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 ٤٩٦ km, of which ٢٩٢ km inside Egypt (Naser Lake), and ٢٠٤ km for Lake Nubia in Sudan. The area of the reservoir at ١٨٠ m level is about ٦٢٧٥ km² of which Lake Nasser occupies about ٥٢٤٨ km².The mean depth of Lake Nasser at ١٦٠ m level is ٢١,٥ m as compared with about ٢٥,٢ m at ١٨٠ m level. The mean width of the Lake at ١٦٠ m level is ٨,٩ km, and ١٨,٠ km when the water level reaches ١٨٠ m. Lake Nasser has many embayments locally called khors (Fig. ١). The total number of important khors is ٨٥ (٤٨ on the eastern side and ٣٧ 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 ٤٩٠٠ km٢ = ٧٩ % of the total surface area, but in volume they contain only ٨٦٫٤ km٣ water (= ٥٥٪ of the total Lake volume).   Geological and stratigraphical studies dealing with the area surrounding the Lake were carried out by different authors (Ball ١٩٠٢, El-Shazly ١٩٥٤, Attia ١٩٥٥, El-Ramly and Akkad I٩٦٠, Shata ١٩٦٢, Said and Issawy ١٩٦٤, El- Ramly ١٩٧٣, Klitzch and Lejal-Nicol ١٩٨٤, Latif ١٩٨٤, Hendriks *et al.* ١٩٨٧… 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, ١٩٩٩; ٢٠٠٦). There have been many attempts to correlate soil properties with various factors, such as parent material and topography (Mahmoodi et al., ٢٠٠٧). 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, ٢٠٠١).

Hammad *et al.* (١٩٧٧) 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 (٢٠٠١) 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.* (٢٠٠٨) 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 (١٩٦٨)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;

١-Studying the morphology, and classification of soils around Lake Nasser according to the Soil Taxonomy (Soil Survey Staff, ٢٠٠٦).

٢-Presenting a Soil Landscape Map of the area around the lake.
٣- 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 ٢٢° and ٢٤°N and longitudes ٣١° and ٣٣,٥°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),
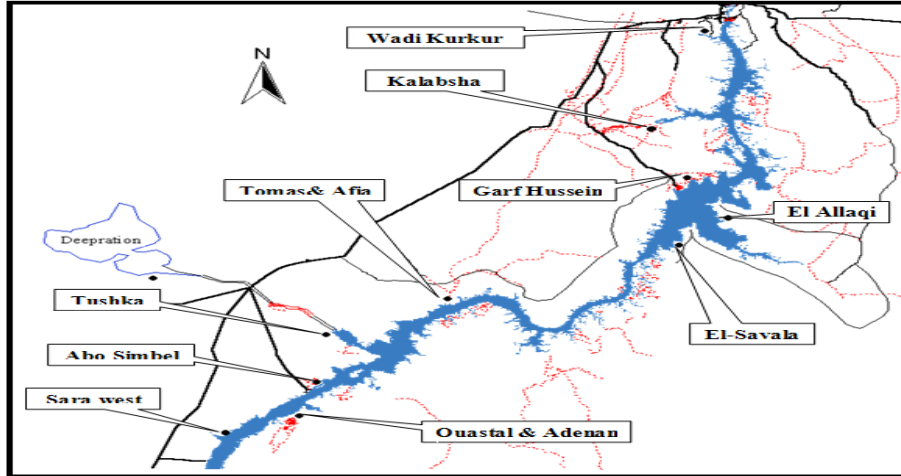
- Areas on the eastern side of the lake, as Wadi el Allaqui (county Abusco), El-Siala and Quastal and Adendan,

**Fig. ١: 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 ١٩٧٢), (TM ١٩٨٤), and (ETM+ ٢٠٠١and ٢٠٠٥), Digital Elevation Models (DEMs ٩٠ m) extracted from the Shuttle Radar Topography Mission (SRTM) data, and previously published geological map (١:٥٠٠,٠٠٠), Field and laboratory investigations, and other relevant published information were studied. Some software's were principally used, including ERDAS Imagine ٨,٧ and ENVI ٤,٣ digital image processing software and Arc GIS ٩,١.

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 ٣٠ m. However, ١٥ m resolution of ETM+ ٢٠٠٥ 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 ٧, ٤, and ٢ 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.٢);
- Dissected desert uplands and wadis.
- Desert plain.
- Sand sheets.
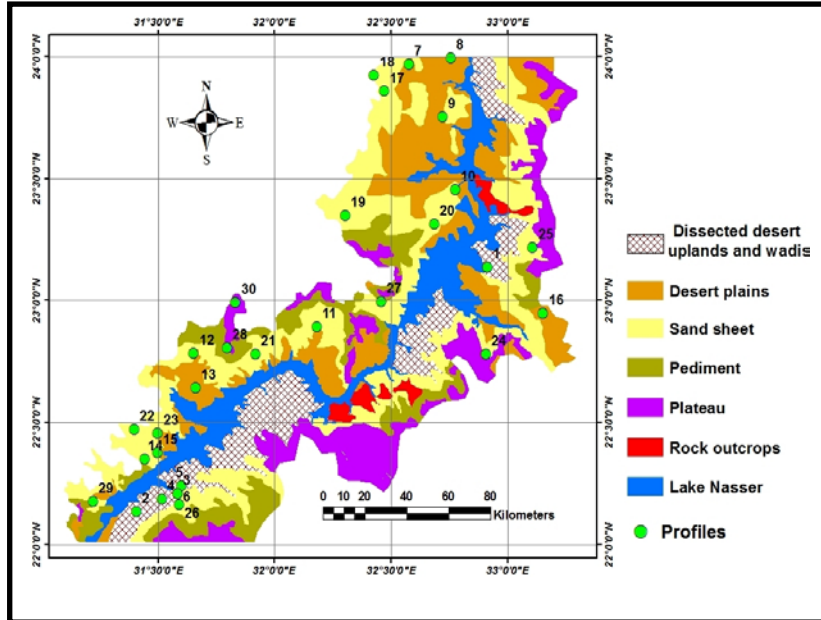
- Pediment.
- Plateau.
- Rock outcrops.

