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SOIL STUDIES ON LAKE NASSER REGION USING REMOTE SENSING AND GIS CAPABILITIES

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ABSTRACT

Nasser Lake is an artificial lake located south of Egypt. The whole region is extremely arid, receiving no rainfall except for occasional thunderstorms which sporadically penetrate the area in winter. The images and GIS capabilities were used to generate soil maps. The data extracted from satellite images and digital elevation model indicated that the area under investigation includes six main physiographic units, Dissected desert uplands and Wadis, Desert plain, Sand sheet, Pediment, Plateau and Rock outcrops. Studying their morphological, chemical and physical characteristics, the soils were classified under the following taxa; Soils of the dissected Desert uplands are dominated by *Typic and Lithic Quartzpssanients Lithic and Typic Torripsamments. Torriorthents* are present where gravel of different sizes is included in a matrix of sand. The difference between *Quartzipsamments and Torripsamments* is only concerning the amount of gravels which is less than to be *Orthents or Quartzipsamments*. Quartz grains are almost composing sand grains where the chriteria used to define *Quartzipsamments* is only the composition of resistant minerals, the Torri moisture regime is prevailing under which both *Torripsamments and Quartzipsamments* are present.

Soils of the Desert plains are dominated by *Torriorthents* with minor tracts of *Torripsamments* and even *Haploduric Torripsamment. Fluvents* are present in areas of Wadis and desert basins *Ardisols* are represented in this unit by salids, *Gypsic Haplosolids and Gypsids, Haplogypsids.*

Soils of the sand sheets are including *Psamments (Quartzipsamment, Orthents (Torriorthent), Fluvents (Torrifluvents), salids (Haplosalids, and Gypsic Haplosalids).* The Fluvents in the area are the soils of wadis covered by sand sheets, while salids are those occupying desert basins. The pediments in the Piedmont plains are occupied by *Entisols, Orthents (Torriorthents), and Ardisols, salids (Gypsi Haplosalids)*. In the plateau parts in the study area, *Entisols, Orthents (Torriorthents)* are dominating.

Evaluating the capability of the studied lands revealed that the soils of the uplands are rated as poor to very poor. The Desert plains are dominated by fair class soils. The sand sheets comprised poor soils in general, fair and poor capability are minor. The pediment lands in this study are occupied by fair capability soils, while the plateau land area comprised poorly capable soils for agricultural use.

Keywords: Landforms, *Entisols*, Nasser Lake, *Ardisols*, Soil ,Capability.

INTRODUCTION

. High Dam Lake reservoir extends for some 496 km, of which 292 km inside Egypt (Naser Lake), and 204 km for Lake Nubia in Sudan. The area of the reservoir at 180 m level is about 6275 km^2 of which Lake Nasser occupies about 5248 km^2.The mean depth of Lake Nasser at 160 m level is 21.5 m as compared with about 25.2 m at 180 m level. The mean width of the Lake at 160 m level is 8.9 km, and 18.0 km when the water level reaches 180 m. Lake Nasser has many embayments locally called khors (Fig. 1). The total number of important khors is 85 (48 on the eastern side and 37 on the western side). Some khors as Kalabsha, Tushka and Allaqi are wide, with a sandy bottom and sloping grade; others as Singari, El-Sabakha and Korosko are steep and relatively narrow with rocky bottom. The total surface area of khors/ as areas outside the main valley covered by water, is about 4,900 km2 = 79 % of the total surface area, but in volume they contain only 86.4 km3 water (= 55% of the total Lake volume). Geological and stratigraphical studies dealing with the area surrounding the Lake were carried out by different authors (Ball 1902, El-Shazly 1954, Attia 1955, El-Ramly and Akkad I960, Shata 1962, Said and Issawy 1964, El- Ramly 1973, Klitzch and Lejal-Nicol 1984, Latif 1984, Hendriks *et al*. 1987… etc).

Today, various soil classification systems are being used in the world. Among these most widely used soil classification systems are the Soil Taxonomy (Soil Survey Staff, 1999; 2006). There have been many attempts to correlate soil properties with various factors, such as parent material and topography (Mahmoodi et al., 2007). Two vital soil forming factors which affect the genesis, development and classification of soils are the climate and topography. Numerous soil characteristics and pedogenic features like calcium carbonate are dependent on climate and may record paleo-climate data (Srivastava, 2001).

Hammad *et al.* (1977) showed that, the soils of Natrun - Maryout area are characterized by the formation of an evaporite horizon. This horizon is differentiated to sub horizons. In the soils of the old deltaic plain, the presence of calcium carbonate and gypsum accumulations are evidences of chemical weathering and leaching in such desert soils. Gypsum crystals accumulations in general, in these soils, are due to lacustrine conditions. They studied two profiles formed under arid conditions, one of them is a weathering profile and the other is stratified due to its high water table, where leaching is impeded. However, the favorable oxidizing condition at the surface can explain the abundant weathering of minerals at that horizon. They also noticed that anhydrite is only found in the soils of depressions irrespective of the presence of gypsum in the depressions or in old deltaic plain, a case which could point out to direct precipitation of anhydrite in a hyper saline solution rather than as accumation in a Gypsic horizon.

Khresat (2001) found a relationship between the landscape and the depth of Calcic horizon and found that the Calcic horizon in the concave landscape is deeper than the other sites. The concave landscape position increases the amount of effective precipitation and consequently leads to higher leaching of carbonates. Emadi *et al.* (2008) stated that, calcium carbonate content in a landscape physiography, indicated that the lower the physiography conditions, the deeper the calcium carbonate accumulation in soils. Such relationship was formerly reached by Hammad and Abdel Salam (1968)in the soils of Mersa Matruh.

