Australian Journal of Basic and Applied Sciences, 1(4): 793-800, 2007
ISSN 1991-8178

# Soil mapping of Wadi Hodein Area, Southeastern Egypt Using Remote Sensing and GIS Techniques

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**Abstract:** The study was carried out on one of the large drainage basin Southeastern Egypt namely "Wadi Hodein". It lies entirely within the catchment area of the Red Sea sub-megabasin. It extends from the coast of the Red Sea to the nearest mountains. The objectives of this study are to identify the main geomorphological units and establishing soil map to provide a comprehensive knowledge about the potentialities of these areas. Thirty four soil profiles have been selected to represent the main geomorphic units in the study area. Based to Remote sensing data, DEM and GIS, the study area is recognized to nine physiographic units, namely; delta plains, sandy plains, main wadies, alluvial plains, tributaries, marine terraces, denuded hills, plain with rock out crops and alluvial fans, these geomorphic units occupy about 49.50, 1.65, 4.37, 7.89, 3.04, 3.44, 7.74, 3.76 and 9.26% respectively of the study area. While about 9.35% are rocky areas. The soils of the study area are classified as Typic Torrifluvents and Typic Haplosalids, Typic Torriorthents, Durothidic Torrifluvents and Typic Petrogypsids. In general more than 50% of the study area is delta plain. These soils can be easily cultivated. Soil survey and classification are very essential and important for investing any virgin area for agricultural development and rural rehabilitation as in the case of Wadi Hodein area.

**Key words:** geomorphology, soil survey and classification, Wadi Hodein, Eastern desert, Egypt

## INTRODUCTION

Wadi Hodein is one of the largest wadies at southeast carnal of Egypt with Latitudes 22° 58′ 00′′ and 23° 13′ 00′′ N, Longitudes 35° 15′ 00′′ and 35° 45′ 00′′ E (Figure 1). It occupies an area of about 759.6 km$^2$. The topography of its area ranges from gently slope plains to rugged mountains and hilly lands, with elevations ranging from 50 m above sea level (at the basin outlet) to salient highs up to 1,443 m.

Drainage basin are the fundamental units of the fluvial landscape and accordingly, a great amount of researches had focused on their geometric characteristics, including the topology of the stream network, and the quantitative description of drainage texture pattern, slope and relief (Abrahams, 1984). Because drainage basins are the physical entities used to measure the volume of water produce by runoff, the analysis of basin morphometry has been extended to include the interrelationships between network characteristics and the resulting water (Hadley and Schumm, 1961).

Soil resources are essential for land evaluation and decision making system. In fact, land evaluation originated with soil surveyor's desire to make their surveys useful to land users. In this research, location of the investigated area belongs to "Wadi Hodein" at Shalatien, in the Eastern Desert of Egypt. Shalatien area received more attention as a promising region for different developmental activities, such as; tourism, fishery, animal husbandry, agriculture and mining, and for its importance as a trading route between Egypt and Sudan. According to the meteorological data of Shalatien Station (Deseret Research Institute 1998) prevailing in the investigated area the aridity is common during summer season as the follows: the highest air temperature ranges between 45º and 50 ºC during April to September, and the monthly mean of daily relative humidity is 50% in October and November, whereas it reaches 60% in January and February. The evaporation rate reaches the maximum value of 6-10.5 mm/day. The maximum rate of wind speed is 9-11 konts during April-May which known as khamaseen winds. Wadi Hodein drainage basin is the largest wadi in Shalatien area, from the areal point of view, where its area is about 1,153 km$^2$ and received about 282.2 million cubic meters of rainfall water, this volume is contributed in as surface runoff of 143.9x10$^6$ m$^3$ and an evaporation loss of about 110.1x10$^6$ m$^3$ with 28.2x10$^6$ m$^3$ as infiltrated part. Constructing a system of proposed rocky dams which may retard the runoff flow and increasing the chance for infiltration. These dams could be oriented in

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

zigzag patterns across the wadi's course eastwards to the sea to decrease the runoff velocity and prevent the desisting problems upstream side of the dams. These dams are highly recommended, especially around the already existing water points where pervious and fracture rock units prevail. This will lead to increasing the productivity of wells and enhancing their water quality (NARSS, 2000).

The extension of rehabilitation in Egypt into the vast desert areas is a must to enhance the agricultural income after the overwhelming increase in population on the limited cultivable land of the Nile Delta and Valley. The old Wadis of the southeastern Egypt are the most promising and prospective regions for agricultural development investing the Nubian water reservoir. The old Wadis of the southeast Egypt have very distinct ecological conditions for its location, geomorphology, land and water resources. However few investigations have been conducted mostly from geological point of view (Ball, 1912; Shta, 1962 and Abo El Ezz**,** 1966) as a group of essential mountains chains of Eastern desert, among it low sand plains. Few studies have been published about this area are mainly focused in the geology and mineral resources (El-Rakiby *et al.,* 1996, Zaghloul, 1996, Abdel Rahman, 1997a & b).

## MATERIALS AND METHODS

Landsat ETM+ images (Figure 2) and digital elevation model were used to delineate the physiographic and soil units. The enhanced Landsat ETM+ image is draped over the digital elevation model and processed in ERDAS Imagine 8.7 software to define the different physiographic units of the study area following the geomorphic approach of Dobos et al. (2002) and Zinck and Valenzuela (1990).