Fig. ٢: 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 (١٩٩٣) and were classified according to soil taxonomy (Soil Survey Staff, ٢٠٠٦). The location of these profiles is demonstrated in Fig. ٣ and Table ١.
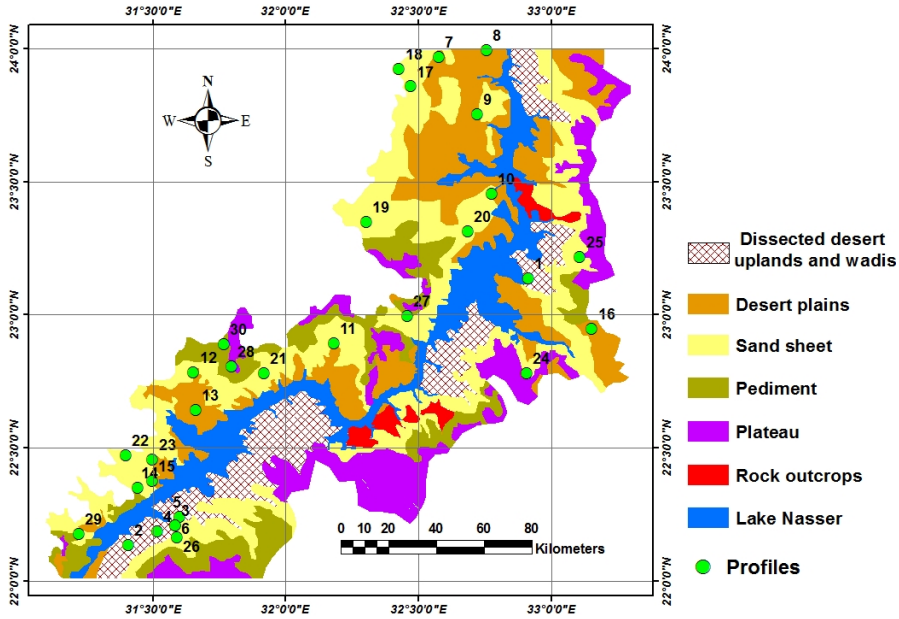
Fig. ٣:Soil profile locations map.

Analyses of soil samples.

Samples were collected for the identified layers (٨٨). Soil samples were air-dried and sieved through a ٢ massive. Gravels contents were estimated by volume. Particle – size distribution analysis was carried out by sieving and sedimentation, using the pipette method (Day ١٩٦٥). Prior to dispersion, samples were treated to remove carbonates (dissolution by ٢N HCL), organic matter (oxidation by ٣٠٪ 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 ١:٢٬٥ 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, ١٩٥٤). Soluble caution and anions in the saturation extracts were determined according to the procedures described by Jackson (١٩٧٥).

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 (١٩٦٨) the geomorphology features around the High Dam lake (lakeNasser) could be classified generally into the following groups from west to east:

١- Rocky hills with intermediate or steep slopes and relatively high relief.
٢- Tablelands with rain-eroded crevices or Wadis.
٣- Sandy plains studded with hills and rocky outcrops.

٤- Lower plains with gentle slopes and varying depths of sandy top soils bordering the western side of the lake
٥- 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 (١٩٨١), surface exposed rocks include widely and extremely Cretaceous lithology composed mainly by the following formations (EL-Ramly ١٩٧٣);

١. Lower Cretaceous Nubia Sandstone Formation (Aptian-Albian).
٢. Upper Cretaceous Variegated Shells (Cenomanian-Santonian).
٣. Upper Cretaceous phosphatic bed (Companion).
٤. 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.٤,) showed that the elevation ranges from about ٤٥ m to ٤٧٠ 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 ٣D 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.
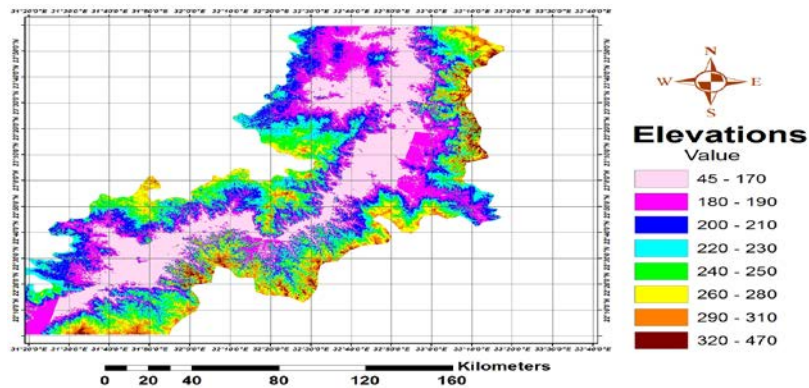

Fig. ٤: Digital elevation model of the study area

Table ١: Location of different soil profiles representing different physiographic units around High Dam Lake.

