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PHYSIOGRAPHIC MAPS EXTRACTION USED MODERN TECHNIQUES TOWARDS SOIL MAPPING AND LAND CAPABILITY ASSESSMENT OF WADI ARABA, EASTERN DESERT, EGYPT.

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ABSTRACT

The study area is allocated between longitudes 31° 58′ 1.9″ and 32° 44′ 42.3″ easting and latitudes 28° 47′ 32.7″ and 29° 00′ 4.9″ northing, at the eastern desert of Egypt. The study area covers about 1079070 feddans include Mountains, part of suez gulf and wadi Araba. Their acreages are 513995, 135032, and 430043 feddans respectively. The actually study area represent wadi Araba covers about 430043 feddans. Seven physiographic units were distinguished in the study area .i.e. Marine sediments, Coastal braided deltas, Wadis, Piedmont, Alluvial terraces, Alluvial fans, and Bajadas. These units area are 8480, 21455, 111042, 5890, 234515, 38381, and 10280 feddan respectively. For studying the soil of the investigated area, 17 profiles were excavated to represent the soil of the different physiographic units. The profiles were dugged to 150 cm depth impervious layer or water table whichever is shallower. The soils were morphologically examined, sampled for lab investigation and classified. The distinguished subgroups are: Typic Aquisalids, Typic Haplocalcids, Typic Torrifluvents, Typic Torriorthents, Aquic Torrifluvents, Calcic Haplocalcids, Gypsic Haplocalcids and Lithic Torriorthents. The capability index (Ci) for irrigated agriculture was collected representing to the current land capability map of the study area comprises of seven units i.e. S3sn-1 (with limitations of severe salinity and alkalinity, moderate for texture and calcium carbonate, and slight for topography and gypsum.), S3sn-2 (with limitations of moderate for texture, salinity and alkalinity, and slight for topography, calcium carbonate and gypsum), N1tsn-1 (with limitations of sever for texture, salinity and alkalinity, moderate for topography and calcium carbonate and slight for gypsum), N1tsn-2 (with limitations of sever for texture, moderate for topography, depth, calcium carbonate, salinity and alkalinity, and slight for gypsum), N1tsn-3 (with limitations of very sever for salinity and alkalinity, sever for depth, moderate for topography and texture, slight for calcium carbonate and gypsum), N1sn (with limitations of severe for texture, moderate for salinity and alkalinity, slight for topography, calcium carbonate and gypsum.), N1wsn (with limitations of very severe for wetness, severe for texture, depth, salinity and alkalinity, slight for topography, calcium carbonate and gypsum). Their acreages are 21455, 111042, 38381, 10280, 5890, 234515 and 8480 feddan respectively The potential land capability map of the study area comprises of five units i.e S2s (with limitations of moderately for texture, slight intensity of calcium carbonate and gypsum),. S3s-1 (with limitations of moderate for texture, calcium carbonate and slight intensity of gypsum s), S3s-2, (with limitations of sever texture, moderate intensity of calcium carbonate, and slight intensity of gypsum), S3s-3 (with limitations of sever intensity of depth, moderate intensity of texture and slight intensity of calcium carbonate gypsum limitations).and N1ws (with limitations of sever intensity of wetness, moderate intensity of texture and depth and slight intensity of calcium carbonate and gypsum limitations). Their acreages are 111042, 21455, 283176, 5890 and 8480feddan respectively. Generally, the soil mapping units are grouped primarily on the basis of their capability to produce common cultivated crops and pasture plants without deterioration over a long period of time.

The aims of the current investigation are on screen interpretation and delineation of the physiographic units, soil mapping, and (current and potential) land capability assessment of the study area.

Keywords: Landsat-8 remote sensing data, Geographic Information System, physiographic units, soil classification, and Land Capability Classificatio, wadi Araba, Egypt.

INTRODUCTION

Undoubtedly, the horizontal expansion in the cultivated area is one of the major aims of the agricultural policy of Egypt to increase the cultivated lands in order to face the serious over-population problem. The identification of the land resources of Egypt for the agricultural development justifies the importance of producing a collective physiographic-soil map of Egypt for building up database of land information system. The Eastern Desert covers an area of about 223,000 km². It is bordered by the Nile Valley on the West and by the Suez Canal, the Gulf of Suez and the Red Sea on the East. The backbone of this desert is a series of mountain chains (Red Sea Mountains), running parallel to the Red Sea and separated from it by a narrow coastal plain (*DRC, 2005*). The study area represents promising area for dry Wadi Araba is located in west Suez Gulf. The exposed rock units in the area under investigation are represented by various lithologic associations ranging in age from Late Paleozoic to Quaternary (*El-Aassy, 1981*) and (*EGSMA, 1987*); 1) Rod El-Hamal Formation is of upper Carboniferous age (*Abdallah, and El-Adindani, 1963*) and (*Awad and Abdallah, 1966*). It is essentially constituted of argillaceous and arenaceous beds with some limestone-rich horizons; 2) Malha Formation is possibly equivalent to a part of what is called the Nubian sandstone and shales. It represents the Early Cretaceous sediments outcropping in the western part of the Gulf of Suez area (*Abdallah, et al, 1963*). This formation has been subdivided into two members: a lower shale, clay, and sandstone with conglomerate member and an upper tabular and cross-bedded sandstone member; 3) Quaternary Sediments the most considerable part of Wadi Araba area. They are mainly composed of clastic sediments of different textures ranging from silt to boulder. Wadi sediments comprise various particles of gravel, sand, and silt, and are present in the main courses of the wadis.

Remote sensing techniques as well as geographic information systems offer numerous advantages over traditional methods of conducting agricultural, water and soil resources surveys (*Aronoff, 1989*). Satellite data, with aircraft and in conjunction with field observations, can provide valuable information on soil types, potential groundwater resources, mineral resources, and other parameters, which can be used, along with information from other sources through GIS application (*Shrestha, 1989*). One of the advanced facilities is USA Satellite landsat-8 that visual interpretation includes the follow elements as: gray tone, color, pattern, structure, texture, parceling, and linear features. Linear features may be important for delineating infrastructure, while parceling pattern and texture may be useful in delineating areas (*Colwell, 1963*). In pattern analysis, interpretation is carried out by identification of various patterns and delineation of the recognized items in a given area. For analysis of surface-cover type, understanding of spectral reflectance or absorption characteristics of the items is important (*Shrestha, 1989*). Current land capability classes refer to the present use of land, either with existing or improved management practices, or to a different use. The current suitability of the studied area is estimated by the present land characteristics and their ratings outlined by (*Sys, and Debavey, 1991*). Potential land capability classes refers to the suitability of units, for a defined use, in their conditions at some future date, after specified major improvements have been completed where necessary as activities which cause beneficial changes in the qualities of the land itself. The structure of suitability classification (*FAO, 1976*) recognized four categories as follows: order, classes, subclasses and units. They reflect kinds of suitability, degrees of suitability, kinds of limitation and the required management for the first, second, third and fourth respectively. The major land improvement is a substantial and reasonably permanent improvement in the qualities of the land affecting a given use. A large non-recurrent input is required, usually taking the form of capital expenditure on structure and equipment. Examples are large irrigation schemes, drainage of swamps and reclamation of salinized land. The minor land improvement is one which either has relatively small effects or is non-permanent or both, which lies within the capacity of individual farmers or other land users. Stone clearance, eradication of persistent weeds and field drainage.