The delineated physiographic units were checked through field observation. Soil patterns, land forms and characteristic landscape were surveyed in a semi detailed manner. 34 soil profiles were taken to represent the different mapping units; the morphological description of these profiles was carried out according to the guidelines edited by FAO (1990). Representative disturbed 98 soil samples have been collected and analyzed using the soil survey laboratory methods manual USDA (2004). The soils were classified to the sub great groups based on the USDA (2003).

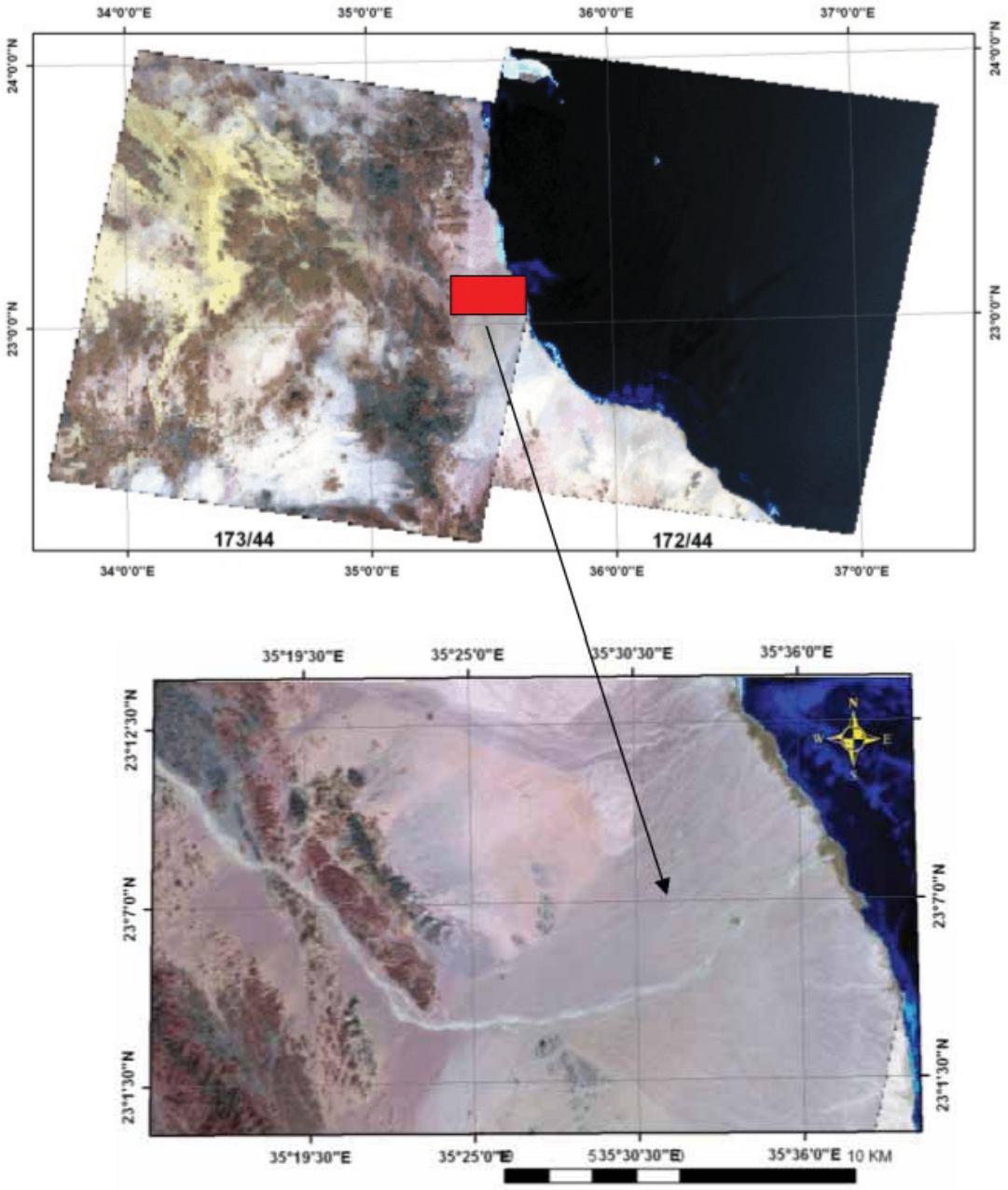


**Fig. 2:** Landsat ETM+ image for the investigated area (path 172 / row 44 &173/row 44)

## RESULTS AND DISCUSSIONS

The main objective of this study is to classify and establishing soil map to provide a comprehensive knowledge about the potentialities of these areas. Interpretation of Landsat images, (Fig.2) illustrates that the investigated area comprises different types of landforms. The main physiographic units, soil types (Fig. 3) and its main characteristics are described in the following:

***Delta Plain:***

This unit occupies an area of about 376 $km^2$ (49.5%) covering the largest area in Wadi Hodien. It is represented by 12 soil profiles. Profiles from 1 to 9, are characterized by the present of fluvial materials