Profile No.	Location	Km²	represents	Fedan	units	DMS.ss Latitude	Longitude
١	Wadi El-Allaqi					٢٣ ٠٤ ٤١	٣٢ ٥٧ ٣٥
٢	Quastal & Adendan	٢٤٩٧,٥٤	١٢,٨٢	٥٩٤٦٥٢,٣٨	Desert uplands	٢٢ ١٤ ٣٠	٣١ ٣٦ ٠٢
٣						٢٢ ١٢ ٣٢	٣١ ٣٥ ٠٨
٤						٢٢ ١١ ١٠	٣١ ٣١ ٠٢
٥						٢٢ ١٤ ٣٠	٣١ ٣٦ ٠٢
٦						٢٢ ١٢ ٣٢	٣١ ٣٥ ٠٨
٧	Wadi Kurkur					٢٣ ٥٨ ٠٢	٣٢ ٣٤ ٣٧
٨	Wadi Kurkur					٢٣ ٥٩ ٢٩	٣٢ ٤٥ ١٨
٩	Kalabsha					٢٣ ٤٥ ٠٥	٣٢ ٤٣ ١٨
١٠	Garf Hussein					٢٣ ٢٧ ١٨	٣٢ ٤٦ ٣٣
١١	Tomas & Afia	٤٣٢٤,٤٥	٢٢,٢٠	١٠٢٩٦٣١,٠	Desert plain	٢٢ ٥٣ ٣٧	٣٢ ١١ ٠٢
١٢	Tushka					٢٢ ٥٠ ٠٣	٣١ ٣٦ ١٠
١٣	Abu Simbel					٢٢ ٢٢ ٣٩	٣١ ٣٥ ٠٧
١٤	Abu Simbel					٢٢ ٢١ ٠٠	٣١ ٢٦ ٤٣
١٥	Abu Simbel					٢٢ ٢٢ ٣٥	٣١ ٢٩ ٥٦
١٦	Wadi El-Allaqi					٢٢ ٥٦ ٥٠	٣٣ ٠٩ ٠٨
١٧	Wadi Kurkur					٢٣ ٥١ ٢٣	٣٢ ٢٨ ١٣
١٨	Wadi Kurkur					٢٣ ٥٥ ١٦	٣٢ ٢٥ ٣٦
١٩	Kalabsha					٢٣ ٢٠ ٥٥	٣٢ ١٨ ١٤
٢٠	Garf Hussein					٢٣ ١٨ ٤٢	٣٢ ٤١ ٠٥
٢١	Tomas & Afia	٥٦٩٠,٢٤	٣٣,٨٣	١٥٦٩١٠٤,٨	Sand sheet	٢٢ ٤٦ ٥٠	٣١ ٥٥ ٠٥
٢٢	Abu Simbel					٢٢ ٢٨ ١٧	٣١ ٢٤ ٠٠
٢٣	Abu Simbel					٢٢ ٢٧ ٢٦	٣١ ٣٠ ٠٠
٢٤	Wadi El-Allaqi					٢٢ ٤٦ ٥١	٣٢ ٠٤ ٢٥
٢٥	Wadi El-Allaqi					٢٣ ١٠ ٣٤	٣٣ ٠٤ ٠٠
٢٦	Quastal & Adendan					٢٢ ٠٩ ٥٥	٣١ ٣٥ ٣٠
٢٧	Tomas & Afia					٢٢ ٥٧ ٣٠	٣٢ ٢٣ ٤٩
٢٨	Tushka	٢٦٧٩,٤٢	١٣,٧٥	٦٣٧٩٥٧,١٤	Pediment	٢٣ ١١ ٠٥	٣١ ٤١ ٠٠
٢٩	Abu Simbel					٢٢ ٠٩ ٠٠	٣١ ١٧ ٤٤
٣٠	Tushka	٢٩٨٩,٥٨	١٥,٣٥	٧١١٨٠٤,٧٦	Plateau	٢٣ ٠٠ ٣٠	٣١ ٠٥ ٠٠

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.١ and Fig.٢). 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.٣). 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 ٢٤٩٧,٥٤ Km². 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 ١, ٢،٣،٤،٥ and ٦ are shown in Tables (٢, ٣). The analytical results (Tables. ٢, ٣) show that the soils are of mineral origin, sand to sandy loam, occasionally sandy clay loam. CaCO₃ content is very low to moderate ranging between ٠،٧ to ٩،٧٤٪. Soil reaction is mild in general. pH values are around ٧،٥٥ – ٨،٦ except in profile ١ at Allaqi it is alkaline (pH values around ٩،٠ – ٩،٥). Total salinity show that the soil are almost free of salts as indicted by E.C. values rang my between ٠،٣ to ٩،٥ 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. ٤)

Entisols	Psamment	Quartizipsamment Lithic and Typic	(١،٣،٤)
		Torripsamment Lithic and Typic	(٥،٦)
	Orthents	Torriorthents Typic	(٢)

