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# Delineation, Classification and Evaluation of Physiographic Units in some Promising Areas for Agriculture in the North Eastern Part of Sinai Peninsula, Egypt

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## ABSTRACT

The magnificence of the studied desert soils has been increased fast due to scale efforts to bring additional areas under the agricultural utilization projects in recent decades.The studied area is located in the North Eastern side of Sinai Peninsula, Egypt. It is considered as a promising area for agricultural utilization as well as a model for representing some landscape features in North Sinai. So, the current work has been undertaken for delineation of physiographic units, soil classification and land evaluation. The technique of space images interpretation plays an important role for tracing the prevailing physiographic units as well as identifying the promising sites for agricultural purposes. The obtained data of landsate images interpretation indicate that the area under consideration is occupied by ten main physiographic units namely, Coastal plain (Cp), Sand sheets (SS); Alluvial plain (Ap); Upper terraces (Ut); Lower terraces (Lt); Wadi bottom (Wb); Sand dunes (Sd); Pediplain (Pb), Sabkha (Sa) and Dissected hills (DH). Soils taxa were surveyed according to the Keys to Soil Taxonomy (USDA, 2014) and could be categorized into two Orders Aridisols and Entisols and seven sub great groups as follows: i) Aridisols, include three subgroups of Calcic Haplosalids, Typic Haplocalcids and Sodic Haplocalicids ii) Entisols include four sugroups of Aquic Quartzipsamments; Typic Quartzipsamments, Typic Torripsamments and Typic Torrifluvents According to land evaluation system undertaken by Sys and Verheye (1978) and Sys *et al*.(1991), the current suitability for agricultural irrigated soils could be categorized into two suitability classes i.e., marginally suitable (S3) and not suitable (N) and six subclasses (S3s, S3t, N1tws, N1sn, N1tsn and N1wsn) , which are suffering from some soil properties , i.e., soil texture , soil depth, wetness, topography and salinity and alkalinity as soil limitations with different intensity degree (moderate and severe). By executing the suitable soil improvement practices, the potential suitability classes assessed three classes i.e., moderately suitable (S2), marginally suitable (S3) and not suitable (N2); and five subclasses (S2s, S2ws, S2sn, S3s and N2). Also, soil suitability for specific crops (i.e., alfalfa, barley, wheat, sunflower, tomato, potato, watermelon, green pepper, citrus, guava, olives and mango), were presented for soils developed on the identified physiographic units in land suitability guide tables.

**Keywords:** Remote Sensing (RS), GIS, soil taxa and land evaluation.

## INTRODUCTION

In Egypt, agriculture is considered to be one the main sources of national income. The rapid and continuing increase in human population cause shortage in this income and increasing the consuming food. The increasing cultivable area in the challenging responsibility of soil pedologists where, the pedological studies are considered the first steps for horizontal and vertical expansions.

Sinai Peninsula covers 61.000 $Km^2$, extending between latitudes 27º 15' and 31º 10' North, and Longitudes 32º 10' and 34º 30' East. It is triangular in shape and is separated geographically from Egypt's main land by the Suez Canal and the Gulf of Suez. It is connected with the Asiatic continent a large 200 km. between Rafah on the Mediterranean Sea and the tip of the Gulf of Aqaba on the Red Sea.

Great plans had been developed for agricultural extension in Sinai since its return to Egypt in 1973. These plans aimed to the reclamation and cultivation of new lands concentrated mainly in the North Eastern part of Sinai Peninsula in order to create new and stable communities in this area.

Integration of Remote Sensing (RS) within the GIS database can decrease the cost, reduce the time and increase the detailed information gathered for Soil Survey (Green 1992). Particularly the use of Digital Elevation model (DEM) is important to derive landscape attributes that are utilized in land forms characterization (Dobos *et al*, 2000).

The study area is located in the North Eastern part of Sinai Peninsula , between longitudes 33º 50' and 34º 30' East, and latitudes 30º 30' and 31º 20' North (Fig. 1). It covers about 4796.5 $km^2$ (about 1151149 feddans). It is situated between the Egyptian-Palestinian border on the East, the Mediterranean Sea on the North and Abu Aweigila region on the South.

The climatic data of the studied area is ling in the arid Mediterranean zone according to the UNESCO (1977).

The meteorological data of the nearest station of El-Arish after CLAC (2015), showed that the total rainfall does not exceed 103.9 mm/year and the mean minimum and maximum annual temperatures are 8.5 Cº and 31.1 Cº, respectively. The evaporation rates are coinciding with temperatures where the lowest evaporation rate (3.5 mm/day) was recorded in January, while the highest value (4.7 mm/day) was recorded in June. According to the aridity index classes (Hulme and Marche, 1990) the area is located under arid climatic condition.

Geology of the north eastern side of Sinai Peninsula has attracted the attention of many workers among them El-Shazly *et al*. (1974), Henry and Chorowiez (1987) and Said (2000). Information given by the above mentioned authors revealed that the surface of the North Eastern side of Sinai is occupied by different types of rocks varying between Quaternary (Holocne), whereas the Southern portion is occupied by Tertiary (middle Eocene) and Cretaceous. Quaternary deposits cover most of the studied area and the subsurface and surface lithology consists of sandy, limy, chalky or clay dolomitic, and sand dunes extend from El-Arish-Rafah.

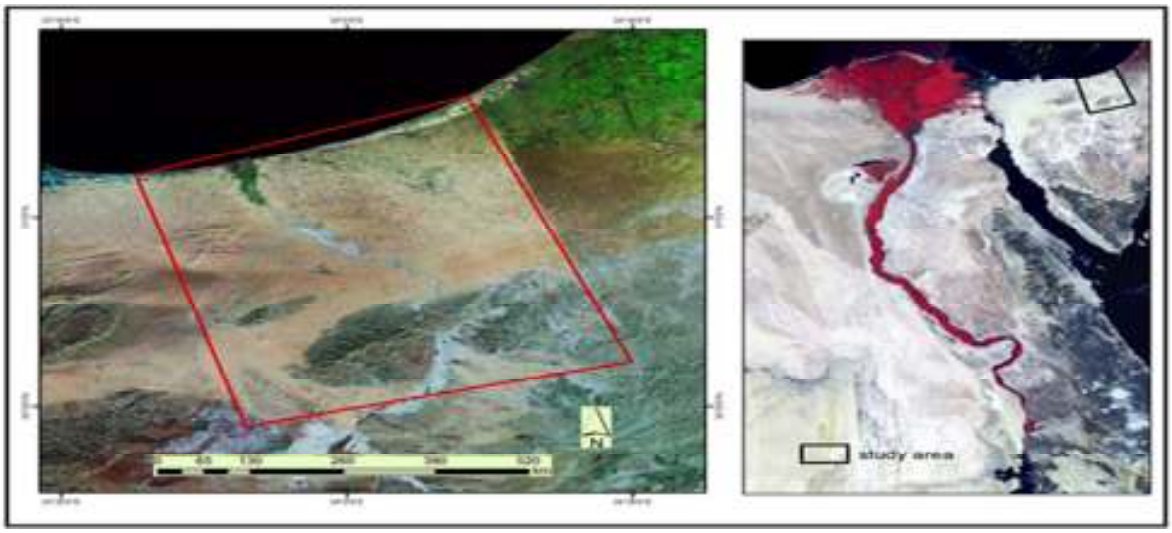


**Fig.1. Location of the studied area.**

The main identified land forms in the North Eastern part of Sinai Peninsula are foot slope, old coastal plain, younger coastal plain, wadis, salt marsh modern short line and mountainous region (Ibrahim, 1993).

According to the Interntanional Congress on Irrigation and Drainage (1996), the ground water in the North Easter side of Sinai Peninsula is topped from two aquifers. The shallow aquifer is the alluvial deposits of quaternary and the deep aquifer occurs within Early Cretaceous sandstone formation as well as limestone and chalk of Eocene and late Cretaceous ages. The salinity varies between saline, very saline and brackish. Water of the deep aquifers, occurs under artesian condition and has a relatively low salinity, which is suitable.