The present investigation confirms the value of satellite remote sensing data as a tool for landform analysis and mapping of soils in their total perspective. The study area covers six units, at various locations in the area. The objectives of this research are;

1-Studying the morphology, and classification of soils around Lake Nasser according to the Soil Taxonomy (Soil Survey Staff, 2006).
2-Presenting a Soil Landscape Map of the area around the lake.
3- Evaluating the capability of the studied soils for agriculture.

MATERIALS AND METHODS

Location and environmental setting.

The lake area is an important part of the High Dam of Egypt. It is one of the promising areas of development in Egypt. The study area is located between latitudes 22° and 24°N and longitudes 31° and 33.5°E including;

- Areas on the western side of the lake, as Wadi Kurkur, Wadi Kalabsha, Garf Hussein, Thomas&Afia, WadiToshka, Abu Simbel, and Sarah (West),
- Areas on the eastern side of the lake, as Wadi el Allaqui (county Abusco), El-Siala and Quastal and Adendan,

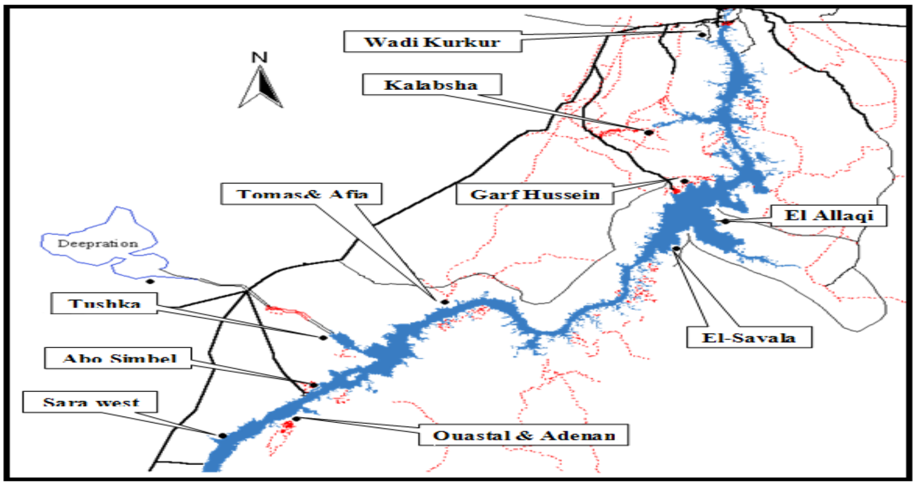

Fig. 1: Important areas in the lake vicinity.

Data and Software Used.

In the present study, various types of data have been used including multi-temporal satellite images including, (MSS 1972), (TM 1984), and (ETM+ 2001and 2005), Digital Elevation Models (DEMs 90 m) extracted from the Shuttle Radar Topography Mission (SRTM) data, and previously published geological map (1:500,000), Field and laboratory investigations, and other relevant published information were studied. Some software's were principally used, including ERDAS Imagine 8.7 and ENVI 4.3 digital image processing software and Arc GIS 9.1.

Image Preprocessing: The images that were used in the study area were already geometrically rectified. Band subset, layer stacking, and image fusion methods were used; the final resolution used in this study is 30 m. However, 15 m resolution of ETM+ 2005 image was used to establish on screen digitizing and plotting of the other recent activities and future planned projects. Image processing has been done to improve the image false color composites (FCC) bands 7, 4, and 2 in RGB respectively.

The data extracted from satellite images and digital elevation model established a good basic data to produce a physiographic map. The map includes six main units (Fig.2);

-Dissected desert uplands and wadis.
-Desert plain.
-Sand sheets.
-Pediment.
-Plateau.
-Rock outcrops.

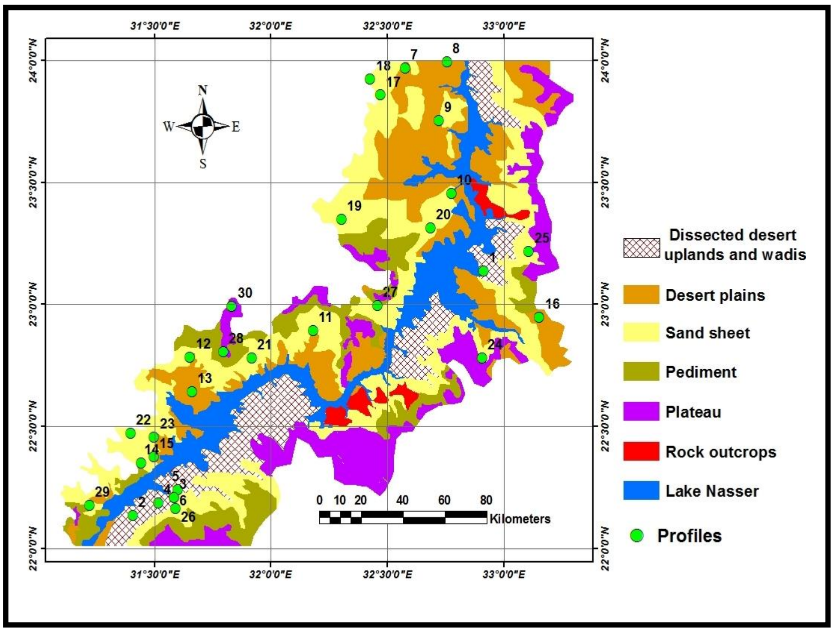

Fig. 2: Physiographic Map of the studied area.

Field Investigations.

Thirty soil profiles were selected according to differences in geomorphic units. The soil profiles were described in the field according to Soil Survey Staff (1993) and were classified according to soil taxonomy (Soil Survey Staff, 2006). The location of these profiles is demonstrated in Fig. 3 and Table 1.