Soils of the Desert plains: -

Desert plains unit exhibit an area of ٤٣٢٤،٤٥ km² as shown in Table ١ . 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 ٧, ٨, ٩،١٠،١١،١٢،١٣،١٤،١٥ and ١٦. The description of these representative profiles together with their relevant physical and chemical characteristics are given in Tables (٢, ٣). The analytical results show that these soils are mineral soils, the texture vary from sand to sandy clay loam. CaCO₃ content is low to moderate ranging from ٠،٦ to ٦،٢٪ except for two samples of profile (٩) where ٨،١ and ٨،٧٪ values are noticed. Salinity level general is slightly saline to moderately saline ranging between ٠،٣ and ٧،٣ ds/m. Soil reactions are mildly alkaline in general, as depicted from pH values (Table ٢) which range between ٧،٤ and ٨،٥٥. 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 ٤) as;

Entisols	Psamment	Torripsamments	
		Haploduric Torripsamments	(١١)
		Typic Torripsamments	(١٤)
	Orthents	Typic Torriorthents	(٩،١٠،١٢،١٣،١٥)
	Fluvents	Typic Torrifluvents	(١٦)
Aridisols	Salids	Gypsic Haplosalids Salids	(٧)
	Gypsids	Typic Hoplogypsic	(٨)

Soils in the Sand sheet unit:-

Sand sheets exhibit an area of about ٦٥٩٠،٢٤ km² shows in Table ١. 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 ٢ m thick, and is transparent to L-band (٢٣ 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 ٣ and ٤.

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.

CaCO₃ content is very low to moderate, being in the range of ٠,٥ to ٨,٧٪ except in profile No. (١٧) at Kurkur area (Kalabsha plain) it range from moderate to high ٧,٤ to ١٤,٧٪. Soil reaction is mildly alkaline in general; pH values are around ٧,٣ to ٨,٨٪ except in Allaqi plain area of profile No. (٢٥), it is alkaline (٩,٠ to ٩,٥). Total salinity indicates that some soils are free of salts while other is saline as externally E.C. values are ranging from ١,١ to ٣٠ ds/m in soil paste. The soils are classified as follows; (Table٤).

Entisols	Psamment	Typic Quartizipsamment	(٢٦)
		Lithic Quartizipsamment	(٢٥)
	Orthents	Typic Torriorthents	(١٧،١٩،٢٢،٢٣)
	Fluvents	Typic Torrifluvents	(٢٤)
Aridisols	Salids	Typic Hoplosalids	(٢٠،٢١)
		Typic Gypsic Hoplosalids	(١٨)

٤. Soils of the Pediment

Pediment unit exhibit an area of about ٢٦٩٥,٤٢ km² (Table (١). 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 ٢٧, ٢٨ and ٢٩, concerning analytical results of physical and chemical characteristics were outlined Table (٢, ٣). The analytical results reveal that soil texture ranges between sandy, loamy sand and sandy loam, CaCO₃ content is very low to moderate between ٠,٨ to ٧,١٪ while soil reaction is mildly alkaline. pH values are around ٧,١ – ٨,٢. Total salinity show that the soils have low to moderate values as indicated by EC, which ranges between ٠,٣ to ١٠,٠ dSm⁻¹.

Soil profile No. ٢٨ 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	(٢٧،٢٩)
Aridisols	Salids	Typic Gypsic Hoplosalids	(٢٨)

Soils of the Plateau:

Plateau unit attains an area of ٢٩٨٩,٥٨ km². 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 ٣٠). 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. ٣٠ are considered. The analytical results of physical and chemical characteristics are outlined in Tables (٣, ٤).

The soil texture is sand to loamy sand. CaCO٣ content is very low to moderate between ١,١ to ٢,٨٪. Soil reaction is mildly alkaline, pH values are around ٧,١ – ٨,٠ 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 ٢.

Rock outcrops:-

Rock outcrops exhibit an area of about ٤٠٠,٠٨ km٢ (Table. ١). These landforms predominate in the area under study especially in Umm Naqa uplands and Korosko hills at eastern side of the lake.

Table ٢: Classification Legend of physiographic – Soil map of the studied area.

Soil Mapping Units	order	suborder	great group
Dissected desert uplands and Wadis	Entisols	Psamment	Quartzipsamment
			Lithic ,TypicTorripsamment
		Orthents	Torriorthents
Desert plains	Entisols	Psamment	Haploduric Torripsamments
			Typic Torripsamments
		Orthents	Typic Torriorthents
		Fluvents	Typic Torrifluvents
	Aridisols	Salids	Gypsic Haplosalids Salids
		Gypsids	Typic Hoplogypsic
Sand sheet	Entisols	Psamment	Quartzipsamment
		Orthents	Torriorthents
		Fluvents	Torrifluvents
	Aridisols	Salids	Typic Hoplosalids
			Typic Gypsic Hoplosalids
Pediment	Entisols	Orthents	Typic Torriorthents
	Aridisols	Salids	Typic Gypsic Hoplosalids
Plateau	Entisols	Orthents	Torriorthents

Table٣: Physical analyses of the landforms soils around the High Dam Lake.