Water Research Center (1994) pointed out that, in North Sinai, most of the rainfall occurs in the winter season. The annual rainfall average increase on the North Coast East wards is 100 mm on El-Arish and 300 mm on Rafah.

Aeolian plain thus-has played a great role in this region, forming dunes which parallel to the North westerly wind, this dunes have the ability to absorb rain water, thus the low land between the dunes are permanent source of water that can be topped by digging shallow wells (Abu Al-Izz, 2000).

The Nile water flows to North Sinai through El-Salam canal crossing one of underground tubs under the bottom of Suez Canal. It is situated south of Port Said.Carrying water eastwards to El-Shiekh Gaber irrigation canal to irrigate the area of north Sinai (a total area of about 400000 feddans). This canal receives the water from Damietta Nile branch, the water is mixed with drainage water from El-Serw and Bahr Hadous drains.This process resulting in water of expected salinity as 1000 $mg^{-1}$ (International Congress on Irrigation and Drainage, 1996).

The current work of this study is to identify the physiographic units in the North Eastern part of Sinai Peninsula using remote sensing techniques and evaluation the soil resources for a sustainable agricultural development and its suitability for specific crops at the North Sinai Governorate.

## MATERIALS AND METHODS

**Remote sensing and GIS works:**

Landsat 8 satellite images (path 175, Row 39) covering the studied area were acquired on 2013. The images were geometrically corrected and rectification method (image for map) was followed. The geometric model used in the rectification process was second order polynomial and the resampling method is the nearest neighbor method, SRTAM Digital Elevation model (DEM) was acquired on 2017 and used as the source data for elevation heights of the study area (Fig. 1). Morphological map was produced using digital image processing of landsat and DEM using ENVI 5.1 software (III, 2014). The image was stretched, smoothly filtered, and its histograms were matched for its rectification and restoration according to Lillesand and Kiefer (2007). GIS works were preformed to produce base, physiographic capability and suitability maps of the studied area using ArcGIS 10.2 software (ESRI, 2014).

**Field work:**

A reconnaissance survey was made in the studied area to obtain the broad soil and landscape characteristics.

Sixteen soil profiles were selected to represent the major physiographic units in the North eastern part of Sinai Peninsula. Seventy five minipits were dug for checking the boundaries between mapping units.

A Garmin 12 x L GPS Garmin Co. (1997) was used to locate the profile locations, using the UTM northing-easting coordinate systems. These profiles were dug down to 150 cm, unless hindered by bedrock or watertable.

Morphological description of the soil profiles were recorded on the basis outlined by USDA (2017), Table (1). Forty five soil samples were collected, air dried, crushed, sieved and used for physical and chemical analyses.

**Laboratory Analysis:**

**A- Physical Analysis:**

Soil color in both wet and dry conditions was determined using Munsell soil color charts (2010). Particle size distribution was determined according to Klute (1986) using hexa-methaphosphate a dispersing agent.

**B- Chemical Analysis:**

The following analysis were carried out using the Soil survey laboratory Methods Manuall USDA., (2004): Calcium Carbonate, Gypsum, Organic matter, Electrical conductivity ($EC_e$), Soil reaction (pH) in soil paste, Cation Exchange Capacity (CEC) and Exchangeable Sodium Percentage (ESP) were determined.

**Soil Classification and Land Evaluation:**

According to the morphological, physical and chemical properties, the soils under study were classified to the subgroup levels according to Soil Taxonomy System (USDA,2014).

Soil limitations as well as land suitability evaluation for irrigated agriculture were obtained by using the Parametric Systems undertaken by Sys *et al.*(1991). The main soil parameters used in this system are climate, soil depth, texture, gravel percent, calcium carbonate percentage , gypsum percentage, salinity ($EC_e$), alkalinity (ESP), slope pattern and drainage conditions. Land suitability classification for specific crops was

done according to Sys *et al* (1991) and Sys *et al* (1993) by matching the land characteristics with crop requirements.

## RESULTS AND DISCUSSION

Physiographic unit is defined as the study and description of physical earth surface features or landscapes including the causes and processes responsible for their formation and evolution. It is of particular importance when using satellite data (Sleen, 1984).

Interpretation of satellite image and DEM is used to identify the physiographic features of the study area .The results revealed that the major landscape in the studied area is coastal plain, sand sheets, alluvial plain, upper terraces, lower terraces, wadi bottom, stabilized sand dunes, pediplain, sabkha and dissected hills. The physiographic map of the investigated area is shown in Fig. (2) and Table (1).

A brief note about the identified physiographic units, which occupied the studied area, was carried out as follows:

**1- Soils of Coastal Plain**

This physiographic unit covered about 24882 feddans representing 2.3% of the total area and it is extended from west to east and represented by profiles 1 and 2. Topography of this unit is undulating with deep soil profiles. Soil dry color varied from yellow (10YR 8/8) to brownish yellow (10YR 6/6), while moist color ranged between very pale brown (10YR 8/3) and light gray (10YR 7/2). Texture class of this unit is sand throughout the entire profiles depths with single grain structure. Soil consistence coincides well with soil texture being non sticky and non plastic (Table 2).

**Table 1. Legend of the physiographic units of the studied area.**

| Landscape | Origin | Relief | Landform | Mapping unit | Area (feddans) | % |
|---|---|---|---|---|---|---|
| Plain | Alluvial deposits | Flat to almost flat | Alluvial plain | AP | 254245 | 22 |
| | Aeolian deposits | Flat to almost flat | Sand sheets plain | SS | 75998 | 7 |
| | | Undulating | Coastal plain | CP | 24882 | 2 |
| | | Undulating to very gently sloping | Stabilized dunes plain | SD | 225902 | 20 |
| | Fluvio-lacustrine deposits | Almost flat to undulating | Sabkha | SA | 2281 | 0.2 |
| | Limestone mixed with sand | Flat to gently undulating | Pediplain | PP | 141051 | 12 |
| Wadi | Alluvial deposits | Flat to almost flat | Lower terraces | LT | 19050 | 2 |
| | | Flat to almost flat | Upper terraces | UT | 51016 | 4 |
| | | Almost flat | Wadi bottom | WB | 102683 | 9 |
| | | Flat | Cultivated area | CA | 13201 | 0.8 |
| Rock land | Limestone mixed with sandstone | Moderately steep to steep | Dissected hills | DH | 240842 | 21.0 |
| Total | | | | | 1151149 | 100 |

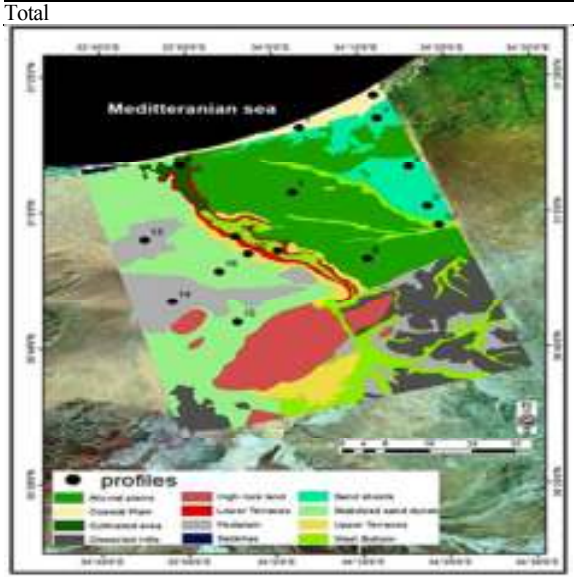


**Fig .2. physiographic map of the studied area**

Considering the analytical data in Table (3) indicate that pH values varied from 8.2 to 8.7 indicating that these soils are moderately alkaline to strongly alkaline. Soils are generally very slightly saline to slightly saline where $EC_e$ values varied from 2.35 to 4.6 $dsm^{-1}$. Organic matter is very low not exceeds 0.9%. CEC values ranged between 3.15 and 7.88 Cmole $kg^{-1}$, while ESP values varied from 2.61 to 8.35% (non-sodic soils). $CaCO_3$ contents ranged from 2.25 to 4.4% with an irregular distribution pattern with soil profiles depths while gypsum content is very low and varied from 0.15 to 0.39%.