The main goals of this study are to produce physiographic soil map with correlated attributes to be a base for extra modifiers within the land information system, study of currently and potentially land Capability maps using advanced techniques.

MATERIALS AND METHODS

The study area “Wadi Araba” is located in the northern part of the Egyptian Eastern Desert. This area is bounded northward by jabal al-jalalah al-baharyyah, southward by the jabal al-jalalah al-qiblyyah and eastward by the Gulf of Suez. The study area is allocated between longitudes 31° 58′ 1.9″ and 32° 44′ 42.3″ easting and latitudes 28° 47′ 32.7″ and 29° 00′ 4.9″ northing, at the eastern desert of Egypt (Fig.1).

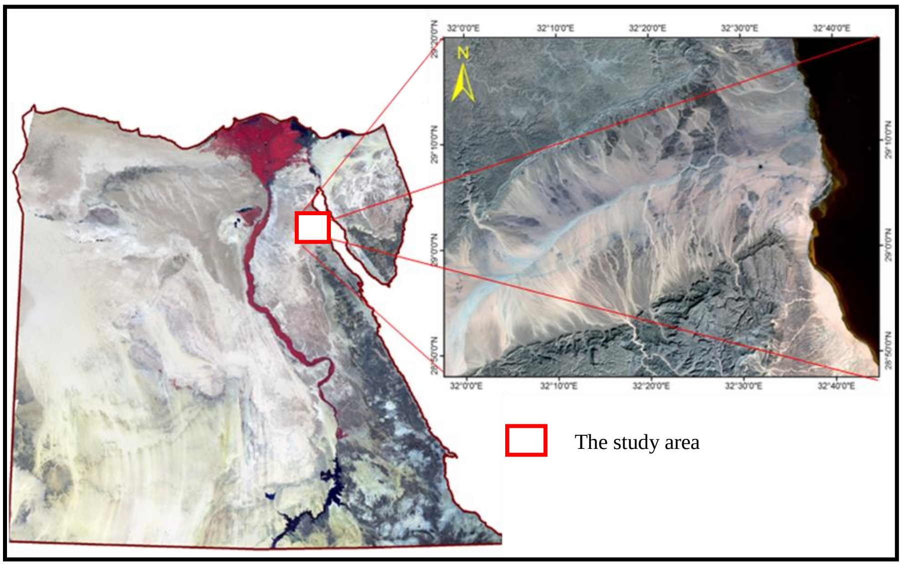

Fig.1. Location map of the study area.

The metrological data (Table, 1) indicate that the mean annual temperature value is 22.4 ºC. Accordingly the temperature regime is hyperthermic (*Soil Survey Staff, 2014*). The rainfall in the study area is scarce. In turn and generally the moisture control section is dry in all parts all over the year. According the moisture regime is torric.

Table1. Main Suez Metrological Station data (1946 to 1996).

Months	Temperature (ºC)			Relative Humidity (%)	Evaporation (mm day^{-1})	Rainfall (mm)	Wind Speed (meter $Second^{-1}$)
	Mean Max.	Mean Min.	Mean				
Jan.	19.2	10.4	14.7	55	7.4	5.0	5.9
Feb.	21.4	11.5	16.0	53	8.2	0.3	6.8
Mar.	23.4	13.2	18.0	46	10.7	2.6	8.4
Apr.	28.1	16.2	22.0	42	13.0	0.6	9.1
May.	31.0	19.3	25.0	44	14.0	2.6	9.4
Jun.	33.7	22.4	27.9	44	15.4	0.0	9.3
July	34.5	23.6	28.9	50	14.5	0.0	10.5
Aug.	34.6	24.1	28.9	54	13.2	0.0	9.4
Sep.	31.8	22.6	27.0	55	12.9	0.0	10.4
Oct.	29.2	19.9	24.2	55	11.8	6.2	8.8
Nov.	24.6	16.5	20.4	56	9.0	1.0	7.4
Dec.	20.3	11.8	15.8	55	7.6	1.3	6.2
Total Annual mean	- 27.6	- 17.6	- 22.4	- 51	- 11.5	19.6 1.4	- 8.5

Exceptionally, the soils of marine sediments, the moisture control section is aquic water table of such unit fluctuated between 40-60cm. The moisture control section in the coarse loamy extends from 20-60cm below the soil surface, and between 30-90 cm if the particle size class is sandy (*Soil Survey Staff, 2014*).

The used data are:

Image data of the enhanced thematic mapper (Landsat-8), their specification are (Path 175, Raw 40, and Path 176, Raw 40) pixel size resolutions (30 and 15m) acquired in 07/02/2015 and 29/01/2015 respectively.

Four topographic maps of 1:100000 scale sheets id are NH 36-F2, NH 36-F3, NH 36-B5, and NH 36-B6 (*Military Survey Authority, 1978*).

Geological map scale (1:500000) sheets number (NH 36 sw Benisuef) (*EGSMA, 1987*).

The hardcopy data were converted to digital format. Then the digital data subjected to the geometric correction image-to-map procedure in ENVI 4.8 software (*ENVI, 2008*). The aforementioned geographic data were stored in one database set. Integrate imagery of different spatial resolutions (pixel size). Since higher resolution imagery is generally single band (panchromatic 15m data), while multispectral imagery generally has the lower resolutions (30m), these techniques are often used to produce a high resolution, multispectral imagery. This improves the interpretability of the data by having high resolution information which is also in color. Resolution merging over three techniques: multiplicative, principal components, and Brovey Transform (*ERDAS, 2008*). The spectral signatures were interpreted for the assessment of l landscape evolution and physiographic unit’s delineation, applying the physiographic approach as proposed by (*Goosen, 1967*), and based on the author’s local reference level. Photo-interpretation was achieved realizing the reflectance of the different physiographic unit's variation, guided by the auxiliary data (Image enhanced thematic mapper (Landsat-8), topographic maps and Geological map. The on screen digitization of physiographic units boundary realized seven physiographic units .i.e. Marine sediments, Coastal braided deltas, Wadis, Piedmont, Alluvial terraces, Alluvial fans, and Bajadas (Fig.2.).