landforms	Profile No.	Depth Cm	Sp %	CaCO٣ %	Gravels %	Sand %	Silt %	Clay %%	Texture class
Dissected desert uplands and Wadis	١	٠-٥٠	٢٠,٠	٠,٧٠	١٣,٤	٩٤,٣٠	٣,٢٠	٢,٠٠	S
		٥٠-١٢٥	١٨,٠	٠,٧٠	١٥,٧	٩٧,٢٠	٢,١٠	١,٠٠	S
	٢	٠-١٥	٣١,٠	٠,٢٥	١٢,٦	٩٥,٩٠	٠,٣٠	٣,٨٠	S
		١٥-١٠٥	٢٤,٠	١,١٠	١١,٣	٨٥,٧٠	٠,٣٠	١٤,٠٠	S.L
	٣	٠-١٠	٢٣,٠	٧,٦٤	١٦,٢	٩٥,٨٠	٢,١٠	٢,١٠	S
		١٠-٤٥	٢٢,٠	٩,٧٤	١٨,٣	٩٣,٣٠	٢,٩٠	٣,٨٠	S
	٤	٠-١٠	٢٠,٠	٦,٧٧	٢٣,٤	٩٧,٧٠	١,٢٠	١,٢٠	S
		١٠-٤٥	٢١,٦	١,٩٠	١٥,٧	٩٧,٧٠	٢,٠٠	٠,٣٠	S
	٥	٠-١٠	١٧,٠	٢,٥٥	١٨,٣	٩٨,١٠	١,٤٠	٠,٥٠	S
		١٠-٥٠	٢٠,٠	٠,٠٩	٢٣,٦	٩٧,٣٠	٠,٧٠	١,٠٠	S
	٦	٠-١٠	٣٢,٠	٥,٤٤	١٨,٤	٩٨,٢٠	١,٠٠	٠,٨٠	S
		١٠-٣٠	٢٠,٠	٠,٤١	١٥,٦	٩٨,٠٠	١,٦٠	٠,٤٠	S
		٣٠-١٣٠	١٨,٥	٢,٢٣	١٨,٣	٩٦,٧٠	٢,٧٠	٠,٦٠	S
Desert plain	٧	٠-٢٠	٢٥,٠	٤,٥٠	٨,٣	٧٣,٢٠	١٥,٢٠	١١,٦٠	S.L
		٢٠-٥٠	٣٤,٠	٦,٢٠	٦,٤	٦٥,٢٠	٢٠,٣٠	١٤,٥٠	S.L
		٥٠-١٥٠	٣٨,٠	٥,١٠	١٢,٣	٥٩,١٠	١٩,٣٠	٢١,٦٠	S.C.L
	٨	٠-٢٠	٢٢,٠	٤,٣١	٨,٢	٩١,٢٠	٧,٦٠	٨,٧٠	S
		٢٠-٥٠	٣٣,٠	٤,٣١	١٠,٦	٧٧,٨٠	١٠,١٠	١٢,١٠	S.L
		٥٠-٧٥	٢٥,٠	١,٨٥	١٢,٦	٨٦,٢١	٥,٥٣	٥,٢٦	L.S
	٩	٠-٣٠	٢٧,٠	٥,٦٠	١٢,٣	٨٤,٠٠	٤,٥٠	١١,٥٠	L.S
		٣٠-٦٠	٢٨,٠	٨,١٠	١٧,٥	٧٨,٧٩	٩,٠٩	١٢,١٢	S.L
		٦٠-٩٠	٢٨,٠	٨,٧٠	١٢,٣	٨١,٥١	١١,٩٨	٦,٥١	L.S
	١٠	٠-٢٠	٢٠,٠	٢,٤٠	٨,٤	٨٤,٦٠	٥,٢٠	١٠,٢٠	L.S
		٢٠-٧٥	١٩,٠	١,٢٠	٨,٦	٨٤,٣٠	٦,٢٠	٩,٥٠	L.S
		٧٥-١٣٠	١٨,٠	١,٩٠	٢١,٣	٩٦,٧٠	٣,١٠	٠,٢٠	S
	١١	٠-٢٠	٢٢,٠	٥,٧٠	٥,٨	٨٧,٥٠	٨,٧٠	٥,٨٠	L.S
		٢٠-٥٠	١٨,٠	٢,٤٠	٧,٦	٩٠,٢٠	٨,٥٠	١,٣٠	S
		٥٠-٩٠	١٧,٠	٢,٠٠	١٣,٤	٨٩,٠٠	٩,٨٠	١,٢٠	S
	١٢	٠-١٠	١٨,٠	٢,٣٠	١٢,٤	٨٩,١٠	٨,٤٠	١,٥٠	S
		١٠-١٢٠	٢٥,٠	١,٦٠	٨,٧	٧٣,٤٠	١٥,٠٠	١١,٦٠	S.L
	١٣	٠-١٠	٢٢,٠	٢,٠٠	٨,٢	٨٨,٠٠	٤,٢٠	٧,٨٠	L.S
		١٠-٤٥	٢٧,٠	٣,٦٠	١٨,٠	٨١,٤٠	٩,١٠	٩,٥٠	L.S
		٤٥-٩٠	٢٤,٠	٣,٦٠	١٧,٦	٨١,٧٠	٩,١٠	٩,٢٠	L.S
		٩٠-١٣٠	٢٣,٠	١,٦٠	١٢,٧	٨٣,١٠	٧,٨٠	٩,١٠	L.S
	١٤	٠-١٠	١٩,٠	٣,٢٠	٨,٧	٨٩,٢٠	٤,٣٠	٥,٥٠	S
		١٠-٤٠	١٩,٠	٣,٦٠	١٠,٠	٨٩,١٠	٣,٨٠	٧,١٠	S
		٤٠-٨٥	٢٠,٠	٣,٢٠	١٦,٢	٨٦,٨٠	٣,٥٠	٩,٧٠	L.S
		٨٥-١٢٥	١٨,٠	٢,٨٠	١٨,٦	٩٠,٤٠	٥,١٠	٤,٥٠	S
	١٥	٠-٢٥	١٨,٠	٣,٢٠	١٦,٣	٨٩,١٠	٤,٢٠	٦,٧٠	S
		٢٥-٨٠	١٩,٠	١,٨٠	١٥,٦	٨٩,٢٠	٣,٧٠	٧,١٠	S
		٨٠-١٢٠	٢٠,٠	١,٩٠	١٢,٤	٨٧,٣٠	٣,٢٠	٩,٥٠	L.S
	١٦	٠-٤٠	١٨,٠	٠,٦٠	٧,٦	٩٧,٢٠	١,٤٠	١,٨٠	S
		٤٠-١٢٠	١٨,٠	٠,٦٠	١٠,٤	٩٥,٤٠	٢,٣٠	١,٧٠	S

