Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Land Evaluation of some Soils for El- Farafra Oasis, New Valley Governorate, Egypt

Abdellatif, A. D.[1*]; M. M. Soliman [1]; Y. K. El Ghonamey[1] and Ahlam S. Allam[2]

Cross Mark

[1]Soil, Water and Environment Research Institute – ARC
[2]Faculty of Agric.- Fayoum Univ.

ABSTRACT

This work aims to identify the main physiographic units and their soil taxonomic ones as well as land evaluation for some promising areas of El- Farafra Oasis. The main materials and methods were Sentinel 2 image (2019), visual interpretation and digital elevation model (DEM) were used to produce physiographic soil map. The physiographic point of view, the landscapes include two units, i.e. plateau and depression floor. Eighteen profiles and seventy-two augers were dug to check the main physiographic mapping units in the studied area. Soil samples have been collected from the representative soil profiles for physical and chemical analysis. The main results pointed out that the El-Farafra oasis were classified into four capability classes, i.e. S2, S3, N1 and N2. The soils of S_2 have moderate limitations for agricultural crops, whereas texture is the main limiting factor (18.55). The main limiting factors of soils of S_3 are texture, soil depth and salinity (41.22 %). The soils of N1 (11.46 %), also the permanent not suitable of N2 (21.06 %) include rocky areas and very shallow soils. The cultivated area is about 7.7% of the total aforementioned area. The suitability for cultivation four main crops namely wheat, barley, sorghum and olive in the studied area are assessed. Olive was the most suitable to cultivation in these soils.

Keywords: Land evaluation, Remote sensing (RS), GIS, Soils, Digital Elevation Model (DEM), Egypt.

INTRODUCTION

The Western Desert depressions generally called as Oases are excavated from south to north in cretaceous (Dakhla, Kharga, Bahariya depressions and Farafra), and Eocene - Miocene for Wadi El Natrun, Siwa and Qattara.

El- Farafra one of the five Oases of Western Sahara, with an excellent groundwater potentialities and potential soils for agricultural expansion, thus considered promising for future agriculture development. It is considered the second largest depression in size, but the smallest in population within the large Western Desert of Egypt, approximately midway between Dakhla and Bahariya oases.

GIS is an organized suit of computers to facilitate and efficient service for users. Remote Sensing (RS) in integration with GIS proved to be more important in soil sustainability (DeVries, 1985). RS and GIS techniques are considered very important geometric tools, which are fully utilized in the developing countries (Arafat, 2003).

GIS and spatial statistics provides useful tools for modeling variability to predict the distribution, presence, and pattern of soil characteristics (Kalkhan *et al*., 2000). These advanced technologies (GIS and Remote Sensing), which is "state-of-the-art" for handling geo-referenced data in a digital format. One major advantage of GIS is the integration of diverse database such as conventional maps and satellite imagery.

Soil evaluation can be defined as the evaluating of land situation when used for specified purposes, with a principal objective to select the optimum land use for defined land units (Van Benthem 2013). Soil evaluation is concerned with the assessment of land performance when used for specified purposes (FAO, 1976). Although several land evaluation models have been developed to provide a quantified procedure to match land with various actual and proposed uses, there is no single or unified land evaluation modelling approach (Rossiter, 2003).

The aim of the current investigation is to identify the main physiographic units and their soil taxonomic ones as well as land evaluation for some promising areas of El- Farafra Oasis.

MATERIALS AND METHODS

a) Location

The studied area is located between longitudes 27° 53' 25.264" to 28° 16′ 20.63" East and latitudes 26° 59' 11.05" to 27° 23' 50.430" North. It is representing about 408649 Feddans. The studied area is belong to Farafra district, New Valley Governorate. El-Farafra is located in western desert and connected with Cairo through El-Bahariya Oasis and Giza Governorate by approximately 600 km paved road. It is also linked with El- Dakhla Oasis to the south by the same paved road, about 200 km, through Abu Monquar depression and with Siwa Oasis to the northwest by a desert track (Figure1).

b) Geology

Sanad (1972) stated that the rock unit belonging to lower-middle Eocene is Farafra limestone. Conformably, above the Esna shale and caps all the escarpments surrounding the depression. The rock unit belonging to the Eocene low is Esna shale and covers the scarp- slopes

* **Corresponding author.**
E-mail address: abdellatifdeyb@yahoo.com
DOI: 10.21608/jssae.2020.111747

surround the whole depression of Old Farafra. It above the limestone and is under lowed by the Bishwa formation.

Geological Map (scale 1: 500000), (EGSA, 1988) showed that Khoman Chalk is the main formation which represents an area of about 307836 Feddans (75.33 %), followed by sand sheets (10.27 %) as shown in Fig. 2 and Table 1.