The preliminary physiographic map was refined during the ground truth to precise the boundaries between the physiographic units. Seventeen pedons were located to represent the different physiographic units.

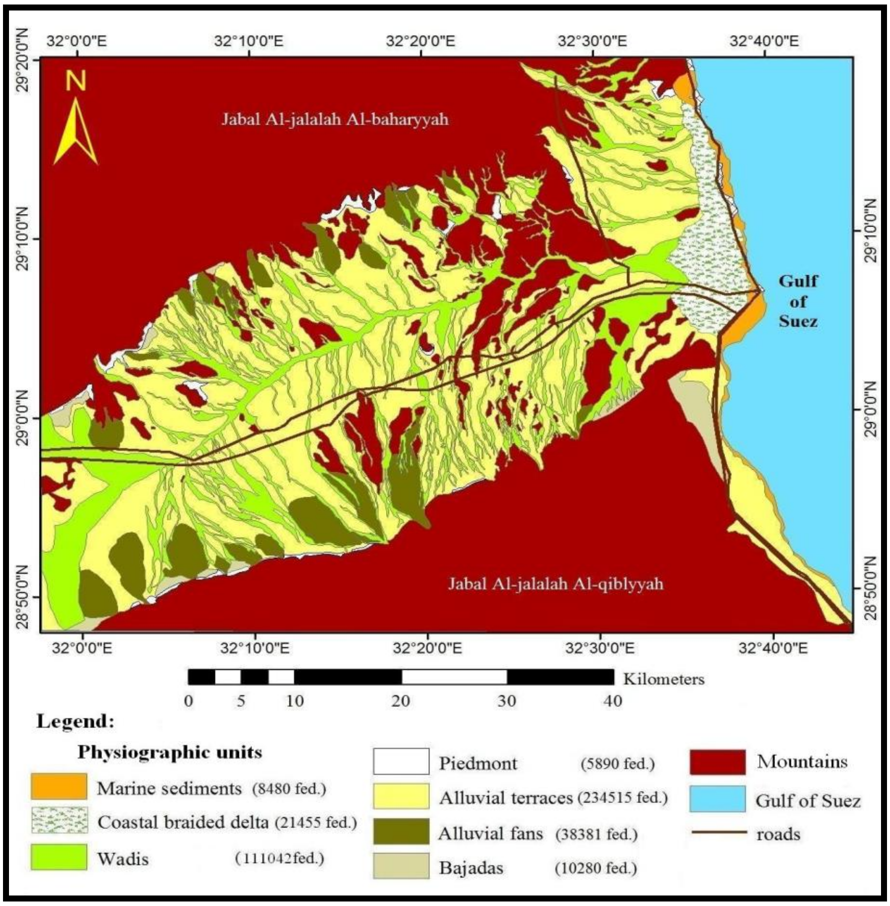

Fig.2. Delineated physiographic units of the study area using Landsat-8 data.

For studying the soils of the investigated area, 17 profiles were allocated (Fig.3) and excavated to represent the soil of the different physiographic units. The profiles were dugged to 150 cm depth or to impervious layer or water table which is shallower. The profiles were morphologically examined, sampled for lab investigation and classified.

Particle size distribution was carried out according to (*Carter, and Gregrich, 2007*). CaCO3 content was estimated by the Collin's Calcimeter (Black, et al, 1965). Soil pH was measured in the saturated soil paste (*Richards, 1954*). Soil salinity (EC) was measured in the soil paste extract using a conductivity meter. Gypsum content was determined by the acetone method (*Bower, and Huss, 1948*). Table, 2.

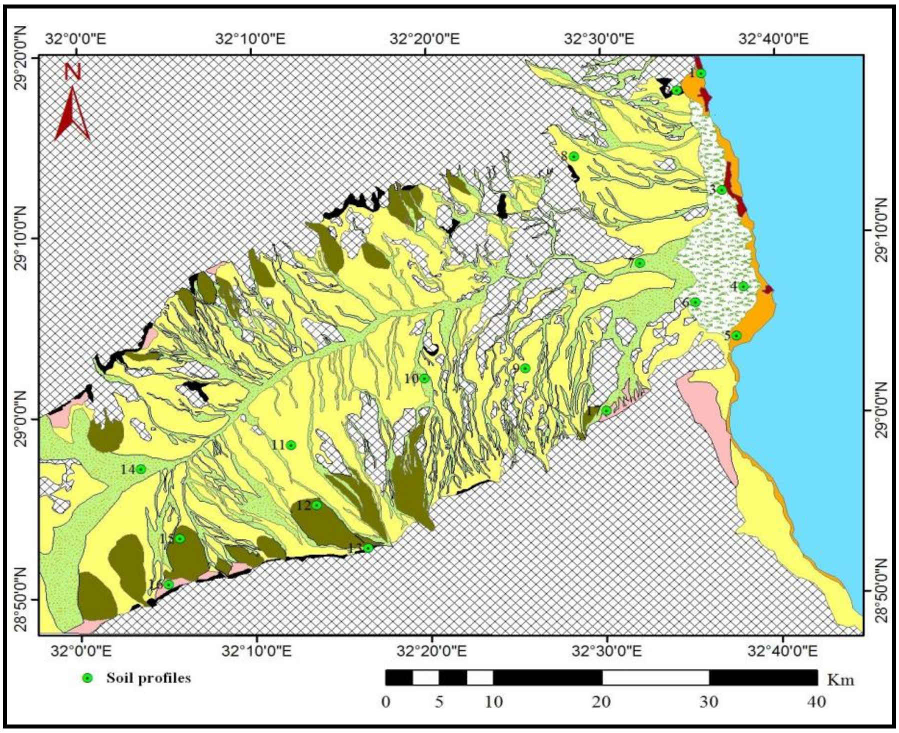

Fig.3. Soil profiles locations in the study area.