Cont.:table ٣

Landform	Profile	Depth							Texture
	١٧	٠-٣٠	٢٨,٠	١٠,٢٠	١٢,٦	٦٧,٣٠	١٩,٥٠	١٣,٢٠	S.L
		٣٠-٥٠	٢٨,٠	٨,٢٠	١٠,٦	٦٧,٥٠	١٩,٧٠	١٢,٨٠	S.L
		٥٠-٨٠	٣٢,٠	٧,٣٠	١٨,٤	٥٥,١٠	١٩,٦٠	٢٥,٣٠	S.C.L
		٨٠-١٢٥	٣٥,٠	١١,٨٠	١١,٢	٦٠,٨٠	٢٤,٦٠	١٤,٦٠	S.L
		+ ١٢٥	٢٥,٠	١٤,٧٠	١٠,٢	٦٠,٤٠	٢٥,٣٠	١٤,٣٠	S.L
	١٨	٠-١٥	٢٤,٠	١,٤٠	١٦,٢	٩٩,٢٠	٠,٥٠	٠,٣٠	S
		١٥-٣٥	٣٣,٠	١,١٠	١٢,٤	٥٤,٣٠	٢٤,٢٠	٢١,٥٠	S.C.L
		٣٥-٧٠	٣٤,٠	٠,٨٠	١٢,٨	٥٤,٣٠	١٤,٥٠	٣١,٢٠	S.C.L
		٧٠-١١٠	٣٤,٠	٣,١٠	١٥,٢	٥٦,٥٠	١٢,٢٠	٣١,٣٠	S.C.L
	١٩	٠-٣٥	٢٠,٠	٢,١٠	١٣,٤	٨٩,٦٠	٣,٧٠	٦,٧٠	S
		٣٥-٤٥	٢١,٠	١,٤٠	١٤,٢	٨٦,٥٤	٢,٢٧	١٠,٧٧	L.S
		٤٥-٦٥	١٨,٠	١,٣٠	١٧,١	٩٠,٢٤	١,٥٩	٨,١٧	S
		٦٥-١٠٠	١٩,٠	٠,٩٠	١٢,٤	٩٢,٧٣	١,٥٩	٥,٦٨	S
	٢٠	٠-٢٠	١٦,٠	١,٢٠	١٢,٦	٩٦,٤٠	٣,٠٠	٠,٦٠	S
		٢٠-٥٠	١٦,٠	١,٠٠	١٨,٦	٩٣,٢٠	٦,٤٠	٠,٤٠	S
		٥٠-١١٠	٢٠,٠	١,١٠	١٠,٨	٨١,٦٠	٦,٢٠	١٢,٢٠	S.L
	٢١	٠-١٥	١٩,٠	٥,٢٠	١٧,٢	٩٩,٠٠	٠,٨٠	٠,٢٠	S
		١٥-٧٥	١٩,٠	٠,٧٠	١٩,٧	٩٨,٤٠	٠,٥٠	١,١٠	S
		٧٥-١٥٠	١٧,٣	٠,٥٠	١٣,٤	٩٩,٢٠	٠,٦٠	٠,٢٠	S
	٢٢	٠-١٠	٢٢,٤	١,٤٠	١٠,٨	٩٥,٩٠	١,٦٠	٣,٥٠	S
		١٠-١٠٠	٢٤,٢	٢,١٠	١٦,٨	٩٤,١٠	٠,٨٠	٥,١٠	S
	٢٣	٠-٢٠	١٨,٠	١,٥٠	١٧,٦	٩٣,٢٠	٢,٥٠	٤,٣٠	S
		٢٠-٤٥	١٨,٠	٣,٥٠	١٢,٦	٨٨,٩٠	٦,٢٠	٤,٩٠	S
		٤٥-٨٥	٢١,٠	٤,٦٠	٨,٧	٨٧,٢٠	٥,٢٠	٧,٦٠	L.S
		٨٥-١٥٠	٢١,٠	٣,٦٠	١٩,٣	٨٤,٣٠	٤,٥٠	١١,٢٠	L.S
	٢٤	٠-٤٠	١٨,٠	٥,١٠	١٨,٥	٩٥,٨٠	٣,٢٠	١,٠٠	S
		٤٠-٥٥	٢٠,٠	٣,٥٠	١٢,٨	٩٢,٤٠	٤,٣٠	٣,٢٠	S
		٥٥-١٠٠	٢٦,٠	٠,٧٠	١٤,٧	٧٠,٣٠	١٩,٣٠	١٠,٢٠	S.L
	٢٥	٠-١٠	٣٢,٠	٣,٤٠	١٣,٤	٦٠,٩٠	٢٣,٨٠	١٧,٢٠	S.L
		١٠-٤٥	٢١,٠	٢,٠٠	١١,٦	٨٧,٣٠	٨,٩٠	٤,٤٠	L.S
	٢٦	٠-١٠	٢٠,٠	٧,٤٤	١٦,٥	٩٥,٢٠	٢,٦٠	٢,٢٠	S
		١٠-١٣٠	١٨,٠	٠,٩٣	١٢,٣	٩٧,٧٠	١,٣٠	١,٠٠	S
Pediment	٢٧	٠-٢٥	١٧,٠	٧,١٠	٨,٧	٩٨,٥	١,٠	٠,٥	S
		٢٥-٦٠	٢٣,٠	٠,٨٠	٤,٦	٨٦,٩	٨,٩	٤,٢	L.S
		٦٠-١٥٠	٢٦,٠	٠,٩٠	٨,٦	٨١,٣	٦,٧	١٢,٠	S.L
	٢٨	٠-١٠	١٩	٣,٦٨	١٧,٦	٩١,٢	١,٦	٧,٢	S
		١٠-٥٠	٢٥,٥	١,٤٥	١٢,٦	٦٨,٥	١١,٣	٢٠,٢	S.L
		٥٠-١٥٠	٢٣,٥	٠,٧٠	١٠,٢	٧٥,١	٨,٢	١٦,٧	S.L
	٢٩	٠-١٥	٢٤	١,٨٠	-	٨٦,٢	٤,٥	٩,٣	L.S
		١٥-٤٥	٢٤	٢,٤٠	١٤,٠	٨٥,٢	٥,٣	٩,٥	L.S
		٤٥-٨٥	٢٢	٣,٦٠	١٢,٣	٨٥,٥	٥,٨	٨,٧	L.S
		٨٥-١٤٥	٢٣	٤,٢٠	١٦,٤	٨٤,٢	٤,٦	١١,٢	L.S
Plateau	٣٠	٠-٥	١٩,٠	٢,٨٠	١٢,٦	٩١,٨	٦,٣	١,٩	S
		٥-٥٠	١٩,٠	١,٧٠	١٧,٦	٨٩,٨	٢,٢	٨,٠	S
		+٥٠	٢٠,٠	١,١٠	٨,٤	٨٢,١	٧,٢	١٠,٧	L.S