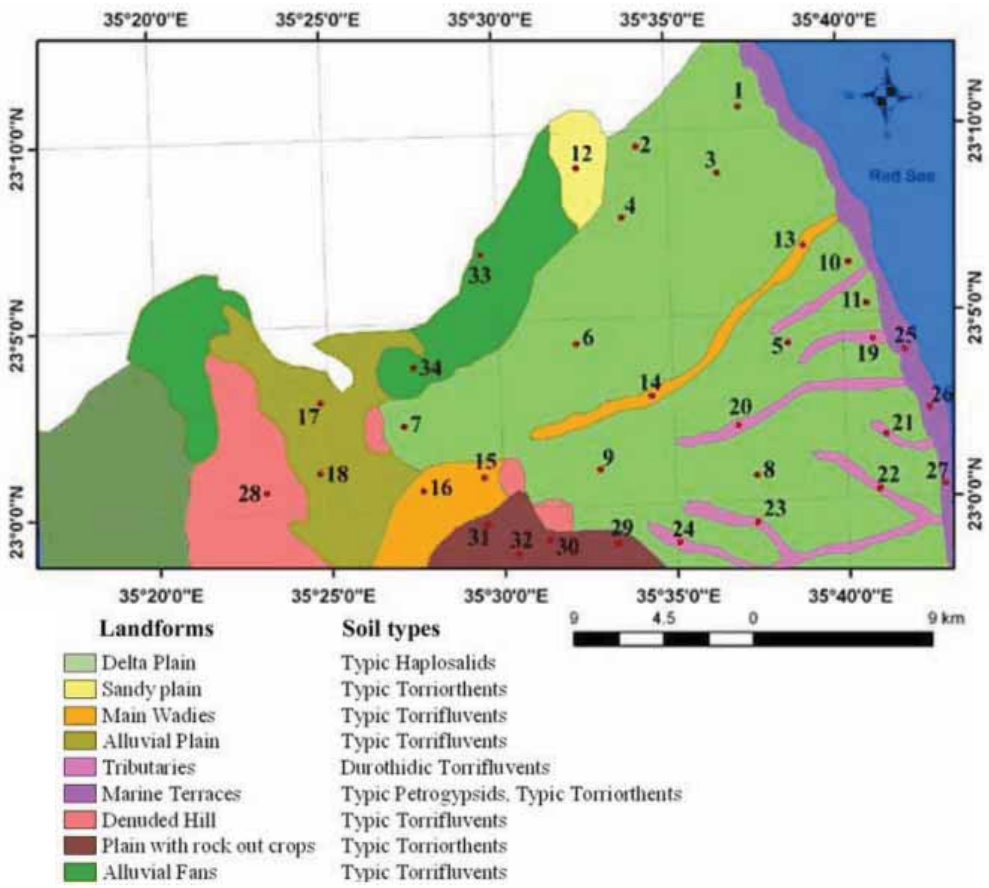


**Fig. 3:** The physiographic soil map of the investigated area.

with level landscape. The natural vegetation is many to few, and present as small shrubs and some trees of "Acacia Tortilis". Soil profiles are deep, naturally well drained due to its coarse soil texture, mostly coarse sand. EC values ranged from 0.1 to 26 dS/m. Salts are concentrated on the soil surface and decreased downwards to the deep layers. Profiles nos. 1,4,5,7 and 9 contain soluble salts more than 16 dS/m. The precipitation of lime is found in some profiles and $CaCO_3$ content ranges between 0.8 – 8.2% (Table 1) except the deeper layer of profile no. 7 it reach 14.3% due to the present of some shells. The pH values range from 7.2 to 9.8. These profiles are classified as Typic Torrifluvents. While, profiles no. 10 and 11 in the same unit, due to its salts content meet the requirements of salic horizon where the values of EC ranged from 24 to 230 dS/m. These profiles classified as Typic Haplosalids.

***The Sandy Plain:***

This unit occupies an area of about 12.53 $km^2$ (1.65%). It located at the north of Shalaten City. The unit represented by profile no. 12.The surface is almost flat and sloped towards the sea. There are some denuded hills and there is no vegetation cover except some scatters shrubs. Soil is characterized by deep sandy profile, naturally well drained due to its coarse soil texture, mostly sand. EC values very low and ranged from 0.1 to 3.1 dS/m. $CaCO_3$ content ranges between 1.6 – 4.2%. These soils are slightly alkaline and data show the values of pH ranged from 8.5 to 8.9. The soils of the sandy plain are represented by profile no.12, and classified as Typic Torriorthents.

***The Main Wadies:***

This unit occupies an area of about 33.17 $km^2$ (4.37%). The identification of these wadies are easy wherever it in the mountainous rocky areas or in low lands. These main wadies are recognized to wadi bottom,