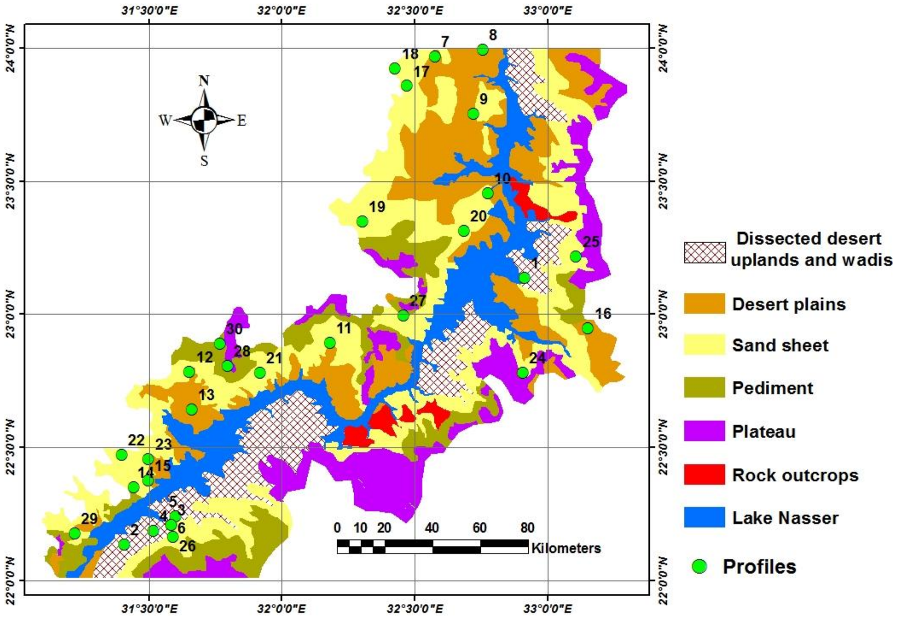

Fig. 3:Soil profile locations map.

Analyses of soil samples.

Samples were collected for the identified layers (88). Soil samples were air-dried and sieved through a 2 massive. Gravels contents were estimated by volume. Particle – size distribution analysis was carried out by sieving and sedimentation, using the pipette method (Day 1965). Prior to dispersion, samples were treated to remove carbonates (dissolution by 2N HCL), organic matter (oxidation by 30% H_2O_2) and soluble salts (by leaching). Sodium Hexametaphosphate was added to prevent re-flocculation of colloidal material. Soil reaction (pH value); measured in a 1:2.5 soil suspension. The salt content (electrical conductivity, EC) was measured in saturation extracts. Total carbonates were determined using the Collines Calcimeter method, (Salinity laboratory staff, 1954). Soluble caution and anions in the saturation extracts were determined according to the procedures described by Jackson (1975).

Physiographic Features

Geomorphology of Lake NasserRegion.

The High Dam Lake is bordered from the eastern and western sides by hilly desert. According to Butzer and Hansen (1968) the geomorphology features around the High Dam lake (lakeNasser) could be classified generally into the following groups from west to east:

1- Rocky hills with intermediate or steep slopes and relatively high relief.
2- Tablelands with rain-eroded crevices or Wadis.
3- Sandy plains studded with hills and rocky outcrops.

4- Lower plains with gentle slopes and varying depths of sandy top soils bordering the western side of the lake
5- Wadis draining the western desert.

At the eastern side of the lake, the region is dominated by uplands dissected with deep and locally wide drainage lines, rising to the east connecting to the Red Sea Ranges.

Geology of Lake Nasser Region.

The surface geology of the region is demonstrated in the geological map of Egypt published by Egypt Geological Survey (1981), surface exposed rocks include widely and extremely Cretaceous lithology composed mainly by the following formations (EL-Ramly 1973);

1. Lower Cretaceous Nubia Sandstone Formation (Aptian-Albian).
2. Upper Cretaceous Variegated Shells (Cenomanian-Santonian).
3. Upper Cretaceous phosphatic bed (Companion).
4. Upper Cretaceous Dakhia Shales (Maestrichtian-Danian).

RESULTS AND DISCUSSION

Soil landscape Map and Digital Elevation Model (DEM).

Digital Elevation Model (DEM) of the study area (Fig.4,) showed that the elevation ranges from about 45 m to 470 m above sea level. The highest elevation represents the hills located on the plateau and parts of the Red Sea ranges. Digital Elevation Model (DEM) and a 3D electronic model of the land's surface provide better functionalities than the topographic maps. A DEM can be employed to offer varieties of data that can assist in mapping of landforms and soil types. Information derived from a DEM, slope % and slope direction, could be used with the satellite images to increase their capabilities for soil mapping.

The landforms of the study area were delineated by using the digital elevation model, Landsat ETM+ and ground truth data. The produced map was imported into a Geo-database as a base map.

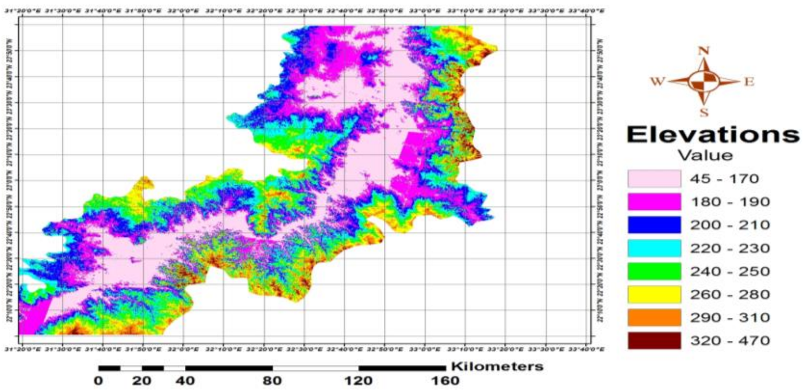

Fig. 4: Digital elevation model of the study area

Table 1: Location of different soil profiles representing different physiographic units around High Dam Lake.