RESULTS AND DISCUSSION

The physiographic approach can provide a good basis for explaining geomorphologies through aerospace image interpretation brief description of the distinguished physiographic units are as follows:

1- The marine sediments units cover about 3561.6 ha. (8480 fed.), which represent about 1.97% of the study area. The parent materials are mainly deposited by sea water activity, waves and currents. These sediments occupy a narrow strip of complex pattern along the shoreline of Suez Gulf. This is in agreement with (*FAO/SF, 1964*) and (*Van Dorsser, 1984*). This pattern is dominated by beaches, and covered with overblown sand and scattered natural vegetation of halophytic communities. The surface unit is almost flat. The unit is represented by profiles No. 1 and 5. Soils texture is sandy loam to loamy sand and the colour is very pale brown to light yellowish brown (10YR 8/3 to 6/4, dry) and pale brown to yellowish brown (10YR 6/3 to 5/4, moist). The soils of such unit possesses aquic moisture regime as the water table fluctuated between 40-60 cm blew soil surface. Fine and medium roots are detectable in the surface layer. Fine and medium shells and fragments are detected depth wise. The reaction with

HCl is violence (Table, 2). Calcium carbonates content ranges from 28.6 to 47.1%, gypsum content ranges from 0.57 to 5.2%, EC from 27 to 61.5 (dS m^{-1}), and ESP from 7% to 27%.

Table.2. The main chemical and physical properties of the studied soil profiles.

Physiographic unit	Profile No.	Depth (cm)	Soil past	pH	EC (dS m^{-1}) soil past	ESP %	Gravel %	$CaCO_3$ %	Gypsum %	Clay %	Silt %	Sand %	Modified texture class	Slop %
Marine sediments	1	0-20	27	7.4	61.5	27.0	1	43.2	1.53	10.9	15.3	73.8	SL	1
		20-40	34	7.7	45.8	19.1	1	47.1	0.57	12.5	13.5	74.0	SL	
		+40	Water table											
	5	0-20	26	7.4	40.2	14.2	1	33.5	5.20	6.7	17.1	76.2	LS	1
		20-35	25	7.6	27.0	7.0	1	28.6	2.45	6.4	16.8	76.2	LS	
		35-60	30	7.5	32.3	7.9	1	32.1	2.32	9.7	14.3	76.2	SL	
		+60	Water table											
Coastal braided delta	3	0-20	27	8.0	2.9	20.1	2	27.7	0.32	6.7	17.3	76.0	LS	2
		20-60	29	8.1	79.3	15.0	1	46.0	2.80	6.8	19.2	74.0	SL	
		60-150	29	7.7	80.6	16.2	1	64.8	1.09	9.0	15.9	75.1	SL	
	4	0-25	24	7.6	127.4	1.0	3	42.9	3.20	12.5	20.1	67.4	SL	2
		25-65	26	7.6	5.7	4.1	1	28.0	1.65	16.8	19.6	63.6	SL	
		65-100	25	7.7	7.5	4.6	1	30.7	1.11	10.5	18.9	70.6	SL	
		100-150	25	7.6	7.2	2.0	1	30.2	0.7.0	9.9	22.5	67.6	SL	
	6	0-15	26	7.8	3.8	20.6	2	27.9	0.4.0	6.3	17.1	76.6	LS	2
		15-60	28	8.0	79.3	15.2	1	45.0	3.74	6.3	18.7	75.0	SL	
		60-150	29	7.8	80.6	16.0	1	65.2	1.0	8.0	14.9	77.1	SL	
Wadis	7	0-25	29	8.2	5.9	2.1	31	17.7	2.10	6.0	19.4	74.6	LS	2
		25-40	28	8.1	18.5	1.3	7	30.9	0.35	8.1	13.9	78.0	LS	
		40-85	30	8.0	12.8	1.2	62	27.8	1.11	8.4	17.1	74.5	SL	
		85-150	26	8.3	24.0	5.7	53	22.9	0.85	6.9	16.5	76.6	LS	
	10	0-25	26	7.7	4.6	3.0	13	22.6	1.54	14.1	22.6	63.3	SL	2
		25-70	27	7.7	15.9	4.4	37	23.4	1.52	17.9	23.7	58.4	SL	
		70-100	25	7.6	16.1	0.3	55	18.1	3.29	10.2	15.3	74.5	SL	
		100-150	25	7.6	21.1	1.1	30	31.1	1.53	6.9	17.6	75.5	LS	
	14	0-30	22	7.6	15.9	2.0	18	18.2	0.30	11.4	15.9	72.7	SL	2
		30-50	26	7.3	16.2	6.1	12	21.4	0.65	10.2	13.8	76.0	SL	
		50-90	26	7.5	76.0	5.8	5	40.6	1.28	9.7	16.1	74.2	SL	
		90-100	25	7.6	29.1	10.9	26	22.1	1.06	7.7	14.5	77.8	LS	
		100-150	26	7.6	65.9	9.4	4	39.8	0.30	7.3	18.7	74.0	SL	
Piedmont	2	0-15	26	7.4	43.4	10.1	35	36.6	4.20	10.7	15.1	74.2	SL	3
		15-35	25	7.5	21.2	36.8	65	26.9	1.55	10.5	17.1	72.4	SL	
		35-55	28	7.5	40.9	11.0	71	33.7	3.65	8.0	18.3	73.7	SL	
		+55	Lithic											
	13	0-10	25	7.6	32.6	4.5	33	29.3	0.55	13.5	14.4	72.1	SL	4
		10-50	29	7.3	31.5	5.4	40	38.9	1.47	12.8	16.6	70.6	SL	
		+50	Lithic											

2- The Coastal braided deltas are formed from alluvial material transported by streams which deposited its load at and near the sea as the water velocity slow down and suspended load deposited. The alluvial fans, however are originated near the foot of mountain escarpments, having relatively coarser fractions (*NSSH, 2001*) and (*Chorley, et al, 1985*).

Table .2. Cont.