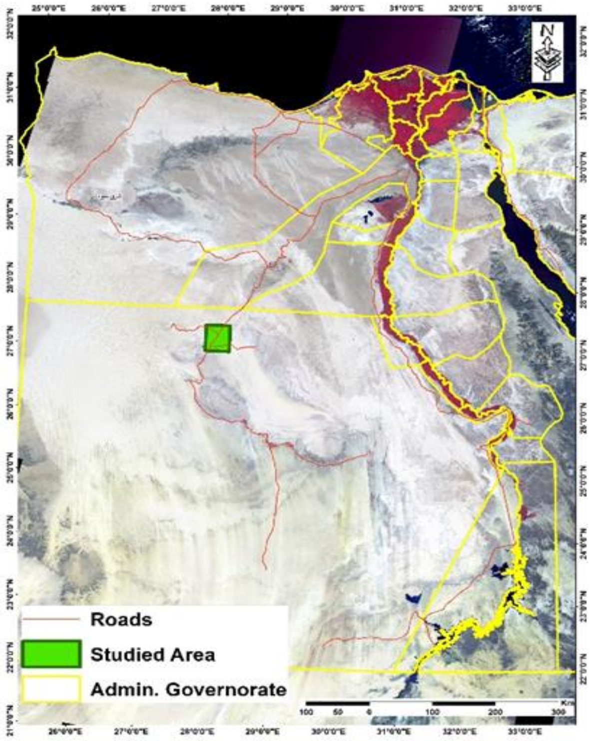

Fig. 1. Location map of the studied area.

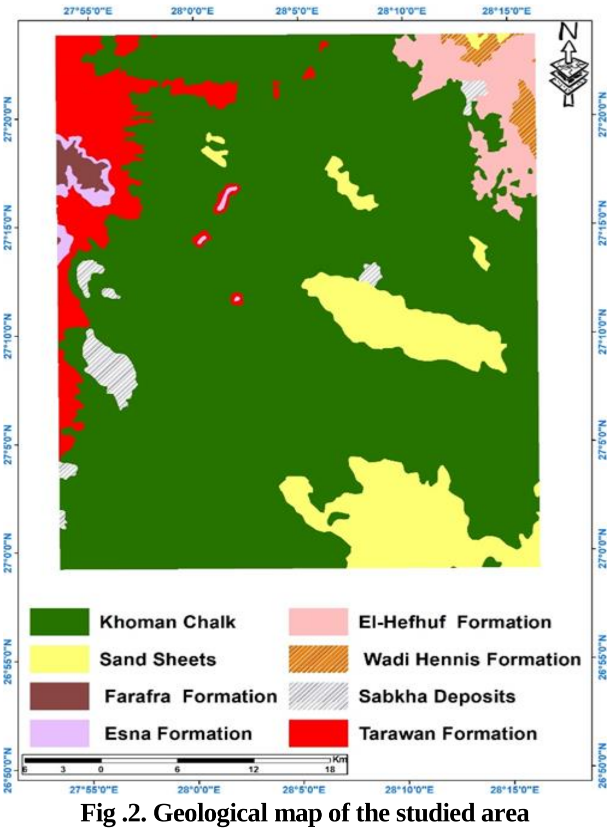

Fig .2. Geological map of the studied area

Table 1. Geological formations of the studied area (EGSA, 1988).

Geology Formation	Area Feddans	%
Khoman Chalk	307836	75.33
Sand Sheets	41981	10.27
Farafra Formation	2403	0.59
Esna Formation	3012	0.74
El-Hefhuf Formation	16215	3.97
Wadi Hennis Formation	3429	0.84
Sabkha Deposits	6532	1.60
Tarawan Formation	27241	6.67
Total	408649	100.00

Feddan = 4200 m^2

Resources of the Water:

Groundwater supplies represent the main water resources of Farafra depression. The two sources which provide the cultivated areas with water are considered the Springs and wells and are also used for civic purposes. Euroconsult, (1983) this was announced genesis of Farafra groundwater could be distinguished into two water bearing complexes; Farafra chalk and Ain El-Wadi limestone water bearing complex and Nubian series water bearing complex.

c) Digital Elevation Model (DEM)

The use of contour lines and spot heights of the statistical analysis through interpolation Kriging inverse distance method, which used the semi-variogram parameters (Stein, 1998) (Figure 3). The height areas located in the northwest side where as the elevation ranged from 105 to 303 meter above sea level. The low areas located in the eastern side whereas the elevation between 4 below sea level and 37 meter above sea level.