Profile No.	Location	Km^2	represents	Fedan	units	DMS.ss	
						Latitude	Longitude
1	Wadi El-Allaqi	2497.54	12.82	594652.38	Desert uplands	23 04 41	32 57 35
2	Quastal & Adendan					22 14 30	31 36 02
3						22 12 32	31 35 08
4						22 11 10	31 31 02
5						22 14 30	31 36 02
6						22 12 32	31 35 08
7	Wadi Kurkur	4324.45	22.20	1029631.0	Desert plain	23 58 02	32 34 37
8	Wadi Kurkur					23 59 29	32 45 18
9	Kalabsha					23 45 05	32 43 18
10	Garf Hussein					23 27 18	32 46 33
11	Tomas & Afia					22 53 37	32 11 02
12	Tushka					22 50 03	31 36 10
13	Abu Simbel					22 22 39	31 35 07
14	Abu Simbel					22 21 00	31 26 43
15	Abu Simbel					22 22 35	31 29 56
16	Wadi El-Allaqi					22 56 50	33 09 08
17	Wadi Kurkur	6590.24	33.83	1569104.8	Sand sheet	23 51 23	32 28 13
18	Wadi Kurkur					23 55 16	32 25 36
19	Kalabsha					23 20 55	32 18 14
20	Garf Hussein					23 18 42	32 41 05
21	Tomas & Afia					22 46 50	31 55 05
22	Abu Simbel					22 28 17	31 24 00
23	Abu Simbel					22 27 26	31 30 00
24	Wadi El-Allaqi					22 46 51	32 54 25
25	Wadi El-Allaqi					23 10 34	33 04 00
26	Quastal & Adendan					22 09 55	31 35 30
27	Tomas & Afia	2679.42	13.75	637957.14	Pediment	22 57 30	32 23 49
28	Tushka					23 11 05	31 41 00
29	Abu Simbel					22 09 00	31 17 44
30	Tushka	2989.58	15.35	711804.76	Plateau	23 00 30	31 50 00

Soil mapping units.

The data extracted from satellite images and digital elevation model indicated that the area under investigation includes six main physiographic units (Table.1 and Fig.2). Field work verified the presence of these units and enabled the description of these units. Location of soil profiles were preliminary determined to characterize the soils occupying the surfaces of these units. However the field conditions decided their locations (Fig.3). Six major soil mapping units were delineated. These are;

Soils of the Dissected Desert Uplands and Wadis:-

This unit is located at the eastern side of the lake, exhibiting an area of 2497.54 Km^2. These lands are characterized by landforms dominated by sandstone ranges and sand plains. Wadis are almost steep gullies trending east west direction and draining into the lake. These wadis are usually dry, except during rainy season (winter), they flow occasionally. Some geologists believe that features like Wadis were formed during periods when past climates on earth were markedly different, and that these valleys were probably carved by streams and rivers which later dried up.

The bottom of a Wadi is often covered by sand and coarse rock; fragments and the sides may be steep and made of sandstone rocks. Depending on where a Wadi is located, it may be vegetated by scrubby brushes and small trees. Occasionally, the soil in a wadi is very massive, resulting in severe torrential floods. This landfrom extended in Ambikol, Allaqi and Hamid districts at eastern side of the lake.

Soil properties of Desert uplands represented by profiles 1, 2,3,4,5 and 6 are shown in Tables (2, 3). The analytical results (Tables. 2, 3) show that the soils are of mineral origin, sand to sandy loam, occasionally sandy clay loam. $CaCO_3$ content is very low to moderate ranging between 0.7 to 9.74%. Soil reaction is mild in general. pH values are around 7.55 – 8.6 except in profile 1 at Allaqi it is alkaline (pH values around 9.0 – 9.5). Total salinity show that the soil are almost free of salts as indicted by E.C. values rang my between 0.3 to 9.5 ds/m. The cationic composition could be arranged in the descending order; (Na^+, Ca^{++} > Mg^{++} > K^+) while the general anionic composition follows the descending order; $SO^=_4$ > Cl^- > HCO_3^-.
The soils in this unit are classified as; (Table. 4)

Entisols	Psamment	Quartizipsamment Lithic and Typic	(1,3,4)
		Torripsamment Lithic and Typic	(5,6)
	Orthents	Torriorthents Typic	(2)

Soils of the Desert plains: -

Desert plains unit exhibit an area of 4324.45 km^2 as shown in Table 1 . Desert plains are location west of the lake. These are vast plains drained by numerous shallow wadis trending in general west-east ward. Several hills are scattered through these plains, formed by wind and water erosion. They are therefore remnants of old surfaces. Course fragments of fine and course pebbles and gravels are blanketing some localities forming what is called desert pavement. The desert pavement is more prominent in the eastern side. These coarse fragments are frequently present in the subsurface soils. Deflation by wind and erosion by water resulted in making a continuous cover of grovel and pebbles. The surfaces of these coarse fragmented are reflecting diagnosis and oxidation of their mineral composition

Soils of Desert plains are represented and described by profiles 7, 8, 9,10,11,12,13,14,15 and 16. The description of these representative profiles together with their relevant physical and chemical characteristics are given in Tables (2, 3). The analytical results show that these soils are mineral soils, the texture vary from sand to sandy clay loam. $CaCO_3$ content is low to moderate ranging from 0.6 to 6.2% except for two samples of profile (9) where 8.1 and 8.7% values are noticed. Salinity level general is slightly saline to moderately saline ranging between 0.3 and 7.3 ds/m. Soil reactions are mildly alkaline in general, as depicted from pH values (Table 2) which range between 7.4 and 8.55. Chemical composition of the soil saturation extract reveals that the cationic composition has the following trend (Na^+, Ca^{++} > Mg^{++} > K^+). The anionic composition is dominated by Cl^- followed by $SO^=_4$ other anions constitute less pronounced magnitude.