**Table 1:** Some of chemical and physical analyses of the studied soils

| Prof. No. | Depth (cm) | pH | EC (dS/m) | $CaCO_3$ (%) | Gravel (%) | Particle size distribution (%) | | | | | | Texture classes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | VC.S 2.0-1.0 | C.sand 1.0-0.5 | M.sand 0.5-0.25 | F.sand 0.25-0.10 | VF.sand 0.10-0.05 | Silt+clay < 0.05 | |
| | | | | | | mm | | | | | | |
| | | | | | | 1- Delta Plain | | | | | | |
| 1 | 0-50 | 7.9 | 12.0 | 1.4 | 53.0 | 32.2 | 16.2 | 17.6 | 26.4 | 5.9 | 1.7 | vgcs |
| | 50-100 | 7.9 | 17.0 | 0.8 | 60.2 | 28.5 | 18.0 | 19.0 | 25.2 | 7.2 | 2.1 | vgcs |
| 2 | 0-90 | 8.1 | 14.0 | 7.1 | 62.2 | 12.0 | 9.9 | 24.3 | 4.3 | 10.5 | 2.0 | vgfs |
| | 90-120 | 8.1 | 10.0 | 0.8 | 48.3 | 45.4 | 30.9 | 17.4 | 4.1 | 1.3 | 0.9 | vgcs |
| | 120-150 | 8.0 | 0.1 | 0.8 | 48.0 | 39.0 | 37.5 | 14.6 | 6.2 | 2.0 | 0.7 | vgcs |
| 3 | 0-10 | 8.7 | 0.3 | 4.4 | 28.1 | 10.0 | 5.9 | 16.7 | 46.8 | 18.9 | 1.7 | gcs |
| | 10-30 | 8.7 | 0.2 | 5.1 | 58.5 | 24.3 | 18.2 | 22.1 | 26.2 | 6.3 | 2.9 | vgcs |
| | 30-70 | 8.9 | 0.1 | 4.4 | 36.9 | 22.1 | 19.4 | 35.3 | 20.3 | 2.0 | 0.9 | gms |
| | 70-100 | 8.9 | 0.1 | 3.5 | 48.0 | 23.6 | 18.4 | 37.0 | 18.6 | 1.9 | 0.5 | gms |
| 4 | 0-50 | 7.8 | 19.0 | 1.6 | 44.4 | 30.1 | 15.5 | 26.2 | 18.7 | 5.5 | 4.0 | gcs |
| 5 | 0-15 | 8.1 | 25.1 | 1.9 | 15.8 | 6.8 | 12.4 | 53.4 | 22.7 | 3.9 | 0.9 | ms |
| | 15-25 | 8.2 | 8.8 | 1.7 | 20.3 | 5.2 | 14.7 | 55.1 | 20.0 | 4.0 | 1.0 | gms |
| | 25-100 | 8.3 | 2.9 | 0.8 | 16.6 | 23.5 | 28.1 | 30.0 | 15.0 | 2.1 | 1.3 | cs |
| 6 | 0-20 | 8.6 | 1.7 | 1.7 | 18.1 | 9.3 | 9.6 | 20.0 | 42.3 | 16.2 | 2.6 | cs |
| | 20-50 | 8.4 | 6.2 | 2.6 | 12.1 | 6.3 | 11.5 | 21.2 | 40.8 | 17.0 | 3.2 | fs |
| | 50-100 | 8.2 | 4.6 | 1.7 | 8.0 | 4.9 | 12.0 | 56.4 | 22.3 | 3.3 | 1.1 | ms |
| 7 | 0-30 | 8.4 | 18.5 | 1.8 | 11.1 | 18.0 | 11.7 | 18.5 | 29.3 | 18.9 | 3.6 | ms |
| | 30-75 | 7.9 | 22.2 | 8.2 | 2.8 | 14.6 | 15.7 | 25.1 | 30.2 | 10.2 | 4.2 | ms |
| | 75-100 | 7.7 | 26.5 | 14.3 | --- | 11.9 | 12.1 | 19.5 | 39.2 | 14.5 | 2.8 | ms |
| 8 | 0-28 | 8.7 | 2.1 | 5.3 | 7.4 | 7.5 | 7.3 | 36.8 | 44.4 | 2.5 | 1.5 | fs |
| | 28-50 | 8.5 | 1.1 | 2.6 | 13.8 | 12.2 | 9.0 | 17.2 | 42.2 | 16.9 | 2.5 | fs |
| | 50-100 | 8.4 | 0.6 | 2.1 | 51.3 | 9.0 | 20.3 | 37.2 | 28.0 | 4.2 | 1.2 | vgms |
| 9 | 0-15 | 7.9 | 24.4 | 2.8 | 10.6 | 25.9 | 18.5 | 28.2 | 24.5 | 2.1 | 0.8 | ms |
| | 15-60 | 8.1 | 13.7 | 2.8 | 18.2 | 24.4 | 21.5 | 32.9 | 18.4 | 2.0 | 0.8 | ms |
| | 60-110 | 8.3 | 2.9 | 1.2 | 25.8 | 22.8 | 24.5 | 37.5 | 12.2 | 1.8 | 1.2 | gcs |
| 10 | 0-5 | 8.0 | 46.5 | 0.9 | 20.3 | 25.2 | 23.2 | 31.9 | 15.3 | 3.2 | 1.4 | cs |
| | 5-25 | 7.8 | 41.5 | 1.4 | 1.1 | 13.4 | 18.0 | 21.0 | 31.5 | 12.1 | 4.0 | ms |