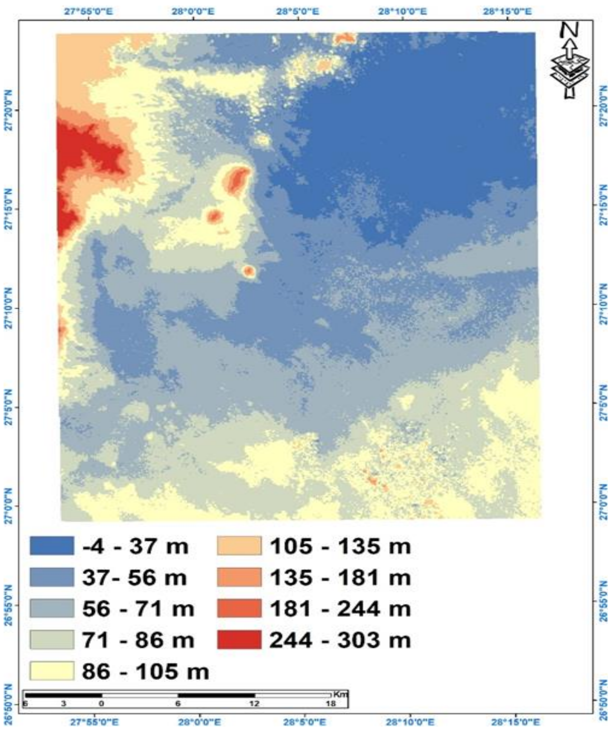

Fig. 3. Elevation system (DEM) of the studied area

d) Satellite data:

Data of sentinel 2 dated 10/4/2019 with spatial resolution of 10 m (Figure 4) and spectral resolution of the bands 5, 3 and 2 used for delineating the physiographic units (Zinck, 1988) of the studied area using the visual analysis, by aid topographic maps, geology map and Digital Elevation Model (DEM). Spatial enhancement was done to have an output image with enhanced edges that related to soil. The pixel values are not manipulated individually but in relation to their four neighbors. This modifies the value of each pixel on neighboring brightness values (Daels, 1986). Colour enhancement was conducted to create new images from original to increase the amount of information that can be visually interpreted from the data.

Data and the output maps used the parameters for GIS displays were Egyptian Transverse Mercator projection (ETM) (Daels, 1986).

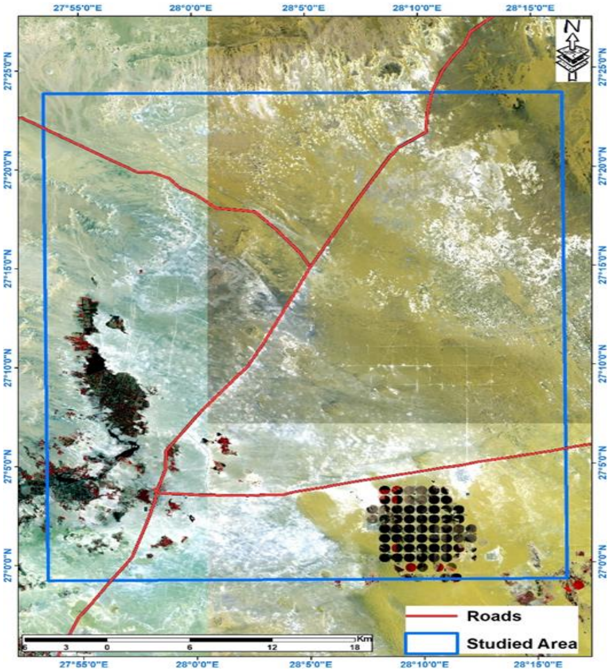

Fig. 4. Satellite image of the studied area

Field Work:

Eighteen soil profiles were chosen to represent the different mapping units of the studied area. Seventy-two mini pits were used for checking the boundaries between mapping units. Representative soil samples from the studied soil profiles were taken for laboratory analyses

Physio-chemical analyses:

The collected disturbed soil samples were air dried, crushed and prepared for laboratory analyses, to determine some soil chemical and physical properties (Burt, 2004). Laboratory analyses were conducted for particle size distribution using the pipette method, calcium carbonate content using Collin's calcimeter, gypsum content by precipitation with acetone, soil pH in the soil suspension (1:2.5), (ECe) by extracting of soil paste, cation exchange capacity and exchangeable sodium percentage using ammonium acetate. Furthermore, the studied soils were classified according to the American system of soil taxonomy (USDA, 1975) and modern Keys to soil taxonomy (USDA, 2014).