Physiographic unit	Profile No.	Depth (cm)	Soil past	pH	EC ($dS\ m^{-1}$) soil past	ESP %	Gravel %	$CaCO_3$ %	Gypsum %	Clay %	Silt %	Sand %	Modified texture class	Slop %
Alluvial terraces	8	0-25	24	7.7	19.6	22.4	13	41.6	2.10	14.8	19.5	65.7	SL	3
		25-50	20	7.6	38.3	5.7	48	31.0	0.23	16.2	13.8	70.0	SL	
		50-100	23	7.5	16.5	8.4	55	26.3	0.27	13.7	14.9	71.4	SL	
		100-150	23	7.5	9.2	4.6	18	13.8	1.30	13.2	16.2	70.6	SL	
	9	0-25	24	7.8	13.9	1.0	12	17.7	0.60	9.1	5.7	85.2	LS	3
		25-80	25	7.7	13.6	0.55	35	21.0	2.50	2.1	3.7	94.2	S	
		80-150	29	7.6	3.9	12.1	50	24.2	1.65	2.5	3.4	94.1	S	
	11	0-20	25	7.8	20.8	23.0	12	42.9	2.56	15.1	19.9	65.0	SL	2
		20-45	18	7.7	40.3	5.4	50	33.0	0.27	15.2	12.8	68.0	SL	
		45-95	25	7.6	14.3	8.9	60	23.1	0.30	13.9	15.1	71.0	SL	
		95-150	25	7.5	8.5	5.0	10	13.0	1.69	13.5	16.5	70.0	SL	
Alluvial fan	12	0-20	27	7.5	41.2	9.3	11	45.8	2.60	10.6	13.1	76.3	SL	4
		20-35	24	7.7	68.1	11.0	7	61.5	0.33	8.8	17.1	74.1	SL	
		35-75	23	7.7	77.0	7.5	2	62.5	1.60	10.7	13.5	75.8	SL	
		75-100	29	7.6	30.2	14.1	13	53.5	18.70	8.3	12.5	79.2	SL	
		+100	Lithic											
	15	0-15	26	8.0	6.1	16.0	9	37.0	5.00	4.3	5.9	89.8	S	1
		15-30	28	7.9	100.6	26.1	6	64.0	10.22	9.4	8.3	82.1	LS	
		30-60	24	8.2	16.3	8.7	38	21.6	0.38	5.7	6.5	87.9	S	
		60-90	30	7.8	18.0	8.1	2	30.0	3.31	8.5	11.3	80.2	LS	
		90-150	31	7.6	20.3	6.2	7	33.6	0.23	7.6	11.2	81.2	LS	
Bajada	16	0-20	26	7.6	4.9	16.2	9	23.0	2.10	4.3	5.1	90.6	S	2
		20-55	27	7.4	15.9	10.1	52	26.2	2.35	7.1	9.2	83.7	LS	
		55-75	40	7.5	15.3	16.1	30	32.5	4.00	7.0	8.5	84.5	LS	
		+75	Lithic											
	17	0-25	26	7.6	15.0	13.1	35	33.1	2.80	5.4	15.4	79.2	LS	2
		25-85	32	7.5	8.6	13.2	45	17.0	2.57	7.6	13.8	78.6	LS	
		85-100	27	7.6	9.2	12.8	50	31.0	0.39	7.4	17.6	75.0	SL	
		100-150	24	7.5	72.0	8.4	40	47.4	2.10	8.3	16.7	75.0	SL	

The coastal braided deltas cover about 9011.1 ha. (21455 fed.), which represents 4.99% of the study area. The sediments of the deltas are mainly derived from the dissected horst of the limestone sedimentary rocks, transported by water flow in a meandering stream which has now turned into the dry wadis. It is characterized by almost flat, gently sloping to the east, covered by coarse gravel, stones and locally by hummocks and has gully and sheet erosion. This physiographic unit is represented by the profiles No. 3, 4 and 6. Soil texture is in sandy loam. The colour is very pale brown to light yellowish brown (10YR 8/4 to 6/4, dry) and yellow to yellowish brown (10YR 7/6 to 5/4, moist). Fine and medium roots are detected depth wise. The soils attain violence effervesces. The soil surface is covers by 1 to 3% fine, medium gravel and stone in texture. The soil is sandy loam (Table, 2). Calcium carbonates content ranges from 27.7 to 65.2%, gypsum content ranges from 0.32 to 3.74%, EC from 2.9 to 127.4 (dS m^{-1}), and ESP from 1% to 20.6%.

3- The Wadis and their tributaries are found at the Lowe laying land of the study area. The highlands which are sedimentary limestone rocks comprise the main catchments area for water harvesting. Wadis extend from the highland eastwards to the Gulf of Suez. The wadis are filled with alluvial material developed through weathering the parent rock wadis end with interacting the structured and transported by flood water to the lowlands. The wadis end with interacting coalescence of fans which composes a delta-like pouring to the Gulf of Suez. The surface is almost flat, covers about 46637.6 ha. (111042 fed), with 25.82% of the study area. It is represented by profiles No. 7, 10, and 14. The color is very pale brown to brownish yellow (10YR 8/4 to 6/8 dry), and yellow to yellowish brown (10YR 7/6 to 5/8 moist). Very fine and medium roots are detected in the surface layer, Analysis of the fine earth (Table, 2) reveal that the soil is calcareous sandy loam to loamy sand. Sand fraction ranges from 58.4 to 78%, clay from 6 to 17.9% and silt from 13.8 to 23.7%. Calcium carbonates content ranges from 17.7 to 40.6%, gypsum content ranges between 0.30 to 3.29%, EC values from 4.6 to 65.9 (dS m^{-1}), and ESP from 0.3% to 10.9%.

4- The piedmonts unit covers some 2473.8 ha. (5890 fed.), which represent 1.37% of the study area. The sediments covering such unit were transported and deposited by gravity and water forces (Colluvial alluvial foot slopes), (*NSSH, 2001*). This unit is situated along the mountainous escarpments, has stony surfaces, rolling through gently undulating complex slopes and dissected by narrow channels and gullies. It is identified adjacent and abutting the highlands in the surroundings of the lowlands. This unit is distributed, aligning with the break slopes and faults of the mountainous escarpments. The drainage patterns are dentritic and subdentritic which include ravines and gullies. The unit possesses slope of (3:4%), surface gravel and stony of (33:71%). They were developed as residual parent material over limestone parent rock. This unit is represented by profiles No. 2 and 13.

5- The alluvial terraces unit have the parent material is alluvium, derived from the basement calcareous rocks. The surface is covered by much gravel and stone, possesses gently undulating as a result of gully erosion, (*NSSH, 2001*). Alluvial terraces cover about 98496.3 ha. (234515 fed.), which comprises about 54.35% of the study area. This unit is represented by the profiles No. 8, 9 and 11. Soil texture is sand to sandy loam and the color is very pale brown to yellow (10YR 7/4 to 7/6 dry), and light yellowish brown to brownish yellow (10YR 6/4 to 6/6 moist). No roots were detected. The effervesces is violence with HCl. (Table, 2). The soil is calcareous sand and sandy loam in texture. Calcium carbonates content ranges from 13.0% to 42.9%, gypsum content ranges from 0.23 to 2.56%, EC values from 3.9 to 40.3 (dS m^{-1}), and ESP from 1% to 23%.