**2- Soils of Sand Sheets**

It is located in the eastern side of the studied area and extends east of the Egyptian-Palestinian border, exhibit area of about 75998 feddans representing by 7% of the total area and represented by profiles 3, 4 and 5. The morphological properties of this physiographic unit as show in Table (2) showed that topography of this landscape is flat to almost flat with deep soil profiles and the surface is covered with sand sheets. Soil dry color varies from yellow (10YR 8/8) to brownish yellow (10YR

6/6), while moist color ranged from very pale brown (10YR 8/3) to light gray (10YR 7/3).

The soils have a coarse texture classes ranged from sand to loamy sand soil. Structure is undeveloped hence the identified structure classes are single grain to massive . Soil consistence is non sticky and non plastic, (table 2).

Table (3) reveals that reaction values (pH) indicate that these soils are moderately to strongly alkaline as pH values varied between 8.3 and 8.81. $EC_e$ values ranged from 0.65 to 6.65 $dSm^{-1}$ indicating that the soils are non-saline to slightly saline. Organic matter content is extremely low not exceeds 0.08%. CEC values ranged from 2.5 to 5.85 Cmole $kg^{-1}$ and ESP varied from 2.88 to 14.67%. Calcium carbonate content varied from 3.4 to 14.35%, while gypsum content is very low and varied from 0.12 to 0.75%.

**3- Soils of Alluvial Plain**

This physiographic unit is found in the eastern side of the studied area between Wadi El-Arish and sand sheets unit, covering an area of about 254245 feddans representing 22% of total area and representing by profiles 6, 7 and 8. Soil dry color varied from yellow (10YR 7/6) to brownish yellow (10YR 6/6) ,while in moist color ranged from brownish yellow (10YR 6/8) to pale brown (10YR 6/3). Soil texture raised from sand to sandy loam . Soil structure is single grain in the upper most surface layers changed into massive structure in the deepest layers.

**Table 2. Main morphological feature of the studied profiles**.

| Physiographic Unit | Prof. No. | Depth (cm) | color | | Gravels % | Texture | Structure | Consistence | | | Effervescence | Lower boundary | Others |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dry | Moist | | | | Dry | moist | Wet. | | | |
| Coastal plain | 1 | 0-20 | 10YR8/8 | 10YR8/3 | 2 | S | s.g | Lo | Lo | ns, np | + | CS | - |
| | | 20-75 | 10YR7/6 | 10YR7/3 | 1 | S | s.g | Lo | Lo | ns, np | + | CS | - |
| | | 75-150 | 10YR7/6 | 10YR7/3 | 2 | S | s.g | Lo | Lo | ns, np | + | - | - |
| | 2 | 0-35 | 10YR8/8 | 10YR8/2 | - | S | s.g | Lo | Lo | ns, np | + | CS | |
| | | 35-85 | 10YR7/6 | 10YR7/4 | - | S | s.g | Lo | Lo | ns, np | + | CS | - |
| | | 85-150 | 10YR6/6 | 10YR7/2 | - | S | s.g | Lo | Lo | ns, np | + | - | - |
| Sand sheets | 3 | 0-35 | 10YR7/6 | 10YR7/3 | - | S | s.g | Lo | Lo | ns, np | + | CS | - |
| | | 35-70 | 10YR7/6 | 10YR7/3 | - | S | m | So | Fri | ns, np | + | CS | - |
| | | 70-150 | 10YR6/6 | 10YR7/3 | - | S | m | So | Fri | ns, np | + | - | - |
| | 4 | 0-30 | 10YR7/6 | 10YR7/3 | 2 | S | s.g | Lo | Lo | ns, np | + | CS | - |
| | | 30-90 | 10YR6/8 | 10YR7/3 | - | S | m | So | Fri | ns, np | ++ | ds | F.s.lime |
| | | 90-150 | 10YR7/8 | 10YR7/3 | 2 | S | m | So | Fri | ns, np | +++ | - | m.s. lime |
| | 5 | 0-40 | 10YR8/8 | 10YR8/3 | 3 | LS | s.g | Lo | Lo | ns, np | + | CS | - |
| | | 40-80 | 10YR8/8 | 10YR8/3 | - | LS | s.g | Lo | Lo | ns, np | + | ds | - |
| | | 80-150 | 10YR8/8 | 10YR8/3 | - | S | m | So | Lo | ns, np | +++ | - | m.s. lime |
| Alluvial Plain | 6 | 0-35 | 10YR7/6 | 10YR6/6 | 4 | S | s.g | So | Lo | ns, np | + | CS | - |
| | | 35-80 | 10YR7/6 | 10YR6/6 | - | LS | m | So | Fri | ns, np | + | ds | - |
| | | 80-150 | 10YR7/6 | 10YR6/6 | - | LS | m | SH | Fri | ns, np | + | - | - |
| | 7 | 0-40 | 10YR7/6 | 10YR6/8 | 2 | LS | s.g | So | Lo | ns, np | + | CS | - |
| | | 40-75 | 10YR7/6 | 10YR6/8 | - | SL | m | So | Fri | ss, sp | + | CS | - |
| | | 75-150 | 10YR7/6 | 10YR6/8 | - | LS | m | SH | Fri | ns, np | + | - | - |
| | 8 | 0-30 | 10YR6/6 | 10YR6/3 | - | S | m | So | Lo | ns, np | ++ | CS | F.s. lime |
| | | 30-80 | 10YR6/6 | 10YR6/6 | - | S | m | SH | Lo | ns, np | ++ | ds | F.s. lime |
| | | 80-140 | 10YR6/6 | 10YR6/6 | - | S | m | SH | Lo | ns, np | + | - | - |

**Table 2. Cont.**

| Physiographic Unit | | Prof. No. | Depth (cm) | color | | Gravels % | Texture | Structure | Consistence | | | Effervescence | Lower boundary | Others |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Dry | Moist | | | | Dry | moist | Wet. | | | |
| Wadis | Upper Terraces | 9 | 0-30 | 7.5YR7/8 | 7.5YR7/3 | 20 | GSCL | m | So | VFri | S, P | ++++ | ds | m.s. lime |
| | | | 30-90 | 7.5YR7/8 | 7.5YR7/3 | 40 | VGCL | m | So | VFri | S, P | ++++ | CS | m.s. lime |
| | | | 90-150 | 7.5YR7/8 | 7.5YR7/3 | 45 | VGSCL | m | SH | VFri | S, P | ++++ | - | m.s. lime |
| | Lower Terraces | 10 | 0-40 | 7.5YR6/6 | 7.5YR6/3 | 20 | GSCL | m | So | Fri | S, P | ++++ | CS | m.s. lime |
| | | | 40-80 | 7.5YR6/6 | 7.5YR6/3 | 30 | GSCL | m | So | Fri | S, P | ++++ | CS | m.s. lime |
| | | | 80-150 | 7.5YR6/6 | 7.5YR6/3 | 15 | GCL | m | SH | Fri | S, P | ++++ | - | m.s. lime |
| | Wadi Bottom | 11 | 0-30 | 7.5YR6/6 | 7.5YR6/3 | 10 | SGSL | m | So | Fri | S, P | ++++ | CS | m.s. lime |
| | | | 30-75 | 7.5YR6/6 | 7.5YR6/3 | 20 | GLS | m | SH | Fri | Ss, Sp | ++++ | Cw | m.s. lime |
| | | | 75-120 | 7.5YR6/6 | 7.5YR6/3 | 35 | GSCL | m | SH | Fri | ms, mp | ++++ | CS | m.s. lime |
| | | | 120-150 | 7.5YR6/6 | 7.5YR6/3 | 15 | SGSL | m | VH | Fri | ms, mp | ++++ | - | m.s. lime |
| | | 12 | 0-40 | 7.5YR7/4 | 7.5YR7/3 | 3 | S | s.g | Lo | Lo | ns, np | + | ds | |
| | | | 40-90 | 7.5YR7/4 | 7.5YR7/1 | - | S | m | So | Lo | ns, np | +++ | ds | m.s. lime |
| | | | 90-150 | 7.5YR7/4 | 7.5YR7/1 | - | S | m | SH | Lo | ns, np | ++ | - | F.s. lime |
| Pedi Plain | | 13 | 0-20 | 7.5YR8/6 | 7.5YR7/3 | 20 | GS | m | So | Fri | ns, np | ++++ | CS | m.s. lime |
| | | | 20-50 | 7.5YR8/6 | 7.5YR7/3 | 25 | GS | m | SH | Fri | ns, np | ++++ | - | m.s. lime |
| | | 14 | 0-35 | 7.5YR8/6 | 7.5YR7/3 | 15 | GS | m | So | Fri | ns, np | ++++ | CS | m.s. lime |
| | | | 35-55 | 7.5YR8/6 | 7.5YR7/3 | 25 | GS | m | SH | Fri | ns, np | ++++ | - | m.s. lime |
| Sand dunes | | 15 | 0-40 | 7.5YR8/6 | 7.5YR 7/4 | - | S | s.g | Lo | Lo | ns, np | + | ds | - |
| | | | 40-120 | 7.5YR8/6 | 7.5YR 7/4 | - | S | s.g | Lo | Lo | ns, np | + | - | - |
| | | 16 | 0-35 | 7.5YR8/6 | 7.5YR 7/4 | - | S | s.g | Lo | Lo | ns, np | + | ds | - |
| | | | 35-100 | 7.5YR8/6 | 7.5YR 7/4 | - | S | s.g | Lo | Lo | ns, np | + | - | - |