| | 25-70 | 7.9 | 24.0 | 1.4 | 1.1 | 12.9 | 16.2 | 23.2 | 32.0 | 11.5 | 4.2 | ms |
| | 70-100 | 7.9 | 25.5 | 8.4 | 1.3 | 23.6 | 17.5 | 30.5 | 25.0 | 3.1 | 0.3 | ms |
| 11 | 0-15 | 7.2 | 230.0 | 0.9 | -- | 29.2 | 32.1 | 27.5 | 8.7 | 2.2 | 0.3 | cs |
| | 15-65 | 7.3 | 60.0 | 0.9 | -- | 27.2 | 15.1 | 16.3 | 36.5 | 4.3 | 0.6 | cs |
| | 65-100 | 7.4 | 30.0 | 3.6 | 22.2 | 28.1 | 29.0 | 29.1 | 11.9 | 1.7 | 0.2 | gcs |
| | | | | | | 2- The sandy Plain | | | | | | |
| 12 | 0-80 | 8.6 | 3.1 | 4.2 | 30.9 | 12.0 | 9.0 | 14.1 | 41.6 | 20.3 | 3.0 | gfs |
| | 80-120 | 8.3 | 1.6 | 1.7 | 20.0 | 13.0 | 8.1 | 15.2 | 40.0 | 21.0 | 2.7 | gfs |
| | | | | | | 3- The Main Wadies | | | | | | |
| 13 | 0-25 | 9.3 | 0.2 | 4.1 | 27.7 | 40.0 | 26.6 | 19.0 | 9.8 | 3.8 | 0.8 | gcs |
| | 25-50 | 9.4 | 0.1 | 1.8 | 25.7 | 32.9 | 26.3 | 27.8 | 10.9 | 1.9 | 0.2 | gcs |
| | 50-100 | 9.2 | 0.2 | 1.1 | 23.1 | 32.5 | 23.5 | 23.7 | 16.3 | 3.2 | 0.8 | gcs |
| 14 | 0-30 | 8.1 | 9.0 | 1.9 | 18.2 | 18.7 | 20.4 | 32.0 | 23.6 | 4.5 | 0.8 | cs |
| | 30-60 | 8.5 | 0.8 | 2.3 | 19.4 | 17.9 | 19.9 | 35.9 | 21.9 | 3.2 | 1.2 | cs |
| | 60-100 | 8.8 | 0.2 | 1.8 | 27.4 | 31.4 | 23.1 | 31.4 | 11.6 | 1.7 | 0.8 | gcs |
| 15 | 0-30 | 9.1 | 0.6 | 1.7 | 11.3 | 9.7 | 11.9 | 18.6 | 42.6 | 14.7 | 2.5 | fs |
| | 30-65 | 7.9 | 4.6 | 2.5 | 12.0 | 16.0 | 21.6 | 33.4 | 24.6 | 3.8 | 0.6 | cs |
| | 65-110 | 8.0 | 3.5 | 1.8 | 8.8 | 13.1 | 21.9 | 36.3 | 23.8 | 3.5 | 1.4 | cs |
| 16 | 0-20 | 8.9 | 0.2 | 1.1 | 8.5 | 17.1 | 10.5 | 20.2 | 35.4 | 15.1 | 1.7 | cs |
| | 20-95 | 8.7 | 0.2 | 2.5 | 3.7 | 14.5 | 20.3 | 37.7 | 23.2 | 3.2 | 1.1 | cs |
| | | | | | | 4- Alluvial Plain | | | | | | |
| 17 | 0-35 | 9.8 | 0.4 | 5.2 | 15.3 | 11.5 | 7.6 | 12.5 | 62.3 | 5.6 | 0.5 | fs |
| | 35-70 | 8.9 | 0.9 | 1.6 | 11.8 | 16.7 | 20.9 | 34.5 | 23.9 | 3.1 | 0.9 | cs |
| | 70-110 | 9.0 | 0.6 | 1.7 | 37.2 | 20.6 | 23.3 | 36.6 | 16.8 | 2.2 | 0.5 | gcs |
| 18 | 0-25 | 9.2 | 0.2 | 0.9 | 11.5 | 9.9 | 7.4 | 21.0 | 52.6 | 7.7 | 1.4 | fs |
| | 25-60 | 9.4 | 0.2 | 1.1 | 21.5 | 6.9 | 6.4 | 22.6 | 53.7 | 8.5 | 1.9 | gfs |
| | 60-120 | 9.4 | 0.2 | 2.5 | 51.4 | 37.7 | 14.8 | 18.6 | 20.9 | 6.6 | 1.4 | vgcs |
| | | | | | | 5- The Tributaries | | | | | | |
| 19 | 0-30 | 9.2 | 0.2 | 1.4 | 7.0 | 13.1 | 16.9 | 22.1 | 27.3 | 16.5 | 4.1 | cs |
| | 30-60 | 9.4 | 0.2 | 2.6 | 34.3 | 39.7 | 25.2 | 20.6 | 11.0 | 2.7 | 0.8 | vgcs |
| | 60-100 | 9.6 | 0.2 | 2.3 | 14.9 | 27.0 | 24.0 | 32.0 | 12.0 | 3.4 | 1.6 | cs |
| 20 | 0-20 | 8.2 | 2.8 | 1.8 | 59.3 | 28.3 | 23.8 | 26.8 | 15.8 | 4.4 | 0.9 | vgcs |
| | 20-50 | 8.1 | 6.0 | 3.6 | 46.7 | 32.7 | 23.4 | 21.9 | 19.0 | 2.4 | 0.6 | gcs |
| | 50-100 | 8.2 | 2.6 | 1.1 | 44.7 | 46.6 | 22.4 | 17.7 | 6.4 | 1.4 | 0.5 | gcs |