Based on the morphology and properties of these soils, they could be classified (Table 4) as;

Entisols	Psamment	Torripsamments	
		Haploduric Torripsamments	(11)
		Typic Torripsamments	(14)
	Orthents	Typic Torriorthents	(9,10,12,13,15)
	Fluvents	Typic Torrifluvents	(16)
Aridisols	Salids	Gypsic Haplosalids Salids	(7)
	Gypsids	Typic Hoplogypsic	(8)

Soils in the Sand sheet unit:-

Sand sheets exhibit an area of about 6590.24 km^2 shows in Table 1. Sand sheets are local aeolian deposits that extend for some square kilometers in and around dune fields, where they are exposed on inter dune floors and form the aprons or trailing margins of dune fields. Sand sheets are built from successive drift deposits of sand leaving behind small sand ripples, along with fine sediments (dust) deposited from suspension, and gravel or granules moved by creep. With time, and under certain conditions of topography (nearby barriers) and supply of materials, the wind can shift the lag particles within an area and pile them up to form other landforms on top of the sand sheet, such as granule or pebble ripples. In many areas, the sand sheet surface is a series of ripples. Fields of these giant ripples can cover many hundreds of square kilometers of sand plain, but they are not obstacles to cross-country movement.

Where a sand sheet is devoid of a pavement of coarse gravel, it is less than about 2 m thick, and is transparent to L-band (23 cm wavelength) imaging radar. Radar imagery of such areas shows the consolidated material under the sand sheet, such as caliches (in alluvial valley fills) or bedrock. Areas of thicker but similar sand sheet deposits show as dark patches or areas of no radar return. These patterns can be useful for planning travel routes. To an observer on the ground or in an airplane, and on aerial photographs, the surface of the sand plain looks much the same regardless of the nature or depth of underlying materials. Vegetation is almost scanty, and limited to mounds of shrubs that are severely subjected to severe wind erosion. Sand sheet in some localities may cover shallow deposits. Alluvial deposits of such covered wadis may appear at different depths depending on the thickness of sand sheet.

Ten soil profiles were described, representing in general deferent localities east and west of the lake. In some areas near wadi channels and tributaries, the sand is covering alluvial deposits. The descriptions of these representative profiles are considered. Physical and chemical characteristics are shown in Tables 3 and 4.

The analytical results show that these soils are mineral soils, with textures ranging between sandy to sandy loam in general occasionally gravelly sand except in Kurkure area (Kalabsha) it is sandy loam to clay.

$CaCO_3$ content is very low to moderate, being in the range of 0.5 to 8.7% except in profile No. (17) at Kurkur area (Kalabsha plain) it range from moderate to high 7.4 to 14.7%. Soil reaction is mildly alkaline in general; pH values are around 7.3 to 8.8% except in Allaqi plain area of profile No. (25), it is alkaline (9.0 to 9.5). Total salinity indicates that some soils are free of salts while other is saline as externally E.C. values are ranging from 1.1 to 30 ds/m in soil paste. The soils are classified as follows; (Table4).

Entisols	Psamment	Typic Quartizipsamment	(26)
		Lithic Quartizipsamment	(25)
	Orthents	Typic Torriorthents	(17,19,22,23)
	Fluvents	Typic Torrifluvents	(24)
Aridisols	Salids	Typic Hoplosalids	(20,21)
		Typic Gypsic Hoplosalids	(18)

4. Soils of the Pediment

Pediment unit exhibit an area of about 2695.42 km^2 (Table (1). This is a low land formed by erosional processes that cause a constant retreat of the slope of a plateau or a mountain. The upper part of the plain at the foot of the scarp is generally undulating, partly roughly denuded. Going further down with more depositional processes, a pediplain (bajada) is formed. Features like Riqa Hills, Tomas upland, Abu simbel plateau Tushka plain are all at western side of the lake. Three soil profiles were described are considered.

Soil properties of profiles 27, 28 and 29, concerning analytical results of physical and chemical characteristics were outlined Table (2, 3). The analytical results reveal that soil texture ranges between sandy, loamy sand and sandy loam, $CaCO_3$ content is very low to moderate between 0.8 to 7.1% while soil reaction is mildly alkaline. pH values are around 7.1 – 8.2. Total salinity show that the soils have low to moderate values as indicated by EC, which ranges between 0.3 to 10.0 dSm^{-1}.

Soil profile No. 28 seems to be affected by lacustrine conditions where iron oxides spots and gypsum segregations are present in the subsurface horzion. Accordingly, the soils are classified as;

Entisols	Orthents	Typic Torriorthents	(27,29)
Aridisols	Salids	Typic Gypsic Hoplosalids	(28)

Soils of the Plateau:

Plateau unit attains an area of 2989.58 $km^{2.}$ The unit representing the plateau is only occupying a small part of the vast plateau west and east of the lake. Hence it is only represented by one profile (No 30). Generally, the soils are shallow. It should be mentioned that this plateau is generally of sandstone (Nubian sandstone).

Morphological properties of Plateau land represented by profile No. 30 are considered. The analytical results of physical and chemical characteristics are outlined in Tables (3, 4).

The soil texture is sand to loamy sand. $CaCO_3$ content is very low to moderate between 1.1 to 2.8%. Soil reaction is mildly alkaline, pH values are around 7.1 – 8.0 while total salinity is low to moderate.

Morphological and analytical properties of such soils suggest their classification as;

Entisols Orthents Lithic Torriorthents

as demonstrated in Table 2.

Rock outcrops:-

Rock outcrops exhibit an area of about 400.08 km^2 (Table. 1). These landforms predominate in the area under study especially in Umm Naqa uplands and Korosko hills at eastern side of the lake.

Table 2: Classification Legend of physiographic – Soil map of the studied area.