Table ٤: Chemical properties of soil samples from land forms around the High Dam Lake

Cont.: table ٤

٢- Soil capability

The capability of the investigated soils was evaluated using the physical, chemical and soil indices of ASLE capability model (Ismail, et al., ٢٠٠١). The results are illustrated in Table ٥. 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 ٧ to ١٦) differ from ٢٤,٢٦ to ٥٢,٨٩ indicating fair and poor capabilities (C٣, C٤). The soil capability of the soils in sand sheets varied widely from ١٠,١١ to ٦٦,٥١ including a good capability (C٢) for profile ١٦ and very poor capability soils (C٥) for the soils of profile ٢١.

Soil capability indices of the Pediment unit differ from ٤٣,٥٧ to ٥٦,٨ indicating a fair class (C٣) 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 ٣٦,٧٧. The limiting factors in the plateau landform are texture and CEC.

The maps of the soil capability classes (Fig ٥) 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.
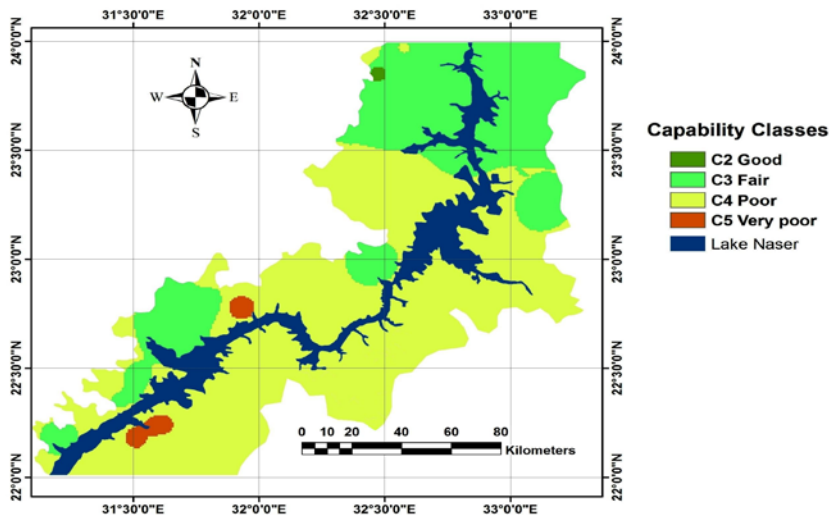

Fig. ٥: Map showing the soil Capability Classes of the investigated soils of the High Dam Lake region.