6- The alluvial fans units cover some 16120.02 ha. (38381 fed.), and represent about 8.93% of the study area. They are identified in the proximity of the faulted escarpments of the sedimentary rock structure. The sediments are transported and deposited by flush floods that intersect the mountainous fronts, crossing the piedmont at certain area. The topography of the unit is gently undulating and gently sloping towards the west ranged from 1 to 4%. The surface is covered by many stones and gravel mostly dissected by narrow channels and gullies. This is in agreement with (*Meteorological Uthority of Egypt, 1998*) and (*Afify, 1999*). The unit is represented by profiles No. 12 and 15. Soils texture is in general sand to sandy loam and the colour is white to yellowish brown (10YR 8/1 to 5/8, dry) and light gray to dark yellowish brown (10YR 7/1 to 4/6, moist). Owing drought no roots are detected. The reaction with HCl is violence. The soil surface contains 8 to10% fine, medium gravel and stone. The coarse fragments in subsurface from 2 to 38%. (Table, 2). The soil texture is sand to sandy loam. Calcium carbonates content ranges from 21% to 64%, gypsum content ranges between 0.33 to 18.7%, EC from 6.1 to 100.6 (dS m^{-1}), and ESP from 6.2 to 26.1%.

7- The Bajadas cover some 4317.6 ha. (10280 fed.), which represent 2.39% of the study area. The sediments of bajada are formed by lateral coalescence of a series of alluvial fans which are transported by the action of the flush floods, that running through feeder channels, intersecting the mountain front, as pointed by (*NSSH, 2001*), (*Afify, 1999*) and (*Chorley, et al,1985*). Bajada is represented by soil profiles 16 and 17. The surface is nearly level, gently sloping with detritus of 2%. Soils texture is sand to loamy sand and the colour is white to yellowish brown (10YR 8/1 to 5/6, dry) and light gray to dark yellowish brown (10YR 7/1 to 4/6, moist). Owing drought no roots are detected. The reaction with HCl is violence. It is very dry, no roots are detected in any layer, calcareous reacts vigorously with HCl. The content sand fraction (Table, 2) ranges from 75% to 90.6%, clay from 4.3% to 8.3%, and silt from 5.1% to 17.6%. Calcium carbonates content ranges from 23% to 47.4%, while gypsum ranges between 0.39 to 4.7%, EC from 4.9 to 72 (dS m^{-1}), and ESP from 8.4 to 16.2%.

3-

The Mountains (parent rock structures) covers some 513995 fed., which represent 54.4% of the study area. They are consists of a series of mountains almost surrounding the lowland; in northward by jabal al-jalalah al-baharyyah, southward by the jabal al-jalalah al-qiblyyah. The sedimentary origin is limestone. The distribution of these rocks at various elevations over the area is controlled by intense fault system, which gives rise to the main mountain blocks.

Current land capability refers to the suitability for a defined land use at the present condition, without major improvements. The current capability is estimated by rating the current land characteristics as outlined by (*Sys, et al, 1991*).

The Soil Taxonomy of the studied area is listed in Table.3, according to (*Soil Survey Staff. 2014*).

Land capability classification: was carried out and listed in Table.4. The capability index for irrigated agriculture (Ci), was calculated according to the following formula: Ci = t x w/100 x s1/100 x s2/100 x s3/100 x s4/100 x n/100 According to (*Sys, et al, 1991*).

Table.4. Rating of limitations and land capability index of the study area.

Physiographic unit	Profile No	Topography (t)		Wetness (w)		Soil physical characteristics (s)				Salinity & Alkalinity (n)		Corrected capability index		Capability classes		Capability subclasses	
		Cs	Ps	Cs	Ps	Texture (s1)	Depth (s2)	Calcium carbonat (s3)	Gyspum status (s4)	Cs	Ps	Cs	Ps	Cs	Ps	Cs	Ps
Marine sediment	1	90	100	30	75	60	55	90	90	58	90	2.6	11.3	N1	N1	N1 wsn	N1 ws
	5	90	100	50	80	50	75	90	90	75	90	6.4	13.7	N1	N1		
Delta	3	95	100	100	100	60	100	80	90	58	90	35.5	41.1	S3	S3	S3sn-1	S3s-1
	4	90	100	100	100	65	100	80	90	80	95	38.9	43.4	S3	S3		
	6	95	100	100	100	60	100	80	90	58	90	35.5	41.1	S3	S3		
Wadis	7	95	100	100	100	65	100	90	90	90	100	43.7	64.2	S3	S2	S3sn-2	S2s
	10	95	100	100	100	65	100	90	90	90	100	43.7	64.2	S3	S2		
	14	95	100	100	100	65	100	90	90	75	95	40.5	63.3	S3	S2		
Piedmont	2	75	95	100	100	65	100	90	90	30	90	8.3	43.7	N1	S3	N1tsn-3	S3s-3
	13	65	95	100	100	65	55	90	90	80	95	9.4	35.6	N1	S3		
Alluvial terraces	8	90	100	100	100	50	100	80	90	75	90	15.2	38.3	N1	S3	N1sn	S3s-2
	9	90	100	100	100	40	100	90	90	80	90	14.6	36.9	N1	S3		
	11	90	100	100	100	50	100	80	90	75	90	15.2	38.3	N1	S3		
Alluvial fan	12	80	100	100	100	50	100	80	90	75	90	13.5	38.3	N1	S3	N1tsn-1	
	15	90	100	100	100	40	100	80	100	58	90	10.4	36.8	N1	S3		
Bajada	16	75	100	100	100	40	75	90	100	80	95	10.1	35.5	N1	S3	N1tsn-2	
	17	80	100	100	100	50	100	80	90	85	95	15.3	39.1	N1	S3		

CS: Current capability. PS: Potential capability. Soil limitations {t: topography, w: wetness, s: (s1: texture, s2: soil depth, s3: calcium carbonate, s4: gypsum), n: salinity and alkalinity} S2: Moderately suitable (50-75), S3: marginally suitable (25-50), N1: Currently not suitable (<25).

The current investigation distinguishes seven subclasses i.e. S3sn-1 (with limitations of severe salinity and alkalinity, moderate for texture and calcium carbonate, and slight for topography and gypsum.), S3sn-2 (with limitations of Moderate for texture, salinity and alkalinity, and slight for topography, calcium carbonate and gypsum), N1tsn-1 (with limitations of Sever for texture, salinity and alkalinity, moderate for topography and calcium carbonate and slight for gypsum), N1tsn-2 (with limitations of Sever for texture, moderate for topography, depth, calcium carbonate, salinity and alkalinity, and slight for gypsum), N1tsn-3 (with limitations of Very sever for salinity and alkalinity, sever for depth, moderate for topography and texture, slight for calcium carbonate and gypsum), N1sn (with limitations of Severe for texture, moderate for salinity and alkalinity, slight for topography, calcium carbonate and gypsum.), N1wsn (with limitations of Very severe for wetness, severe for texture, depth, salinity and alkalinity, slight for topography, calcium carbonate and gypsum). Their acreages are 21455, 111042, 38381, 10280, 5890, 234515 and 8480 feddan respectively as shown in Table. 4. and Fig. 4.According to (*Sys, et al, 1991*).