<table>
<tr><th>Soil Mapping Units</th><th>order</th><th>suborder</th><th>great group</th></tr>
<tr><td rowspan="3">Dissected desert uplands and Wadis</td><td rowspan="3">Entisols</td><td rowspan="2">Psamment</td><td>Quartzipsamment</td></tr>
<tr><td>Lithic ,TypicTorripsamment</td></tr>
<tr><td>Orthents</td><td>Torriorthents</td></tr>
<tr><td rowspan="6">Desert plains</td><td rowspan="4">Entisols</td><td rowspan="2">Psamment</td><td>Haploduric Torripsamments</td></tr>
<tr><td>Typic Torripsamments</td></tr>
<tr><td>Orthents</td><td>Typic Torriorthents</td></tr>
<tr><td>Fluvents</td><td>Typic Torrifluvents</td></tr>
<tr><td rowspan="2">Aridisols</td><td>Salids</td><td>Gypsic Haplosalids Salids</td></tr>
<tr><td>Gypsids</td><td>Typic Hoplogypsic</td></tr>
<tr><td rowspan="5">Sand sheet</td><td rowspan="3">Entisols</td><td>Psamment</td><td>Quartzipsamment</td></tr>
<tr><td>Orthents</td><td>Torriorthents</td></tr>
<tr><td>Fluvents</td><td>Torrifluvents</td></tr>
<tr><td rowspan="2">Aridisols</td><td rowspan="2">Salids</td><td>Typic Hoplosalids</td></tr>
<tr><td>Typic Gypsic Hoplosalids</td></tr>
<tr><td rowspan="2">Pediment</td><td>Entisols</td><td>Orthents</td><td>Typic Torriorthents</td></tr>
<tr><td>Aridisols</td><td>Salids</td><td>Typic Gypsic Hoplosalids</td></tr>
<tr><td>Plateau</td><td>Entisols</td><td>Orthents</td><td>Torriorthents</td></tr>
</table>

Table3: Physical analyses of the landforms soils around the High Dam Lake.

landforms	Profile No.	Depth Cm	Sp %	$CaCO_3$ %	Gravels %	Sand %	Silt %	Clay %%	Texture class
Dissected desert uplands and Wadis	1	0-50	20.0	0.70	13.4	94.30	3.20	2.00	S
		50-125	18.0	0.70	15.7	97.20	2.10	1.00	S
	2	0-15	31.0	0.25	12.6	95.90	0.30	3.80	S
		15-105	24.0	1.10	11.3	85.70	0.30	14.00	S.L
	3	0-10	23.0	7.64	16.2	95.80	2.10	2.10	S
		10-45	22.0	9.74	18.3	93.30	2.90	3.80	S
	4	0-10	20.0	6.77	23.4	97.70	1.20	1.20	S
		10-45	21.6	1.90	15.7	97.70	2.00	0.30	S
	5	0-10	17.0	2.55	18.3	98.10	1.40	0.50	S
		10-50	20.0	0.09	23.6	97.30	0.70	1.00	S
	6	0-10	32.0	5.44	18.4	98.20	1.00	0.80	S
		10-30	20.0	0.41	15.6	98.00	1.60	0.40	S
		30-130	18.5	2.23	18.3	96.70	2.70	0.60	S
Desert plain	7	0-20	25.0	4.50	8.3	73.20	15.20	11.60	S.L
		20-50	34.0	6.20	6.4	65.20	20.30	14.50	S.L
		50-150	38.0	5.10	12.3	59.10	19.30	21.60	S.C.L
	8	0-20	22.0	4.31	8.2	91.20	7.60	8.70	S
		20-50	33.0	4.31	10.6	77.80	10.10	12.10	S.L
		50-75	25.0	1.85	12.6	86.21	5.53	5.26	L.S
	9	0-30	27.0	5.60	12.3	84.00	4.50	11.50	L.S
		30-60	28.0	8.10	17.5	78.79	9.09	12.12	S.L
		60-90	28.0	8.70	12.3	81.51	11.98	6.51	L.S
	10	0-20	20.0	2.40	8.4	84.60	5.20	10.20	L.S
		20-75	19.0	1.20	8.6	84.30	6.20	9.50	L.S
		75-130	18.0	1.90	21.3	96.70	3.10	0.20	S
	11	0-20	22.0	5.70	5.8	87.50	8.70	5.80	L.S
		20-50	18.0	2.40	7.6	90.20	8.50	1.30	S
		50-90	17.0	2.00	13.4	89.00	9.80	1.20	S
	12	0-10	18.0	2.30	12.4	89.10	8.40	1.50	S
		10-120	25.0	1.60	8.7	73.40	15.00	11.60	S.L
	13	0-10	22.0	2.00	8.2	88.00	4.20	7.80	L.S
		10-45	27.0	3.60	18.0	81.40	9.10	9.50	L.S
		45-90	24.0	3.60	17.6	81.70	9.10	9.20	L.S
		90-130	23.0	1.60	12.7	83.10	7.80	9.10	L.S
	14	0-10	19.0	3.20	8.7	89.20	4.30	5.50	S
		10-40	19.0	3.60	10.0	89.10	3.80	7.10	S
		40-85	20.0	3.20	16.2	86.80	3.50	9.70	L.S
		85-125	18.0	2.80	18.6	90.40	5.10	4.50	S
	15	0-25	18.0	3.20	16.3	89.10	4.20	6.70	S
		25-80	19.0	1.80	15.6	89.20	3.70	7.10	S
		80-120	20.0	1.90	12.4	87.30	3.20	9.50	L.S
	16	0-40	18.0	0.60	7.6	97.20	1.40	1.80	S
		40-120	18.0	0.60	10.4	95.40	2.30	1.70	S