Table ٥: 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 المعلومـات 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 المعلومـات الجغرافية لأنتاج خرائط التربة. وأشارت البيانـات المستخرجة من صور الأقمار الصناعية والنمـاذج 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 ١). أظهرت الخريطـة الفيزيوجرافية لمنطقة الدراسة على وجود ستة عدد وحدات أساسيه وهى :-

١)المنـاطق الصـحراوية المرتفعة والأودية Dissected desert uplands and Wadis : وهى تتبع رتبـة Entisols وتحـت رتبـة Psamment و Orthents والمجموعـات الكبــرى Torriorthents - Torripsamments – Quartzipsamment

٢)السـهول الصـحراوية Desert plain: وهى تتبع رتبة Entisols - Aridisols وتحت رتبة Psamment و Orthents - Fluvents - Salids - Gypsids والمجموعـــات الكبــرى Gypsic - Torrifluvents – Torripsamments – Haploduric Torripsamments Typic Hoplogypsic - Haplosalids Salids

٣)الصـفائح الرمليـة sheet Sand: وهـى تتبـع رتبـة Entisols و Aridisols وتحـت رتبـة Psamment و Orthents و Fluvents و Salids والمجموعـــات الكبــرى Typic Hoplosalids - Torrifluvents – Torriorthents – Quartzipsamment Typic Gypsic Hoplosalids.

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

٥)الهضبة Plateau: وهى تتبع رتبة Entisols وتحت رتبة Orthents والمجموعـات الكبـرى Torriorthents

٦)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 صـغيرة فى الشمال الغربي من منطقة الدراسة وهى تسمى منطقة وادى كركر.

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

١- 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 .

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

٣- 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 .

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

٤- 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
١	٣٢,٥٨	٨٥,٠٤	٢٧,٧١	C٤	
٢	٢٩,٠٥	٩٥.٧٢	٢٧,٨	C٤	
٣	٢٠,٤٩	٧٦,٥٢	١٥,٦٨	C٥	Dissected desert uplands and Wadis
٤	١٥,٤٩	٨٢,٧١	١٢,٨١	C٥	
٥	١٤,٣٥	٩٥,٤٤	١٣,٦٩	C٥	
٦	٢٠,٢٤	٨٦,٢٧	١٧,٤٦	C٥	
٧	٣٦,١١	٤٥,٨٨	٣٩,٥١	C٤	Desert plain
٨	٥٣,٥١	٨٢,٢٢	٤٤	C٣	
٩	٥٦,٩	٨٥,٧١	٤٨,٧٧	C٣	
١٠	٥٩,٦٤	٨٠,٧	٤٦,٥٢	C٣	
١١	٤٥,٣٩	٨٦,٦٦	٣٩,٣٣	C٤	
١٢	٤٤,٥	٩٠,٣٩	٤٠,٢٢	C٣	
١٣	٥٨,٧٦	٩٠,٠١	٥٢,٨٩	C٣	
١٤	٤٧,٧٢	٨٩,٢٨	٤٢,٦	C٣	
١٥	٤٦,٦	٩٤,٠٥	٤٣,٨٣	C٣	
١٦	٢٥,٢	٩٥,٩١	٢٤,٢٦	C٤	
١٧	٨١,٦٢	٨١,٤٨	٦٦,٥١	C٢	Sand sheet
١٨	٧٧,٦٣	٣٦,٤٥	٢٨,١٢	C٤	
١٩	٤٠,٠٤	٨٦,٧٥	٣٤,٧٣	C٤	
٢٠	٣٣,٩١	٧١,٣٦	٢٤,٢	C٤	
٢١	١٧,٣٢	٥٨,٣٨	١٠,١١	C٥	
٢٢	٣٠,٥٨	٨٠,٣٣	٢٤,٥٦	C٤	
٢٣	٥١,٢٩	٩١,٠٤	٤٦,٦٩	C٣	
٢٤	٣٤,٣٥	٨٣,٥٧	٢٨,٦٣	C٤	
٢٥	٦٥	٧٠,٨٥	٤٦,٠٠	C٣	
٢٦	٣١,٦٢	٨٨,١١	٢٧,٨٦	C٤	
٢٧	٤٩,٢٥	٤٩,٢٥	٤٣,٥٧	C٣	Pediment
٢٨	٧٥,٧٢	٧٥,٠٢	٥٦,٨	C٣	
٢٩	٥٦,١	٨١,٥١	٤٥,٧٣	C٣	
٣٠	٣٧,٦٢	٩٧,٧٩	٣٦,٧٧	C٤	Plateau

C١=Excellent (٨٠-١٠٠)   **C٢=Good (٦٠-٨٠) C٣=Fair (٤٠-٦٠)**   **C٤=Poor (٢٠-٤٠)**
C٥= Very poor (١٠-٢٠)   **C٦=Non-agriculture (٠-١٠)**

July, ٢٠١٤   *July, ٢٠١٤*   *July, ٢٠١٤*   *July, ٢٠١٤*   *July, ٢٠١٤*

July, ٢٠١٤   *July, ٢٠١٤*   *July, ٢٠١٤*   *July, ٢٠١٤*   *July, ٢٠١٤*

July, ٢٠١٤   *July, ٢٠١٤*   *July, ٢٠١٤ July, ٢٠١٤*