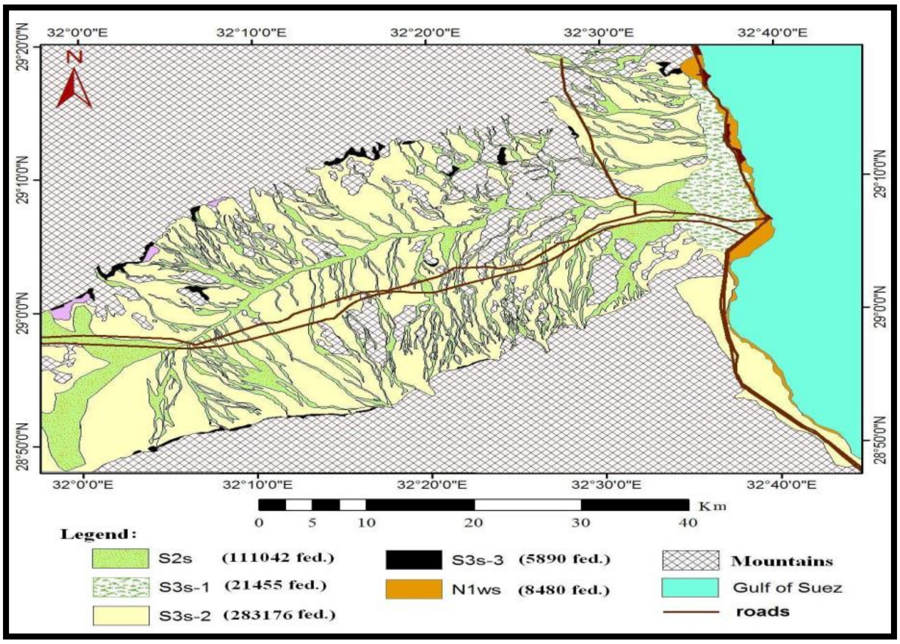

Fig.4. Current land capability map of the study area.

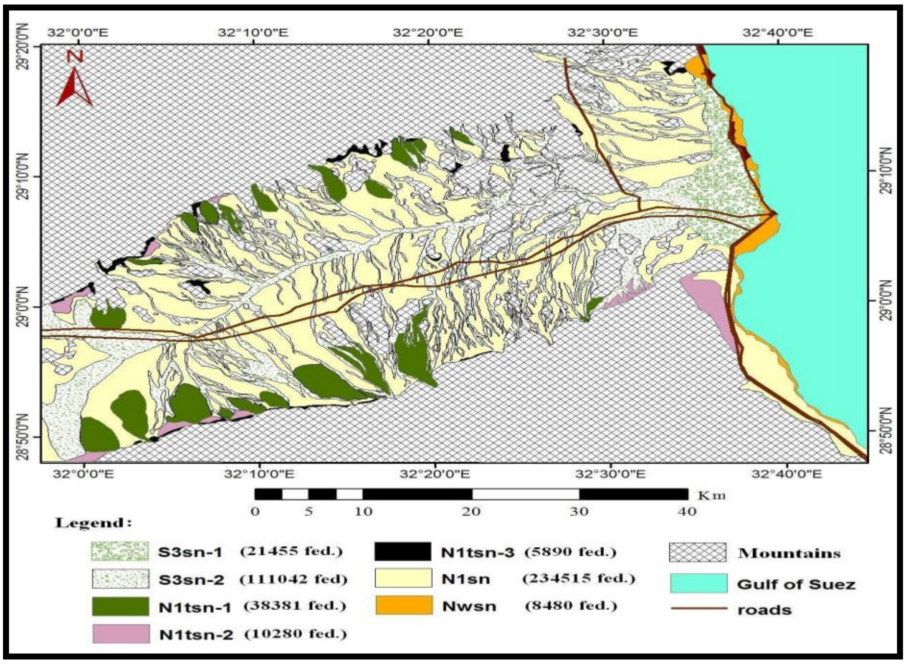

Fig.5. Potential land capability map of the study area.

The potential capability term refers to the suitability of units, for a defined use, in their conditions at some future data, after specified major improvements have been completed where necessary (*FAO, 1976*). The major land improvement is a substantial and reasonably permanent improvement in the qualities of the land affecting a given use such as leaching of saline soils, the use of magnetized water to reduce soil salinity, adding agricultural gypsum $CaSO_4\text{-}2H_2O$ as a source of calcium dissolved soil leads to the elimination of the most harmful sodium ions, which addresses the alkaline soil and get rid of the harmful salts and improve soil texture. The physical properties may also be improved by adding soil amendments. This will improve soil texture and structure which improves all the other physical properties of the soil. The potential land capability map of the study area comprises of five units i.e S2s (with limitations of Moderately for texture, slight intensity of calcium carbonate and gypsum),. S3s-1 (with limitations of Moderate for texture, calcium carbonate and slight intensity of gypsum s), S3s-2, (with limitations of sever texture, moderate intensity of calcium carbonate, and slight intensity of gypsum), S3s-3 (with limitations of Sever intensity of depth, moderate intensity of texture and slight intensity of calcium carbonate gypsum limitations).and N1ws (with limitations of sever intensity of wetness, moderate intensity of texture and depth and slight intensity of calcium carbonate and gypsum limitations). Their acreages are 111042, 21455, 283176, 5890 and 8480feddan respectively as shown in Table.4. And Fig.5.

CONCLUSION AND RECOMMENDATION

The spectral signatures of the physiographic features based on Landsat-8 data (pixel size resolutions (30 and 15m). Integrate imagery of different spatial resolutions (pixel size). Since higher resolution imagery is generally single band (panchromatic 15m data), while multispectral imagery generally has the lower resolutions (30m), these techniques are often used to produce a high resolution, multispectral imagery 15m.

The approach of using the physiographic analysis by the visual interpretation is highly recommended for such study, which leads to a well understanding of landscape genesis and features. This approach also helps for tracing the drainage pattern as mediators between the parent rock in the mountains and the inherited parent materials of the specified soils in the wadi. Produced a physiographic-soil map.

Using physiographic-soil map, this can be used as a base map for land suitability for certain cropping pattern in the future.

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إستخدام التقانات الحديثة فى إستخلاص خريطة الوحدات الفزيوجرافية وتقييم قدرة أراضي وادي عربة - الصحراء الشرقية المصرية

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وحدة الأستشعارعن بعد ونظم المعلومات الجغرافية – معهد بحوث الأراضى و المياة و البيئة – مركز البحوث الزراعية - الجيزة– مصر.