**Table 1:** Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | 0-25 | 9.0 | 0.2 | 1.6 | 9.4 | 31.4 | 24.7 | 24.3 | 16.0 | 3.3 | 0.3 | cs |
| | 25-75 | 9.0 | 0.2 | 1.4 | 11.5 | 29.5 | 27.8 | 26.9 | 13.7 | 1.9 | 0.2 | cs |
| | 75-100 | 8.9 | 0.2 | 1.3 | 57.2 | 23.1 | 28.5 | 29.6 | 15.3 | 2.8 | 0.7 | vgcs |
| 22 | 0-50 | 8.6 | 2.2 | 3.6 | 18.7 | 26.0 | 25.3 | 27.7 | 16.4 | 3.2 | 1.4 | cs |
| | 50-100 | 9.0 | 0.4 | 0.9 | 28.1 | 29.0 | 24.9 | 30.6 | 30.6 | 2.0 | 0.9 | gcs |
| 23 | 0-15 | 7.9 | 2.2 | 1.8 | 18.5 | 24.7 | 23.7 | 27.2 | 21.0 | 2.8 | 0.6 | gS |
| | 15-45 | 8.2 | 0.9 | 1.4 | 17.7 | 23.2 | 23.6 | 29.5 | 19.9 | 2.6 | 1.2 | cS |
| | 45-120 | 8.4 | 0.5 | 0.7 | 32.3 | 33.9 | 28.2 | 27.7 | 8.1 | 1.4 | 0.7 | gcs |
| 24 | 0-15 | 8.9 | 0.9 | 0.8 | 15.6 | 39.2 | 19.5 | 17.1 | 21.4 | 2.5 | 0.3 | Cs |
| | 15-50 | 9.0 | 7.0 | 0.9 | 15.6 | 28.2 | 21.7 | 21.2 | 22.5 | 5.4 | 1.0 | cs |
| | 50-100 | 8.1 | 5.0 | 3.0 | 9.8 | 25.0 | 18.5 | 17.2 | 24.8 | 13.7 | 0.8 | cs |
| | | | | | | 6- The Marine Terraces | | | | | | |
| 25 | 0-20 | 7.7 | 0.1 | 2.5 | 0.0 | 18.0 | 39.0 | 27.0 | 10.0 | 5.4 | 0.6 | cs |
| | 20-50 | 7.2 | 39.0 | 1.8 | 0.0 | 19.0 | 37.0 | 26.0 | 12.0 | 5.5 | 0.5 | cs |
| | > 50 | 7.4 | 2.2 | 0.9 | 0.0 | 33.0 | 16.6 | 29.8 | 18.8 | 1.6 | 0.2 | cs |
| 26 | 0-25 | 8.9 | 0.2 | 2.6 | 6.0 | 7.7 | 10.1 | 15.3 | 43.9 | 20.1 | 2.9 | fs |
| | 25-65 | 9.2 | 0.2 | 2.9 | 11.1 | 10.8 | 13.9 | 23.1 | 37.1 | 13.1 | 2.0 | fs |
| | 65-100 | 9.3 | 0.2 | 0.9 | 8.5 | 15.6 | 23.4 | 33.6 | 21.7 | 4.8 | 0.9 | cs |
| 27 | 0-10 | 8.7 | 0.3 | 0.9 | 8.3 | 10.3 | 12.9 | 23.1 | 34.9 | 15.3 | 3.5 | fs |
| | 10-30 | 8.7 | 0.1 | 2.3 | 7.4 | 14.1 | 17.0 | 23.3 | 31.8 | 2.7 | 1.1 | cs |
| | 30-100 | 8.7 | 0.2 | 2.7 | 44.0 | 20.9 | 17.7 | 22.1 | 28.1 | 8.8 | 2.4 | gcs |
| | | | | | | 7- Denuded Hills | | | | | | |
| 28 | 0-10 | 8.6 | 0.7 | 0.5 | 2.3 | 4.1 | 10.5 | 26.3 | 51.3 | 7.1 | 0.7 | fs |
| | 10-40 | 8.5 | 6.0 | 1.4 | 16.4 | 28.8 | 19.6 | 26.4 | 15.8 | 3.6 | 2.0 | cs |
| | 40-100 | 8.0 | 4.0 | 1.1 | 5.3 | 16.1 | 9.9 | 30.8 | 24.0 | 6.0 | 2.2 | cs |
| | | | | | | 8- Plain with rock out crops | | | | | | |
| 29 | 0-15 | 9.2 | 0.2 | 0.9 | 13.9 | 10.8 | 9.9 | 20.6 | 49.6 | 8.5 | 0.6 | fs |
| | 15-35 | 9.2 | 0.3 | 1.1 | 9.1 | 14.1 | 23.9 | 38.9 | 19.5 | 3.0 | 0.6 | cs |
| | 35-110 | 8.4 | 1.8 | 0.9 | 12.7 | 17.7 | 28.9 | 39.9 | 11.6 | 1.5 | 0.4 | cs |
| 30 | 0-25 | 8.7 | 0.1 | 0.5 | 8.0 | 10.5 | 10.5 | 20.0 | 38.0 | 19.2 | 1.8 | fs |
| | 25-55 | 8.9 | 0.1 | 0.9 | 14.5 | 17.1 | 17.7 | 33.9 | 25.6 | 4.6 | 1.1 | cs |
| | 55-120 | 8.9 | 0.2 | 1.4 | 5.4 | 8.9 | 20.3 | 42.6 | 23.8 | 3.4 | 1.0 | cs |
| 31 | 0-20 | 8.9 | 1.1 | 0.9 | 21.4 | 12.3 | 23.0 | 40.4 | 20.2 | 3.5 | 0.6 | gcs |
| | 20-80 | 7.8 | 6.0 | 2.0 | 58.8 | 10.7 | 22.2 | 45.8 | 17.9 | 2.5 | 0.9 | vgcs |
| | 80-110 | 7.7 | 4.4 | 1.3 | 8.1 | 8.3 | 20.3 | 50.9 | 17.7 | 2.0 | 0.8 | cs |
| 32 | 0-20 | 8.1 | 15.0 | 1.4 | 26.4 | 18.1 | 15.3 | 27.0 | 32.2 | 6.6 | 0.8 | gcs |
| | 20-50 | 8.0 | 7.0 | 1.8 | 4.0 | 7.3 | 18.7 | 46.9 | 24.2 | 2.4 | 0.4 | cs |
| | 50-100 | 8.0 | 5.0 | 1.4 | 3.7 | 7.3 | 17.2 | 51.7 | 19.6 | 3.6 | 0.6 | ms |
| | | | | | | 9- Alluvial Fans | | | | | | |
| 33 | 0-20 | 8.8 | 1.3 | 2.1 | -- | 13.6 | 13.3 | 21.9 | 41.4 | 8.2 | 1.6 | cs |
| | 20-50 | 8.8 | 0.2 | 1.8 | 12.5 | 14.2 | 20.9 | 52.9 | 10.9 | 0.9 | 0.2 | ms |
| | 50-100 | 9.3 | 0.2 | 1.8 | 10.4 | 5.4 | 11.2 | 45.3 | 34.6 | 2.9 | 0.6 | ms |
| 34 | 0-15 | 8.8 | 0.3 | 4.5 | 20.4 | 33.6 | 22.9 | 21.2 | 18.0 | 1.7 | 0.6 | gcs |
| | 15-50 | 8.8 | 0.1 | 1.8 | 4.9 | 6.0 | 12.1 | 42.8 | 37.2 | 1.7 | 0.2 | ms |
| | 50-65 | 8.9 | 0.2 | 1.9 | 30.9 | 13.5 | 16.0 | 36.0 | 32.5 | 1.7 | 0.3 | gcs |
| | 65-100 | 8.9 | 0.2 | 1.6 | 8.1 | 1.9 | 3.4 | 35.2 | 53.4 | 5.5 | 0.6 | fs |