**Texture: Ssand,LS=loamy sand ,SL=sandy loam ,SCL=s\ndy clay loam, SC=sandy clay, Clay, CL=clay loam Structure: sg=single grain, m=Masive**

**Soil consistency: Dry :Lo=loose, So=soft, SH=slightly hard, VH=very hard Moist:LO=loose,Fri=friable,VFir=very friable Wet:ns=Non-sticky, np=non plastic S =sticky, p=plastic, ss:slightly sticky, sp:slightly plstic, MS=moderately sticky Effervescence :+=slightly, ++moderate, +++=strong, ++++= very strong Boundary: CS=clear smooth,ds=diffuse smooth, Cw=clear wavy**

**Others: m.s=many soft F.s=few soft**

**Table 3. Some physical and chemical analysis of the studied soil profiles.**

| Physiographic unit | Prof. No. | Depth (cm) | Particle size distribution (%) | | | | Texture class | pH | $EC_e$ $dSm^{-1}$ | OM (%) | CEC Cmol $kg^{-1}$ | ESP (%) | $CaCO_3$ (%) | Gypsum (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Coarse sand | Fine sand | Silt | Clay | | | | | | | | |
| Coastal plain | 1 | 0-20 | 16.58 | 75.82 | 2.76 | 4.84 | S | 8.20 | 2.35 | 0.02 | 4.75 | 6.11 | 2.25 | 0.25 |
| | | 20-75 | 20.21 | 71.31 | 3.11 | 5.73 | S | 8.60 | 2.60 | 0.90 | 7.88 | 2.92 | 3.70 | 0.35 |
| | | 75-150 | 15.25 | 76.61 | 3.19 | 4.95 | S | 8.70 | 4.55 | 0.05 | 5.75 | 8.35 | 4.40 | 0.35 |
| | 2 | 0-35 | 50.28 | 39.87 | 4.24 | 5.61 | S | 8.50 | 3.75 | 0.06 | 3.15 | 3.92 | 4.20 | 0.20 |
| | | 35-85 | 52.57 | 39.83 | 3.62 | 3.98 | S | 8.20 | 4.60 | 0.01 | 4.60 | 2.61 | 2.25 | 0.15 |
| | | 85-150 | 60.90 | 31.09 | 3.23 | 3.78 | S | 8.30 | 4.35 | 0.01 | 3.65 | 3.29 | 3.60 | 0.20 |
| Sand sheets | 3 | 0-35 | 50.60 | 42.92 | 2.61 | 3.87 | S | 8.50 | 6.65 | 0.07 | 4.62 | 3.48 | 5.20 | 0.25 |
| | | 35-70 | 40.90 | 53.05 | 3.73 | 2.32 | S | 8.72 | 1.20 | 0.08 | 3.50 | 3.23 | 4.20 | 0.19 |
| | | 70-150 | 38.98 | 53.46 | 4.27 | 3.29 | S | 8.81 | 1.55 | 0.02 | 3.35 | 3.46 | 3.40 | 0.12 |
| | 4 | 0-30 | 39.28 | 51.61 | 5.23 | 3.88 | S | 8.50 | 0.70 | 0.01 | 2.50 | 4.89 | 4.52 | 0.22 |
| | | 30-90 | 30.73 | 59.02 | 3.05 | 7.20 | S | 8.60 | 0.65 | 0.05 | 4.75 | 4.16 | 10.50 | 0.16 |
| | | 90-150 | 35.23 | 54.95 | 3.32 | 8.50 | S | 8.40 | 0.65 | 0.01 | 4.20 | 14.67 | 12.35 | 0.12 |
| | 5 | 0-40 | 20.01 | 68.78 | 3.56 | 7.65 | LS | 8.30 | 5.02 | 0.05 | 5.50 | 2.88 | 5.90 | 0.75 |
| | | 40-80 | 36.60 | 52.13 | 3.88 | 7.39 | LS | 8.50 | 4.35 | 0.08 | 5.85 | 11.21 | 3.50 | 0.51 |
| | | 80-150 | 40.59 | 52.07 | 2.86 | 4.48 | S | 8.60 | 4.55 | 0.01 | 4.40 | 4.44 | 14.35 | 0.35 |
| Aluvial plain | 6 | 0-35 | 47.92 | 43.04 | 4.24 | 4.80 | S | 8.60 | 0.65 | 0.01 | 5.50 | 10.73 | 4.55 | 0.16 |
| | | 35-80 | 64.65 | 23.21 | 5.31 | 6.83 | LS | 8.50 | 0.72 | 0.05 | 5.74 | 6.27 | 5.21 | 0.22 |
| | | 80-150 | 69.89 | 18.89 | 5.24 | 6.68 | LS | 8.90 | 0.81 | 0.01 | 9.50 | 4.20 | 4.12 | 0.20 |
| | 7 | 0-40 | 35.11 | 51.58 | 3.95 | 9.36 | LS | 8.60 | 0.82 | 0.05 | 6.20 | 2.35 | 7.30 | 0.23 |
| | | 40-75 | 47.90 | 33.14 | 5.38 | 13.58 | SL | 8.52 | 0.50 | 0.05 | 8.40 | 1.28 | 7.10 | 0.20 |
| | | 75-150 | 37.18 | 50.07 | 2.71 | 10.04 | LS | 8.51 | 0.75 | 0.05 | 4.50 | 2.14 | 7.50 | 0.20 |
| | 8 | 0-30 | 40.37 | 50.98 | 2.90 | 5.75 | S | 8.80 | 0.55 | 0.20 | 8.74 | 2.52 | 8.21 | 0.20 |
| | | 30-80 | 29.50 | 60.35 | 2.45 | 7.70 | S | 8.60 | 1.25 | 0.10 | 9.85 | 2.14 | 10.73 | 0.30 |
| | | 80-140 | 37.89 | 54.40 | 1.14 | 6.57 | S | 8.70 | 0.95 | 0.01 | 9.75 | 2.46 | 6.31 | 0.20 |