تقع منطقة الدراسة بين خطى طول 31° 58′ 1.9″ ، 32° 44′ 42.3″ شرقاً ، خطى عرض 28° 47′ 32.7″ ، 29° 00′ 4.9″ شمالاً فى الصحراء الشرقية المصرية. ، وكانت البيانات الجغرافية المستخدمة لإنجاز الدراسة (أ) مرئيتين فضائتين للقمر الصناعى الأمريكى لاندسات-8 ذات القدرة التوضيحية 30م ، 15م (للمسار رقم 175 والصف رقم 40) ، (للمسار رقم 176 والصف رقم 40) والملتقطة بتاريخ 2015/02/07 ، 2015/01/29 على الترتيب ، (ب) عدد 4 خرائط مساحية مقياس رسم 1:100000 ، (ج) خريطة جيولوجية مقياس رسم 1:500000. وتهدف الدراسة إلى معالجة بيانات الأقمار الصناعية 1) لإنتاج خريطة الوحدات الفزيوجغرافية لوادى عربة والتى تعتبر كأحد مكونات قاعدة بيانات الأراضى 2) إنتاج خريطة قدرة الأرض للاستخدامات الزراعية الحالية والمستقبلية لوادى عربة الواقع فى الصحراء الشرقية ، وتبلغ مساحة منطقة الدراسة الفعلية 430043 فدان. ولقد تم عمل المسح الضوئى للخرائط الطبوغرافية والخريطة الجيولوجية – ثم تلى ذلك عمل التصحيح الهندسى لجميع البيانات الجغرافية. وبالإستعانة بالبيانات الطبوغرافية والجيولوجية والمرئيات الفضائية ، ومن خلال التفسير البصرى تم رسم حدود وحدات الخريطة الفريوجرافية بناءاَ على الأختلافات فى قيم الأنعكاسات الطيفية لكل وحدة أرضية. أظهر تفسير المرئيات الفضائية الوحدات الفزيوجغرافية الأتية: (الرسوبيات البحرية ، الدلتا ، الأودية ، مناطق سفح الجبل ، المصاطب الرسوبية ، الرسوبيات المروحية ، المراوح المتجمعة) ، مساحاتها (8480 ، 21455 ، 111042 ، 5890 ، 1234515 ، 38381 ، 10280 فدان) على الترتيب. وتم فحص و تطوير الخريطة الجغرافية الأولية لتأكيد الحدود الفاصلة بين الوحدات الفزيوجغرافية ، وتم تمثيلها بسبعة عشر قطاع التى تم حفرها على عمق 150سم او الوصول إلى الصخر الأم أو الماء الأرضى أيهما أقرب ، وتم وصف القطاعات مورفولوجيا فى الطبقات المختلفة ، وعمل التحاليل المعملية عليها وعلى ضوء الوصف المورفولوجى ونتائج التحاليل المعملية تم تقسيم أراضى المنطقة إلى مستوى العائلات طبقاً للنظام الأمريكى (Soil Survey Staff. 2014) أتضح أن أراضى المنطقة تقع تحت مجاميع الأراضى الآتية: Typic Aquisalids, Typic Haplocalcids, Typic Torrifluvents, Lithic Torriorthents, Typic Torriorthents, Calcic Haplosalids, Typic Haplocalcids, Gypsic Haplosalids. ، أظهر مؤشر القدرة الأرضية للأراضى المروية الحالية إلى عدد 7 وحدات هى: (S3sn-1 ، S3sn-2 ، N1tsn-1 ، N1tsn-2 ، N1tsn-3 ، N1sn ، N1wsn) ، مساحاتها (21455 ، 111042 ، 38381 ، 10280 ، 5890 ، 234515 ، 8480 فدان) على الترتيب. وأظهر مؤشر القدرة الأرضية للأراضى المروية المستقبلية إلى عدد 5 وحدات هى: (S2s ، S3s-1 ، S3s-2 ، S3s-3 ، N1ws) ، مساحاتها (111042 ، 21455 ، 283176 ، 5890 ، 8480 فدان) على الترتيب.

Table.3. Soil Taxonomy of the study area According to (Soil Survey Staff. 2014).

Physiographic unit	Profile No.	Order	Suborder	Great group	Subgroup	Particle size classes and their substitutes	Mineralogy Classes	Calcareous and reaction classes	Soil temperature Classes	Soil depth classes
Marine Sediments	1	Aridisols	Salids	Aquisalids	Typic Aquisalids	Coarse loamy	Mixed	Calcareous	Hyper thermic	Shallow
	5	Entisols	Fluvents	Torrifluvents	Aquic Torrifluvents	Sandy over loamy				Moderately deep
Coastal braided deltas	3	Aridisols	Salids	Haplocalcids	Typic Haplocalcids	Coarse loamy				Deep
	4	Aridisols	Salids	Haplocalcids	Typic Haplocalcids	Coarse loamy				Deep
	6	Entisols	Fluvents	Torrifluvents	Typic Torrifluvents	Coarse loamy				Deep
Wadis	7	Entisols	Fluvents	Torrifluvents	Typic Torrifluvents	Sandy over loamy skeletal, aniso				Deep
	10	Entisols	Fluvents	Torrifluvents	Typic Torrifluvents	Coarse loamy over sandy				Deep
	14	Aridisols	Salids	Haplocalcids	Typic Haplocalcids	Coarse loamy				Deep
piedmonts	2	Entisols	Orthents	Torriorthents	Lithic Torriorthents	Loamy skeletal				Moderately deep
	13	Entisols	Orthents	Torriorthents	Typic Haplocalcids	Loamy skeletal				Moderately deep
Alluvial terraces	8	Aridisols	Salids	Haplocalcids	Calcic Haplocalcids	Loamy skeletal				Deep
	9	Aridisols	Calicds	Haplocalcids	Typic Haplocalcids	Sandy skeletal				Deep
	11	Aridisols	Salids	Haplocalcids	Calcic Haplocalcids	Loamy skeletal				Deep
Alluvial fans	12	Aridisols	Salids	Haplocalcids	Gypsic Haplocalcids	Coarse loamy				Deep
	15	Aridisols	Salids	Torrifluvents	Gypsic Haplocalcids	Sandy skeletal				Deep
Bajada	16	Entisols	Orthents	Torriorthents	Typic Torriorthents	Sandy skeletal				Moderately deep
	17	Entisols	Orthents	Torriorthents	Typic Torriorthents	Sandy skeletal				Deep

Where: Ci = capability index, t =slope rating, w = wetness rating, s1= rating of texture (including stoniness), s2 = rating of soil depth, and s3 = rating of CaCO3 status, s4 = rating of gypsum status, and n = salinity / alkalinity