flood plain and wadi terraces. The represented profiles were profiles nos. 13, 14, 15 and 16, which are characterized by the present of fluvial materials and level landscape. The vegetation cover is few, and present as small shrubs. The soil surface is covered by desert pavement. The profiles are deep (> 200 cm), naturally well drained due to its coarse soil texture, mostly coarse sand. The EC values range from 0.1 to 2.5 dS/m; except profile no. 14, salts are concentrated on the soil surface and reach to about (9.5 dS/m) and decreased towards the deep layer (0.25 dS/m). The $CaCO_3$ content is less than 3% in the all studied profiles. The Values of pH range from 7.9 to 9.4. Therefore, soil profiles are classified as Typic Torrifluvents.

***Alluvial Plain:***

This unit occupies an area of about 59.96 $km^2$ (7.89%). It located at the coastal area, and derived from alluvial materials translated by water from long times ago. Also deltas and fans are presented in this unit while some other areas are covered by desert pavement. The represented profiles were profiles no. 17 and 18, characterized by level and undulating landscape. The vegetation cover is very few to dense, and present as small shrubs. The soil surface is covered by desert pavement. The profiles are deep (> 200 cm), naturally well drained due to its coarse soil texture, which is mostly sand and fine sand. The EC values are low and range from 0.2 to 0.9 dS/m. The $CaCO_3$ content ranges from 0.9 to 5.2%. The Values of pH are high and range from 8.9 to 9.8. Therefore, it classified as Typic Torrifluvents.

***The Tributaries:***

This unit occupies an area of about 23.09 $km^2$ (3.04%). It represents the narrow and small wadies, which combined to form the main wadi. It comes downhill to the low land. It is alluvial materials transported through runoff from the past. The represented profiles were profiles no. 19, 20, 21, 22, 23 and 24.This unit is characterized by slightly slope. The vegetation cover is medium and scatters as small shrubs. The soil surface is covered by desert pavement. The profiles are deep (> 200 cm). The soil texture is mostly coarse sand. The EC values are low and range from 0.2 to 7 dS/m. The $CaCO_3$ content ranges from 0.7 to 3.6%. The Values of pH are slightly high and range from 7.9 to 9.6. Therefore, these profiles are classified as Durothidic Torrifluvents.