**Table 3. Cont.**

| Physiographic unit | Prof. No. | Depth (cm) | Particle size distribution (%) | | | | Texture class | pH | $EC_e$ $dSm^{-1}$ | OM (%) | CEC Cmol $kg^{-1}$ | ESP (%) | $CaCO_3$ (%) | Gypsum (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Coarse sand | Fine sand | Silt | Clay | | | | | | | | |
| Upper Terraces | 9 | 0-30 | 6.60 | 50.50 | 20.40 | 22.50 | GSCL | 7.50 | 73.00 | 0.02 | 14.88 | 27.20 | 41.30 | 0.20 |
| | | 30-90 | 4.60 | 37.90 | 30.70 | 26.80 | VGCL | 7.40 | 83.00 | 0.01 | 16.30 | 56.44 | 42.70 | 0.10 |
| | | 90-150 | 10.20 | 49.70 | 12.60 | 27.50 | VGSCL | 7.60 | 60.00 | 0.01 | 16.50 | 62.21 | 42.50 | 1.20 |
| Lower Terraces | 10 | 0-40 | 40.20 | 8.80 | 20.40 | 30.60 | GSCL | 8.30 | 1.10 | 0.06 | 17.42 | 60.82 | 51.60 | 0.50 |
| | | 40-80 | 28.20 | 8.30 | 30.30 | 33.20 | GSCL | 8.50 | 0.90 | 0.04 | 18.65 | 57.51 | 45.70 | 0.20 |
| | | 80-150 | 31.10 | 15.60 | 25.20 | 38.10 | GCL | 7.90 | 0.60 | 0.06 | 20.87 | 32.79 | 45.50 | 0.10 |
| Wadi bottom | 11 | 0-30 | 15.10 | 44.70 | 20.90 | 19.30 | SGSL | 8.00 | 0.90 | 0.08 | 12.25 | 9.39 | 42.40 | 0.80 |
| | | 30-75 | 30.40 | 52.30 | 8.70 | 8.60 | GLS | 8.10 | 0.50 | 0.05 | 7.45 | 5.51 | 36.70 | 0.80 |
| | | 75-120 | 33.10 | 37.00 | 12.40 | 17.50 | GSCL | 8.10 | 0.70 | 0.05 | 7.22 | 6.23 | 35.90 | 0.50 |
| | | 120-150 | 19.40 | 30.60 | 43.90 | 6.10 | SGSL | 8.30 | 0.70 | 0.02 | 4.53 | 8.55 | 40.50 | 0.30 |
| | 12 | 0-40 | 25.44 | 64.21 | 4.17 | 6.18 | S | 8.70 | 0.75 | 0.19 | 5.52 | 1.14 | 9.21 | 0.18 |
| | | 40-90 | 15.33 | 72.86 | 3.86 | 7.95 | S | 8.50 | 0.65 | 0.10 | 8.01 | 2.50 | 13.33 | 0.17 |
| | | 90-150 | 45.24 | 46.48 | 3.42 | 4.86 | S | 8.90 | 0.97 | 0.09 | 7.65 | 4.97 | 10.73 | 0.19 |
| Pedi plain | 13 | 0-20 | 5.50 | 91.50 | 1.40 | 1.60 | G.S | 7.72 | 32.50 | 0.02 | 4.21 | 11.56 | 72.50 | 0.11 |
| | | 20-50 | 93.50 | 3.38 | 2.11 | 1.00 | G.S | 7.81 | 41.46 | 0.12 | 3.45 | 8.17 | 49.30 | 0.12 |
| | 14 | 0-30 | 90.70 | 6.45 | 2.30 | 0.55 | G.S | 8.10 | 33.33 | 0.01 | 2.85 | 3.51 | 77.60 | 0.15 |
| | | 30-55 | 90.10 | 5.53 | 2.92 | 2.13 | G.S | 8.30 | 52.62 | 0.22 | 2.76 | 7.25 | 55.90 | 0.12 |
| Sand dunes | 15 | 0-40 | 83.37 | 6.50 | 3.03 | 7.10 | S | 7.93 | 0.40 | 0.08 | 4.25 | 3.27 | 5.38 | 0.18 |
| | | 40-120 | 78.41 | 13.03 | 5.37 | 3.19 | S | 8.47 | 0.30 | 0.03 | 2.95 | 5.12 | 6.90 | 0.13 |
| | 16 | 0-35 | 80.60 | 12.00 | 4.63 | 2.63 | S | 8.00 | 1.50 | 0.04 | 2.65 | 4.57 | 6.65 | 0.14 |
| | | 35-100 | 78.50 | 15.32 | 3.18 | 3.00 | S | 8.12 | 1.05 | 0.01 | 3.84 | 5.21 | 5.85 | 0.09 |

**Gravel: SG:slightly gravels(5-15%) G:Gavelly(15-35%) VG:very gravelly( >35%)**

Soil consistence coincides well with soil texture being non sticky to slightly sticky, non plastic to slightly plastic, moreover , the top layer is soft with a tendency of increasing compaction to slightly hard with depth.

Table (3) reveals that pH values eranged from 8.5 to 8.9 showing that these soils are strongly alkaline. Soils are non-saline where $EC_e$ values not exceed 1.25 $dSm^{-1}$. Organic matter content is extremely low not exceeds 0.20%. The Cation Exchange Capacity (CEC) ranged from 4.5 to 9.85 Cmole $kg^{-1}$, while ESP values less than 15% indicating that these soils are non-sodic . $CaCO_3$ varied from 4.12 to 10.21% with an irregular distribution pattern with depth. Gypsum content is extremely low not exceeds 0.30%.

**4- Soils of Upper Terraces**

This physiographic unit is represented by profile No.9 and covered about 51016 feddan representing 4% of the total area. The morphological description reveals that the soil depth more than 150 cm in the representative profile .

The most layers color hue of these soils is 7.5 YR and soil color value is 7 in dry and moist, while chroma is

8 and 3 in both dry and moist respectively.Soil texture class ranged from very gravelly clay loam to gravelly sandy clay loam and massive structure. Soil consistence is sticky and plastic, Table (2).

Data of chemical properties of the studied soils are shown in Table (3). pH values ranged from 7.4 to 7.6 (slightly alkaline) while $EC_e$ values varied from 60.6 to 83.0 $dSm^{-1}$ indicating that the soils of upper terraces are strongly saline. Organic matter content is generally very low not exceeds 0.02%. CEC values show a narrow range (14.88 to 16.50 Cmole $kg^{-1}$ depending on clay and silt contents). ESP values varied from 27.2 to 62.2% (Sodic soils). Calcium carbonate content was very high ranged from 41.3 to 42.7% and their contents are enough to the requirements of calcic horizon, while gypsum content is mainly less than 1.2%.

**5- Soils of Lower Terraces**

This unit is covering an area of about 19050 feddans (1.7% of the studied area) and representing by profile 10. The soils of this unit are deep (150 cm depth). Soils dry and moist color were reddish yellow (7.5 YR 6/6) and light brown (7.5 YR 6/3), respectively.

Soil texture class was gravelly sandy clay loam in the top layer and gravelly clay loam in the deepest layers with massive structure, where soil consistence was sticky and plastic, Table (2).

Data in Table (3) revealed that these soils were moderately to strongly alkaline where pH values varied from 7.9 to 8.5. The soils were non-saline where $EC_e$ values not exceeds 1.1 $dSm^{-1}$, while organic matter contents were very low and ranged in narrow limit from 0.04 to 0.06%. CEC values varied from 17.42 to 20.87 Cmole $kg^{-1}$. The low values of CEC was linked with the medium texture, while the higher value was connected with fine textures. The soils of lower terrace were Sodic soils where the values of ESP were more than 15%. Calcium carbonate contents were very high where $CaCO_3$ content ranged from 45.5 to 51.6% and their content is enough to the requirements of calcic horizon. Gypsum content was extremely low not exceeds 0.5%.