Cont.:table 3

	17	0-30	28.0	10.20	12.6	67.30	19.50	13.20	S.L
		30-50	28.0	8.20	10.6	67.50	19.70	12.80	S.L
		50-80	32.0	7.30	18.4	55.10	19.60	25.30	S.C.L
		80-125	35.0	11.80	11.2	60.80	24.60	14.60	S.L
		+ 125	25.0	14.70	10.2	60.40	25.30	14.30	S.L
	18	0-15	24.0	1.40	16.2	99.20	0.50	0.30	S
		15-35	33.0	1.10	12.4	54.30	24.20	21.50	S.C.L
		35-70	34.0	0.80	12.8	54.30	14.50	31.20	S.C.L
		70-110	34.0	3.10	15.2	56.50	12.20	31.30	S.C.L
	19	0-35	20.0	2.10	13.4	89.60	3.70	6.70	S
		35-45	21.0	1.40	14.2	86.54	2.27	10.77	L.S
		45-65	18.0	1.30	17.1	90.24	1.59	8.17	S
		65-100	19.0	0.90	12.4	92.73	1.59	5.68	S
	20	0-20	16.0	1.20	12.6	96.40	3.00	0.60	S
		20-50	16.0	1.00	18.6	93.20	6.40	0.40	S
		50-110	20.0	1.10	10.8	81.60	6.20	12.20	S.L
.	21	0-15	19.0	5.20	17.2	99.00	0.80	0.20	S
		15-75	19.0	0.70	19.7	98.40	0.50	1.10	S
		75-150	17.3	0.50	13.4	99.20	0.60	0.20	S
	22	0-10	22.4	1.40	10.8	95.90	1.60	3.50	S
		10-100	24.2	2.10	16.8	94.10	0.80	5.10	S
	23	0-20	18.0	1.50	17.6	93.20	2.50	4.30	S
		20-45	18.0	3.50	12.6	88.90	6.20	4.90	S
		45-85	21.0	4.60	8.7	87.20	5.20	7.60	L.S
		85-150	21.0	3.60	19.3	84.30	4.50	11.20	L.S
	24	0-40	18.0	5.10	18.5	95.80	3.20	1.00	S
		40-55	20.0	3.50	12.8	92.40	4.30	3.20	S
		55-100	26.0	0.70	14.7	70.30	19.30	10.20	S.L
	25	0-10	32.0	3.40	13.4	60.90	23.80	17.20	S.L
		10-45	21.0	2.00	11.6	87.30	8.90	4.40	L.S
	26	0-10	20.0	7.44	16.5	95.20	2.60	2.20	S
		10-130	18.0	0.93	12.3	97.70	1.30	1.00	S
Pediment	27	0-25	17.0	7.10	8.7	98.5	1.0	0.5	S
		25-60	23.0	0.80	4.6	86.9	8.9	4.2	L.S
		60-150	26.0	0.90	8.6	81.3	6.7	12.0	S.L
	28	0-10	19	3.68	17.6	91.2	1.6	7.2	S
		10-50	25.5	1.45	12.6	68.5	11.3	20.2	S.L
		50-150	23.5	0.70	10.2	75.1	8.2	16.7	S.L
	29	0-15	24	1.80	-	86.2	4.5	9.3	L.S
		15-45	24	2.40	14.0	85.2	5.3	9.5	L.S
		45-85	22	3.60	12.3	85.5	5.8	8.7	L.S
		85-145	23	4.20	16.4	84.2	4.6	11.2	L.S
Plateau	30	0-5	19.0	2.80	12.6	91.8	6.3	1.9	S
		5-50	19.0	1.70	17.6	89.8	2.2	8.0	S
		+50	20.0	1.10	8.4	82.1	7.2	10.7	L.S

Table 4: Chemical properties of soil samples from land forms around the High Dam Lake

Cont.: table 4

2- Soil capability

The capability of the investigated soils was evaluated using the physical, chemical and soil indices of ASLE capability model (Ismail, et al., 2001). The results are illustrated in Table 5. In general, the estimated soil capability indices refer to a low capability soils except for a small patch to the northwest of the area. The soil of the dissected desert uplands and wadis are in general poor to very poor. The main limiting soil factors include soil depth and soil texture, EC and CEC. The estimated soil indices in of Desert Plains (profiles from 7 to 16) differ from 24.26 to 52.89 indicating fair and poor capabilities (C3, C4). The soil capability of the soils in sand sheets varied widely from 10.11 to 66.51 including a good capability (C2) for profile 16 and very poor capability soils (C5) for the soils of profile 21.

Soil capability indices of the Pediment unit differ from 43.57 to 56.8 indicating a fair class (C3) for all profiles.

The main limiting factors of these soils are texture, EC and CEC. The soils of the plateau unit are poor, where the estimated index is 36.77. The limiting factors in the plateau landform are texture and CEC.

The maps of the soil capability classes (Fig 5) prevailing in the study area reveals that, the soils are fair to poor, where the main limiting factor is the texture. Slope aspect of these lands could be considered and must be included in the criteria used. One of the most serious contradictions is the un co formality of soil mapping units' boundaries and capability classes, as they

are fused in different capability units. Site descriptions are equally important as they include topography, sloping and stoniness.

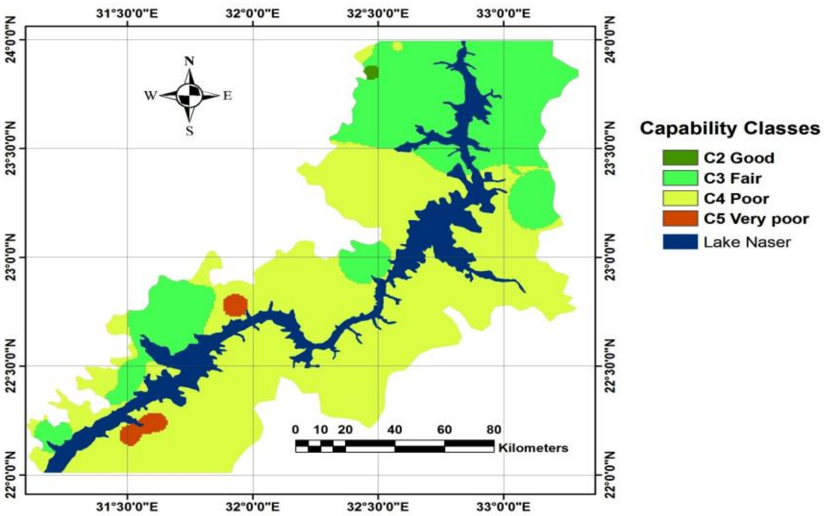

Fig. 5: Map showing the soil Capability Classes of the investigated soils of the High Dam Lake region.