***The Marine Terraces:***

This unit occupies an area of about 26.13 $km^2$ (3.44%). The main constitute of this unit is sandy gravels deposits, located 40 km north of Shalaien City. The represented profiles were profiles no. 25, 26 and 27. It characterized by level and undulating landscape. The vegetation cover is very few to absent, and present as small shrubs. The soils surface is covered by desert pavement. Soil of profile no. 25 is shallow (50 cm depth). The soil texture is coarse sand. The EC values are low and range from 0.1 to 2.2 dS/m, except the subsurface layer (20-50 cm) reach to 39 dS/m. The $CaCO_3$ content ranges from 0.9 to 2.5%. The Values of pH are ranged from 7.2 to 7.7. Therefore, it can classify as Typic Petrogypsids. While soils represented by profiles no. 26 and 27 are deep. The soil texture is fine sand. The EC values are low and range from 0.1 to 0.3 dS/m. The $CaCO_3$ content ranges from 0.9 to 2.9%. The Values of pH are range from 8.7 to 9.3. Therefore, it can classify as Typic Torriorthents.

***Denuded Hills:***

This unit occupies an area of about 58.8 $km^2$ (7.74%). These units are located in wide hill areas, they were subject to strong weathering from long time ago by effect of rainfall, and the result was the break down of its outer surface. This weathered materials moved with water runoff and accumulated in the depressions. The representative soil profile was no. 28. This unit is characterized by steep slope. The soils surface is covered by desert pavement. The profile was taken from depression between hills, naturally well drained due to its coarse soil texture, which is mostly coarse sand. The EC values range from 0.7 to 4 dS/m. The $CaCO_3$ content ranges from 0.5 to 1.4%. The Values of pH range from 8 to 8.6. Therefore, it can classify as Typic Torrifluvents.

***The Plain with Rock out Crops:***

This unit occupies an area of about 28.54 $km^2$ (3.76%). It located between hills & mountains area and coastal plain area, 50 km at the north of Shalaten City, west the main road. The soil surface is almost flat and sloped towards the east. Soil surface covered with gravels and there is some rock out crops areas. There is no vegetation cover except some scatters shrubs. Representative soil profiles no. 29, 30, 31 and 32 are characterized by the present of gravels on the surface, and its percent decrease by deep and ranged from 8-26.4 % in surface. Except profile no 31 the subsurface layer contain 58.8%. The natural vegetations are few, and present as small shrubs. Soils characterized by deep profile, naturally well drained due to its coarse soil texture, mostly coarse sand. EC values ranged from 0.1 to 6 dS/m, except profile no. 32 the soluble salts are concentrated on the surface and decreased towards the deep layers (15, 7, 5 dS/m respectively). Calcium carbonates are very low and $CaCO_3$ % ranges between 0.1 – 2%. The values of pH are close to alkalinity which ranged from 7.7 to 9.2. Therefore, it classified as Typic Torriorthents.

***Alluvial Fans:***

This unit occupies an area of about 70.32 $km^2$ (9.26%). It located at the north of Shalaien City. The represented profiles are profiles no. 33 and 34. The landscape is characterized by level slope. The vegetation cover is few, and present as small shrubs. The soils surface is covered by desert pavement of different sizes. The profiles are very deep (> 200 cm). The soil texture is mostly medium and fine sand. The EC values are low and range from 0.1 to 1.3 dS/m. The $CaCO_3$ content ranges from 1.6 to 4.5%. The Values of pH are high and range from 8.8 to 9.3. Therefore, it can classify as Typic Torrifluvents.

## REFERENCES

Abdel Rahman, S.I., 1997a. Soil and agriculture potentiality of Mersa Shaab area, Southeastern Desert of Egypt. Proceeding of Geoinformation for sustainable development. ITC, Enschede, 17-21.

Abdel Rahman, S.I., 1997b. Application of Remote Sensing for Agriculture Development of Saiyal Area

in the Southeastern Desert of Egypt. Int. Sym. of Salt Affected Soil in the Arid Ecosystem, 22-26. Sept. Cairo. Abo el Ezz. 1996: The Morphology of the Egyptian soils-Cairo.

Abrahams, A.D., 1984. Channel networks: A geomorphologic perspective. Water Resources Res., 20: 161-168

Ball, G., 1912. The geography and geology of south east of Egypt. Egypt Min., Fin., Surv. Dept. Cairo.

Black, C.A., D.D. Evans, J.I. White, L.E. Ensminger and F.E. Clark, 1982. Methods of Soil Analysis. Amer. Soc. Agronmy Inc. Publisher Madison, Wisconsin, USA.

Desert Research Institute, 1998. Meteorological data recoded at Shalatien Station, Installed by Desert Research Institute, Internal unpublished report.

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

FAO, 1990. "Guidelines for soil description" FAO, Rome, pp: 53.

Hadley, R.F. and S.A. Schumm, 1961. Hydrology of the upper Cheyenne River Basin, water supply pp., (U.S.), 1531-B: 186-198.

NARSS (National Authority for Remote Sensing and Space Scince) 2000. Integrated development of Halayib-Shalatien Region. Final Report., pp: 252.

Shta, A., 1962. The lower Nobia area, Egypt, U.A.R. Bull Soc. Geog. Of Egypt, Tom, 35.

USDA, 2003. Soil Taxonomy, Natural Resources Conservation Service. Wishington D.C., 20402

USDA, 2004. "Soil Survey Laboratory Methods Manual" Soil Survey Investigation Report No. 42 Version 4.0 November 2004.

Zaghloul, E., 1996. Water Resources of Halaib-Shalatien, Final Repoc, NARSS, Cairo, Egypt.

Zinck, J.A. and C.R. Valenzuela, 1990. "Soil geographic database: structure and application examples" ITC j., 3: 270.