**6- Soils of Wadi Bottom**

It is located in Wadi El-Arish and Wadi El-Hareidin. It covered about 102683 feddans representing 9% of total area and represented by profiles 11 and 12. The soils of these physiographic units have deep soil profile (>150 cm) with almost flat topography. Soil dry color varies from reddish yellow (7.5 YR 6/6) to pink (7.5 YR 7/4), while moist color ranges between light brown (7.5 YR 6/3) and light gray (7.5 YR 7/1). Soil texture class varied from gravelly loamy sand to gravelly sand clay loam. Soil structure is massive throughout the entire profiles depths. Soil consistence ranged from non sticky to sticky and non plastic to plastic.

Table (3) showed that pH values ranged from 8.0 to 8.9 indicating that these soils are moderately to strongly alkaline. Soil salinity values indicate that these soils are non-saline as $EC_e$ values less than 0.97 $dSm^{-1}$. Organic matter content is extremely low not exceeds 0.19%. CEC values ranged between 4.53 and 12.25 Cmole $kg^{-1}$. Most soils in Wadi bottom were non-sodic soils where the values of ESP were lower than 15%. Calcium carbonate content ranged from 9.21 to 42.4% and their content is enough to the requirements of calcic horizon (profile 11); gypsum content was very low and ranged from 0.30 to 0.50%.

**7- Soils of Pediplain**

It is located in the Western side of the studied area and exhibit an area of about 141051 feddans representing by 12% of the total area and represented by profiles 13 and 14. The morphological description reveals that the soil depth is less than 60 cm in the studied soil profiles (moderately deep), the soil dry color was reddish yellow (7.5 YR 8/6), while moist color was pink (7.5YR 7/3). Soil texture class was gravelly sand throughout the entire profile depths with massive structure. Soil consistence was non sticky and non plastic, (Table 2).

Table (3), reveals that soil pH values indicate that these soils were slightly to moderately alkaline as pH values varied from 7.72 to 8.30. $EC_e$

values ranged from 32.5 to 52.62 $dSm^{-1}$ indicating that these soils were strongly saline. Organic matter and gypsum contents were extremely low and varied from 0.01 to 0.22% and 0.11 to 0.15%, respectively. CEC values were extremely low and varied from 2.76 to 4.21 Cmole $kg^{-1}$, values of ESP varied between 3.51 and 11.56% indicating that these soils were non-sodic soils. $CaCO_3$ content ranged between 49.3 to 77.6% the soil of pediplain were enriched with expanding salts and $CaCO_3$ enrichments that satisfy the requirements of salic and calcic horizons as well as Aridsols.

**8- Solis of sand dunes**

This physiographic unit is located between the pediment plain and Wadi El-Arish covering an area of 225902 feddans representing 20% of the total area and representing by profiles 15 and 16. Topography of this physiographic unit is undulating to very gently sloping. Table (2) showed that soil dry and moist color were reddish yellow (7.5YR 8/6) and pink (7.5YR 7/4), respectively. Soil texture class was sand throughout the entire profiles depths with single grain structure. Soil consistence coincides well with soil texture; it was non-sticky and non-plastic.

Table (3) reveals that pH values ranged from moderately to strongly alkaline as reveled by pH values which ranged from 7.93 to 8.47. The electrical conductivity ($EC_e$) ranged from 0.3 to 1.5 $dSm^{-1}$ indicating that these soils were non-saline. Organic matter content was very low not exceeds 0.080.

The cation exchange capacity (CEC) was very low and ranged from 2.65 to 4.25 Cmole $kg^{-1}$ and ESP varied from 3.27 to 5.21 (non-sodic soils. Calcium carbonate content was very low and ranged from 5.38 to 6.9%, while gypsum content was extremely low not exceeds 0.18%.

**Soil Classification**

Based on the morphological features, soil physical and chemical properties, soil temperature and moisture regime and based USDA (2014); the studied soils could be classified as, Aquic Quartzipsamments, Typic Quarzipsamments, Typic Torripsamments, Typic Torrifluvents, Calcic Haplosalids and Typic Haplocalids and Sodic Haplocalcids .The investigated soil profiles can be grouped as shown in Table (4).

**Land Suitability for Irrigated Agriculture:**

**1- Current Suitability:**

The current suitability of the studied soils was estimated by matching between the present soil properties and their ratings using the parametric system outlines by Sys and Verheye (1978) and Sys *et al*. (1991) as shown in Table (5) and Fig. (3).

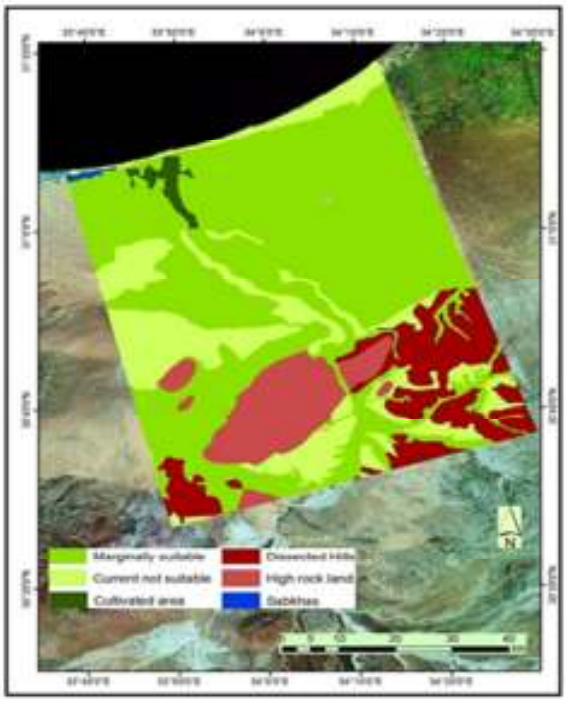


**Fig .3. Current suitability for irrigated agriculture.**

Suitability indices and their classes of the studied soils reveal two suitable classes, i.e., marginally suitable (S3) and non suitable (N), besides six subclasses, i.e., S3s, S3s, N1tws, N1sn, N1tsn and N1wsn were recognized in the investigated area. The soils of these subclasses suffering from some soil characteristics as soil limitations, i.e., topography (t), wetness (w), soil physical properties (texture , soil profile depth, lime and gypsum) and salinity and alkalinity (n), with different intensity degrees, i.e., <90 (slight), <90-60 (moderate), <60-40 (severe) and <40 (very severe). The subclasses of these soils have a limitation in agriculture widely due to unfavorable soil conditions for better cropping and utilization.

The obtained values of suitability indices show that the soils of sand sheets (profiles 3, 4 and 5), soils of alluvial plain (profiles 6, 7 and 8), lower terraces (profile 10) and wadi bottom (profile 11 and 12) could be evaluated as marginally suitable (S3), with moderately intensity of wetness (w), gypsum (S4), Lime $CaCO_3$ (S3) and (salinity & alkalinity (n) and severe intensity of texture (S2) classes.

On the other hand, the soils of Sand dunes (profiles 15 and 16) are evaluated as marginally suitable (S3), the soils of these profiles have moderately intensity of topography (t) and gypsum (S4) and severe intensity of soil texture (S2).

With regard to the soils of Coastal plain (profiles l and 2), soils of Upper terraces (profile 9) and soils of Pediplain (profiles 12 and 13), the values of current suitability varied from 3.65 to 20.41 indicating that these soils were not suitable, the representative soils have moderate intensity of topography, soil depth, texture classes and lime contents and moderate to severe of salinity alkalinity limitations.

