصيل بمنطقة النوبارية.

وللوصول لهذا الهدف تم اختيار ١٠ قطاعات ارضية من اجمالى ٢٥ قطاع تم تجميعها لتمثيل الوحدات الأرضية حيث تم وصفها مورفولوجيا، كما تم جمع عينات التربة للتحليل الطبيعي والكيماوي. وبالاعتماد على تفسير الصور الجوية ونظم المعلومات الجغرافية بجانب النتائج الحقلية والمعلمية تم إنتاج الخريطة الفيزوجرافية الأرضية وأمكن تحديد ثلاث وحدات رئيسية:
١- الترسيبات البحرية والتي تشتمل أراضي مربوط والأراضي البين سهلية.
٢- الترسيبات الرملية والتي تشمل على أراضي السهول.
٣- المصاطب النهرية القديمة والتي تمير بسلسة من المصاطب النهرية.

وقد استخدمت نتائج كل مما سبق في إجراء عملية تقييم لإيجاد أفضل استخدام للأراضي المدروسة. وتم تحديد خصائص الأراضي بالنسبة للوحدات الخرائطية المختلفة وكذلك احتياجات المحاصيل المختلفة ثم استخدم نظام تقيم الأراضي الآلي (*ALES*) للتوفيق بين خصائص الأراضي والاحتياجات الارضية للمحاصيل المختلفة، حيث وجد ان انسب المحاصيل للزراعة بالمنطقة هى البرسيم، القمح ، الفاصولياء ، بنجر السكر، البصل ، الذرة الصفراء ، عبّاد الشمس ، الطماطم ، البطاطا ، الفول السوداني ، البازلاء ، العدس ، الشعير، السمسم والجزر.

وبعد ذلك تم حساب الاحتياجات المائية للمحاصيل المختارة باستخدام برنامج (*Crop wat*.) .