Table 5: The soil quality index of the soil of the High Dam Lake.

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دراسات على أراضى بحيرة ناصر باستعمال إمكانيات الاستشعار من بعد ونظم المعلومات الجغرافية

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بحيرة السد العالي هي واحدة من أكبر البحيرات الصناعية فى العالم. تعتبر هذه المنطقةمن المناطق الجافه، بما في ذلك بحيرة ناصر، لم تتلق الأمطار باستثناء العواصف الرعدية في بعض الأحيان بشكل متقطع في المنطقة في فصل الشتاء. واستخدمت الصور و نظم المعلومات الجغرافية لأنتاج خرائط التربة. وأشارت البيانات المستخرجة من صور الأقمار الصناعية والنماذج الرقمية للارتفاعات أن المنطقة تشتمل على ست وحدات جغرافية رئيسية، Dissected desert uplands and Wadis, Desert plain, Sand sheet, Pediment, Plateau and Rock outcrops (الشكل 1). أظهرت الخريطة الفيزيوجرافية لمنطقة الدراسة على وجود عدد ستة وحدات أساسيه وهى :-

1)المناطق الصحراوية المرتفعة والأودية Dissected desert uplands and Wadis : وهى تتبع رتبة Entisols وتحت رتبة Psamment و Orthents والمجموعات الكبرى Torriorthents - Torripsamments – Quartzipsamment

2)السهول الصحراوية Desert plain: وهى تتبع رتبة Aridisols - Entisols وتحت رتبة Psamment و Gypsids - Salids - Fluvents - Orthents والمجموعات الكبرى Gypsic - Torrifluvents – Torripsamments – Haploduric Torripsamments Typic Hoplogypsic - Haplosalids Salids

3)الصفائح الرملية Sand sheet:. وهى تتبع رتبة Entisols و Aridisols وتحت رتبة Psamment و Orthents و Fluvents و Salids والمجموعات الكبرى - Typic Hoplosalids - Torrifluvents – Torriorthents – Quartzipsamment .Typic Gypsic Hoplosalids

4)السفوح Pediment: وهى تتبع رتبة Entisols و Aridisols وتحت رتبة Orthents و Salids والمجموعات الكبرى Torriorthents - Gypsic Hoplosalids

5)الهضبة Plateau: وهى تتبع رتبة Entisols وتحت رتبة Orthents والمجموعات الكبرى Torriorthents

6)الصخور المستبعدة Rock outcrops: واهمها صخور الحجر الرملى النوبى والجرانيت والرخام .

القدرة الإنتاجية للتربة :-

صنفت الأراضى بمنطقة الدراسة حسب قدرتها الإنتاجية باستخدام نتائج التحليلات الفيزيائية والكيميائية حيث أوضحت انها أراضى فقيرة فى معظمها باستثناء منطقة صغيرة فى الشمال الغربي من منطقة الدراسة وهى تسمى منطقة وادى كركر.

وطبقا لذلك فهناك عدد ٤ أنواع طبقا للقدرة الإنتاجية للاراضى متمثلة فى الاتى :-

1- اراضى جيدة :- هذه الأراضى تكون مناسبة للزراعة على مدى فترات طويلة من الوقت ولها بعض القيود التي تحد من استخدامها . فهي أراضى عميقة فى قطاع التربة ، والأرض مستوية الى شبه مستوية تقريبا .

2- اراضى معتدلة:- وهي مناسبة التربة فى الزراعة على مدى فترات طويلة من الوقت ، ولكن توجد بعض الصعوبات والقيود فى اختيار النباتات .

3- اراضى فقيرة :- وهى اراضى جيدة للمحاصيل التى يمكن زراعتها مع وجود بعض المعاملات عند اختيار النباتات وهناك حاجة إلى المصاطب وغيرها من التدابير للسيطرة على المياه .

4- اراضى فقيرة جدا :- يمكن زراعة محاصيل تتحمل الظروف الشديدة مع الحذر الجيد عند الزراعة .

Profile No.	Physical Index	Chemical Index	Soil Index	Type	Physiographic unit
1	32.58	85.04	27.71	C4	Dissected desert uplands and Wadis
2	29.05	95.72	27.8	C4	
3	20.49	76.52	15.68	C5	
4	15.49	82.71	12.81	C5	
5	14.35	95.44	13.69	C5	
6	20.24	86.27	17.46	C5	
7	36.11	45.88	39.51	C4	Desert plain
8	53.51	82.22	44	C3	
9	56.9	85.71	48.77	C3	
10	59.64	80.7	46.52	C3	
11	45.39	86.66	39.33	C4	
12	44.5	90.39	40.22	C3	
13	58.76	90.01	52.89	C3	
14	47.72	89.28	42.6	C3	
15	46.6	94.05	43.83	C3	
16	25.2	95.91	24.26	C4	
17	81.62	81.48	66.51	C2	Sand sheet
18	77.63	36.45	28.12	C4	
19	40.04	86.75	34.73	C4	
20	33.91	71.36	24.2	C4	
21	17.32	58.38	10.11	C5	
22	30.58	80.33	24.56	C4	
23	51.29	91.04	46.69	C3	
24	34.35	83.57	28.63	C4	
25	65	70.85	46.05	C3	
26	31.62	88.11	27.86	C4	
27	49.25	49.25	43.57	C3	Pediment
28	75.72	75.02	56.8	C3	
29	56.1	81.51	45.73	C3	
30	37.62	97.79	36.77	C4	Plateau

C1=Excellent (80-100) **C2=Good (60-80)** **C3=Fair (40-60)** **C4=Poor (20-40)**
C5= Very poor (10-20) **C6=Non-agriculture (0-10)**