**Table 4. Soil taxonomy and physiographic units of the studied area.**

| Order | Suborder | Great group | Sub great group | Profile No. | Physiographic unit |
|---|---|---|---|---|---|
| Entisols | Psamments | Quartzipsamments | Aquic Quartzipsamments | 1 and 2 | Coastal plain |
| | | | Typic Quartzipsamments | 3, 8, 15 and 16 | Sand sheets Aluvial plain Sand dunes |
| | | Torripsamments | Typic Torripsamments | 4,5 6 and 12 | *Sand* sheet Aluvial plain Wadi bottom |
| | Fluvents | Torrifluvents | Typic TorriFluvents | 7 | Alluvial plain |
| Aridisols | Salids | Haplosalids | Calcic Haplosalids | 9 13 and 14 | Upper terraces Pediplain |
| | Calcids | Haplocalcids | Typic Hplocalcids | 11 | Wadi bottom |
| | | | Sodic Haplocalcids | 10 | Lower terraces |

**Table 5. Land suitability classes for the studied soils profiles.**

| Profile No | Physiographic unit | Topography (t) | | Wetness (w) | | Soil physical characteristics (s) | | | | | Salinity /alkalinity(n) | | Current Suitability | | Potential suitability | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CS | PS | CS | PS | Depth S1 | Texture S2 CS | Texture S2 PS | Lime S3 | Gypsum S4 | CS | PS | Ci | Class | CI | Class |
| 1 | Coastal plain | 80 | 100 | 50 | 80 | 100 | 50 | 70 | 100 | 90 | 100 | 100 | 18 | N1tws | 50.4 | S2ws |
| 2 | Sand Sheet | 80 | 100 | 50 | 80 | 100 | 50 | 70 | 100 | 90 | 98 | 100 | 17.64 | N1tws | 50.4 | S2ws |
| 3 | Sand sheet | 100 | 100 | 90 | 100 | 100 | 50 | 70 | 100 | 90 | 98 | 100 | 39.69 | S3s | 63 | S2s |
| 4 | | 100 | 100 | 90 | 100 | 100 | 50 | 70 | 100 | 90 | 100 | 100 | 40.5 | S3s | 63 | S2s |
| 5 | | 100 | 100 | 90 | 100 | 100 | 50 | 70 | 100 | 90 | 98 | 100 | 39.69 | S3s | 63 | S2s |
| 6 | Alluvial plain | 100 | 100 | 90 | 100 | 100 | 50 | 70 | 100 | 90 | 96 | 100 | 38.88 | S3s | 63 | S2s |
| 7 | | 100 | 100 | 90 | 100 | 100 | 60 | 80 | 100 | 90 | 100 | 100 | 48.6 | S3s | 72 | S2s |
| 8 | | 100 | 100 | 90 | 100 | 100 | 50 | 70 | 90 | 90 | 100 | 100 | 36.45 | S3s | 56.7 | S2s |
| 9 | Upper terrace | 90 | 100 | 90 | 100 | 100 | 70 | 80 | 80 | 100 | 45 | 80 | 20.41 | N1sn | 51.2 | S2sn |
| 10 | Lower terrace | 100 | 100 | 90 | 100 | 100 | 90 | 100 | 80 | 90 | 85 | 100 | 49.57 | S3s | 72 | S2s |
| 11 | Wadi bottom | 100 | 100 | 90 | 100 | 100 | 65 | 80 | 80 | 90 | 85 | 100 | 35.8 | S3s | 57.6 | S2s |
| 12 | | 100 | 100 | 90 | 100 | 100 | 50 | 70 | 90 | 90 | 100 | 100 | 36.45 | S3s | 56.7 | S2s |
| 13 | Pedi plain | 75 | 100 | 50 | 80 | 60 | 50 | 70 | 80 | 90 | 45 | 80 | 3.65 | N1wsn | 19.35 | N2 |
| 14 | | 75 | 100 | 85 | 100 | 85 | 50 | 70 | 80 | 90 | 80 | 100 | 15.61 | N1tsn | 42.84 | S3s |
| 15 | Sand dunes | 75 | 100 | 100 | 100 | 100 | 50 | 70 | 100 | 90 | 100 | 100 | 33.75 | S3ts | 63 | S2s |
| 16 | | 75 | 100 | 100 | 100 | 95 | 50 | 70 | 100 | 90 | 100 | 100 | 32.06 | S3ts | 59.85 | S2s |

**CS: Current suitable PS: Potential suitable Ci: Capability index**

**2- Potential Land Suitability:**

Regarding suitability of the studies soils, data show that the soils are affected mainly by some soil limitation such as drainage conditions, soil depth, texture, soil fertility as well as salinity and alkalinity. Land improvement is required to correct or to reduce the severity of limitation existing in the studies area, such as:

i) Improving the internal and external drainage by preparing system of beds and furrows for cultivation.
ii) Leaching of soil salinity to get rid of soluble salts outside of the area.
iii) Continuous application of organic manure to improve soil physical-chemical properties and fertility status.
iiii) Application of modern irrigation system, i.e., drip and sprinkler to save a pronounced amount of irrigation water.

The rating of soil potential suitability ranged from 19.35 to 72. Potential soil suitability becomes as follows (Table 5 and Fig. 4).

1- Moderately suitable soil (S2); the rating of this class varied from 50.4 to 72 and represented by profiles 1 and 2 (Coastal plain) , profiles 3,4 and 5 (Sand sheets); profile 6,7 and 8 (Alluvial plain), profiles 9 (Upper terraces), profile 10 (Lower terraces), profile 11 and 12 (Wadi bottom ) and profiles 15 and 16 (Sand dunes ).
2- Marginally suitable soils (S3); the rating of this class is 42.84 and representing by soils of Pediplain (profile 14).
3- Not suitable soils (N2): the rating of this class is 19.35 and represented by soils of pediplain (profiles 13).

**Land Suitability for Specific Crops:**

By using the parametric approach of land index as mentioned by Sys *et al*. (1991) and (1993), the obtained data through matching soils properties together with crop requirements (table 6) led to the current and potential suitability indices for each of the studied crops (Table 6).

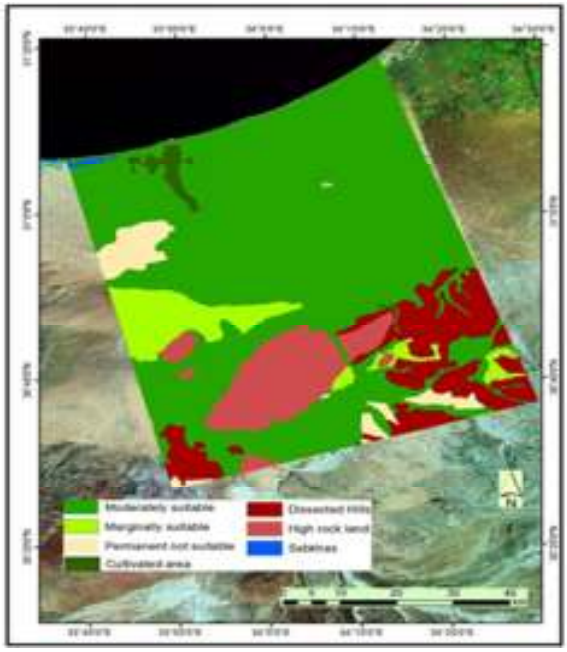


**Fig.4. Potential suitability for irrigated agriculture.**

**Current Suitability:**

Not suitable (N) for all the studied crops, except some physiographic units (Coastal plain, Sand dunes , Alluvial plain, and Sand dunes) for watermelon, green pepper olives and mango.

**Potential Suitability:**

**1- Soils of Coastal Plain:**

Moderately suitable (S2) for alfalfa, barley, wheat, sunflower, potato, watermelon, green pepper, guava and olives.

Marginally suitable (S3) for tomato, citrus and mango.

**Table 6.Suitability classes of the studied soils for specific crops.**

| Certain | Coastal plain | | Sand sheets | | Alluvial plain | | Upper terraces | | Lower terraces | | Wadi bottom | | Pediplain | | sand dunes | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crops | CS | PS | CS | PS | CS | PS | CS | PS | CS | PS | CS | PS | CS | PS | CS | PS |
| Field crops | | | | | | | | | | | | | | | | |
| Alfalfa | S3 | S2 | N1 | S2 | N1 | S2 | N2 | N2 | N2 | N2 | N1 | S3 | N2 | N2 | S3 | S2 |
| Barley | N1 | S2 | N1 | S2 | N1 | S2 | N2 | N2 | N2 | S3 | N1 | S3 | N2 | N2 | N1 | S2 |
| Wheat | N1 | S2 | N1 | S2 | N1 | S2 | N2 | N2 | N1 | S3 | N1 | S3 | N2 | N2 | N1 | S2 |
| Sun flower | N1 | S2 | N1 | S2 | N1 | S2 | N2 | N2 | N2 | N2 | N1 | S2 | N2 | N2 | N1 | S2 |
| Vegetables | | | | | | | | | | | | | | | | |
| Tomato | N1 | S3 | N1 | S3 | N1 | S3 | N2 | N2 | N2 | N2 | N1 | S3 | N2 | N2 | N1 | S2 |
| Potato | N1 | S2 | N1 | S2 | N1 | S2 | N2 | N2 | N2 | N2 | N1 | S3 | N2 | N2 | S3 | S3 |
| Water melon | S3 | S2 | S3 | S2 | S3 | S2 | N1 | S3 | S3 | S2 | S3 | S2 | N2 | N2 | S3 | S2 |
| Green pepper | S3 | S2 | S3 | S2 | S3 | S2 | N2 | N2 | N2 | N2 | N1 | S3 | N2 | N2 | S3 | S2 |
| Fruits | | | | | | | | | | | | | | | | |
| Citrus | N1 | S3 | S3 | S2 | S3 | S2 | N2 | N2 | N2 | N2 | N1 | S3 | N2 | N2 | S3 | S3 |
| Guava | N1 | S2 | N1 | S2 | S3 | S2 | N1 | S3 | N1 | S2 | S3 | S2 | N1 | S3 | S3 | S2 |
| Olives | S3 | S2 | S3 | S2 | S3 | S2 | N1 | S3 | S3 | S2 | S3 | S2 | N1 | S3 | S3 | S2 |
| Mango | S3 | S3 | S3 | S2 | S3 | S2 | N2 | N2 | N2 | N2 | N1 | S3 | N2 | N2 | S3 | S2 |

**S1: Ci is more than 75; S2: Ci is between 50land 75 S3: Ci is between 25 and 50**
**N: not suitable for irrigation (Ci is less than 25) N1: with limitations which can be corrected**
**N2: with limitations which cannot be corrected**
**CS: current suitability PS: potential suitability**

**2- Soils of Sand Sheets and Alluvial Plain:**

Moderately suitable (S2) for alfalfa, barley, wheat, sunflower, potato, watermelon, green pepper, citrus, guava, olives and mango.

Marginally suitable (S3) for tomato.

**3- Soils of Upper Terraces:**

Marginally suitable (S3) for watermelon, guava and olives.

Not suitable (N2) for alfalfa, barley, wheat, sunflower, tomato, potato, green pepper, citrus and mango.

**4- Soils of Lower Terraces:**

Moderately suitable (S2) for watermelon, guava and olives

Marginally suitable (S3) for barley and wheat; not suitable (N2) for alfalfa, sunflower, tomatoes, potato, green pepper, citrus and mango.

**5- Soils of Wadi Bottom:**

Moderately suitable (S2) for sunflower, watermelon, guava and olives.

Marginally suitable (S3) for alfalfa, barley, wheat, tomato, potato, green pepper, citrus and mango.

**6- Soils of Pediment:**

Marginally suitable (S3) for guava and olives ,not suitable (N2) for alfalfa. Barely, wheat, sunflower, tomato, potato, watermelon, green pepper, citrus and mango.

**7- Soils Sand Dunes:**

Moderately suitable (S2) for alfalfa, barley, wheat, sunflower tomato, watermelon, green pepper, guava, olives and mango, marginally suitable (S3) for potato and citrus.

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# تحديد وتصنيف وتقييم الوحدات الفيزيوجرافية في بعض المناطق الواعدة في مجال التنمية الزراعية في الجزء الشمالي الشرقي بشبه جزيرة سيناء – مصر


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هناك جهود تبذلها الحكومة المصرية وعلى نطاق واسع متزايد وسريعة بهدف ادخال مساحات جديدة من الأراضي الصحراوية في مشاريع التنمية الزراعية خلال العقود الحديثة وتعتبر المنطقة الواقعة في الجزء الشمالي الشرقي من شبه جزيرة سيناء من المناطق الواعد في مجال التنمية الزراعية والتي تشتمل على بعض المظاهر الفيزيوجرافية المختلفة في الشمال الشرقي لسيناء. وتهدف هذه الدراسة إلى تحديد هذه الوحدات الفيزيوجرافية من خلال تحليل صور الأقمار الصناعية وتحديد وتقييم المعوقات المرتبطة بتحسين صفات هذه الأراضي الصحراوية تحت الظروف البيئية السائدة في شبه جزيرة سيناء. وتشير نتائج تحليل صور الأقمار الصناعية إلى أن الوحدات الفيزيوجرافية السائدة في منطقة الدراسة هي : ١- السهل الساحلي (Cp) ( Coastal plain) ٢- الفرشات الرملية (SS) Sand sheets ٣- السهل الرسوبي (AP) Alluvial plain ٤- المصاطب المرتفعة Upper terraces (UT) ٥- المصاطب المنخفضه terraces (LT) Lower ٦- قاع الوادي (WB) Wadi bottom ٧- الكثبان الرملية (SD) Sand dunes ٨- السهل التحاتي (اقدام الجبال ) (PP) Pediplain ٩- السبخات (SA) Sabkha ١٠- التلال المتقطعة العالية (DH) Dissected hills ومن الوصف المورفولوجي ونتائج التحليلات الطبيعية والكيميائية للتربة تم تصنيف اراضي منطقة الدراسة طبقاً لنظام التصنيف الامريكي عام ٢٠١٤ حتى مستوى تحت المجموعات الكبرى وقد اتضح ان اراضي منطقة الدراسة تقع تحت رتبتي الأراضي الجافة (Aridisols) والأراضي الحديثة Entisols وتحت المجموعات الكبرى التالية: 1- Calcic Haplosalids 2- Typic Haplocalcic 3- Sodic Haplocalcic 4- Aquic Quartzipsamments 5- Typic Quartzipsamments 6- Typic Torripsamments 7- Typic Torrifluvents وطبقاً لنظام تقييم الأراضي المتبع بواسطة Sys and Verheye (1978),Sys *et al* (1991) تم تقييم أراضي الوحدات الفيزيوجرافية بغرض تحديد ملائمتها للزراعات المروية بصورتها الحالية والمستقبلية (الكامنة) بعد معالجة محددات التربة بها وتشير ادلة الملائمة الحالية لهذه الأراضي إلى انتمائها الى رتبتين هما الاراضي هامشية الصالحة (S3) والغير صالحة (N) بصورتها الحالية بجانب ستة تحت رتبة للأراضي تحت الدراسة وهي (S3s, S3t, N1tws, N1sn, N1tsn and N1wsn) والتي تعاني من بعض معوقات التربة وهي القوام الخشن وعمق قطاع التربة الفعال ومستوى الماء الارضي، الطبوغرافية والملوحة والقلوية كمحددات للتربة وبدرجات شدة مختلفة ( من متوسطة إلى شديدة). ويرفع القدرة الانتاجية لهذه الأراضي عن طريق عمليات التحسين للتربة تصبح درجات الصلاحية الكامنة (المستقبلية) لهذه الأراضي هي متوسطة الصلاحية (S2) وهامشية الصلاحية (S3) وغير صالحة دائما (N2) بجانب خمسة تحت رتبة هي S2s, S2ws, S2sn, S3s and N2 ، كما تم تقييم اراضي الوحدات الفيزيوجرافية من حيث ملائمتها لزراعة المحاصيل المختلفة وذلك لتحديد درجة الصلاحية لكل محصول في كل وحده فيزيوجرافية سواء بالنسبة إلى صفات التربة الحالية أو بعد اصلاحها وتحسينها حيث قدمت هذه الموائمات بين هذه المحاصيل المختارة واراضي الوحدات الفيزيوجرافية تحت الدراسة في صورة جداول لتكون دليلا للاستخدام الامثل لاراضي منطقة الدراسة.