Classification of Land Capability:

Land evaluation for the purpose of the agricultural capability was assessed according to the method of Land Capability techniques that done using the rating tables suggested by FAO (1985), Sys and Verheye (1978) and Sys *et al*. (1991) as common method for land evaluation according to the equation:

$$Ci = t \times \frac{w}{100} \times \frac{s_1}{100} \times \frac{s_2}{100} \times \frac{s_3}{100} \times \frac{s_4}{100} \times \frac{n}{100} \times 100$$

Where:

Ci = Capability index (%)
t = Slope
w = Drainage conditions
S_1 = Texture
S_2 = Soil depth
S_3 = $CaCO_3$ content
S_4 = Gypsum content
n = Salinity and alkalinity

Capability classes arbitrary defined according to the value of the index as follows:

Capability class	Land index (Ci) %	Definition
S1	> 75	Soils are highly suitable for cultivating all crops.
S2	75-50	Soils are moderately suitable for agriculture
S3	50-25	Soils are marginally suitable for agriculture
N	< 25	Soils are not suitable for agriculture

Land suitability assessment for specific crops.

The assessment of land suitability for four different land use types (LUT) has been conducted for soil units using Sys *et. al*, (1993) by implementing the FAO Framework for Land Evaluation (FAO, 1976). Soil characteristics of the different mapping units were compared and matched with the requirements of each crop. The suitability maps were produced.

RESULTS AND DISCUSSION

1. Physiographic map

Visual interpretation of sentinel 2 image was done on false colour composite of bands 5, 3, 2 scale 1:50000 to produce a base map according to the difference in landscape from the field work activities. The integration between geology, Digital Elevation Model and visual interpretation was carried out to produce a base map. This base map was used in the field to check, confirm, correct and modify the mapping unit boundaries, coupled with the results of the field work to produce final physiographic soil map of the studied area (Figure 5 and Table 2).

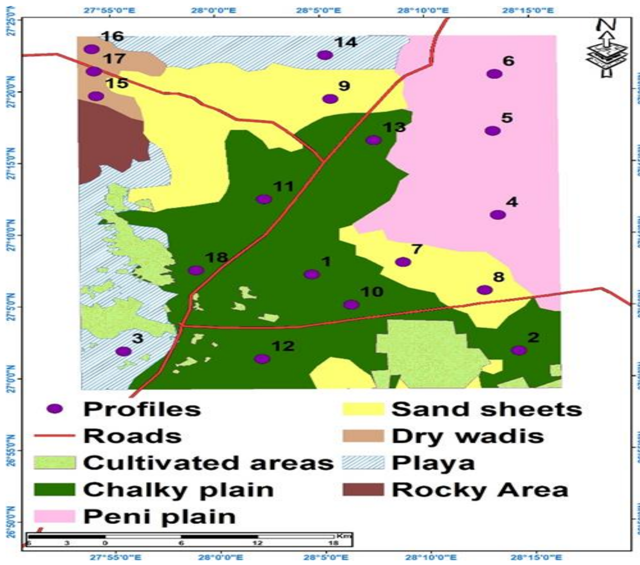

Fig. 5. Location of soil profiles and physiographic map (according to Zinck, 1988)

Table 2. Physiographic mapping of interested area

Landscape unit	Relief	Lithology	landforms	Area (Fed)	%
Plateau (PL)	Almost flat PL1	Limestone mixed with Shale (PL11)	Summit (Rocky Area) (PL111)	2319	0.57
Depression (D)	Almost flat to gently undulating D1	Limestone mixed with shale and sand stone (D11)	Chalky plain (D111)	141476	34.62
			Peni plain (D112)	90565	22.16
			Playa (D113)	52807	12.92
	Almost flat D2	Sandstone (D21)	Sand sheets (D211)	77386	18.94
	Undulating D3	Limestone (D31)	Dry wadis (D311)	12620	3.09
	Almost flat D4	Limestone mixed with sand stone (D41)	Cultivated areas (D411)	31476	7.70
Total				408649	100.00

There are two landscape units representing the studied area, Plateau (PL), and Depression (D). The first landscape was represented an area of about 0.57 % of the total area. The topography is flat to almost flat. The second landscape (depression) about 99.43 % of the area under investigated.

2. Soil Properties of physiographic units:

a. Chalky plain mapping Unit:

This unit is represented by profiles No's 1, 2, 10, 11, 12, 13 and 18 and covered about 141476 Faddens (34.62 %). Chalky plain is detected in the depression floor as erosional remnants of the chalk. Table (3) reveals that variation in texture classes ranging from sand to clay loam, Calcium carbonate contents are between 1.0 and 7.7% for surface layer except for profile No. 5 is high (33.75 %), OM% is very low and ranges from 0.03 to 1.79%.

The moderately alkaline dominates in the soil situation where pH values varies from 6.66 to 8.10. ECe values varies from 1.95 to 19.1 dS/m clarify the soils are non-saline to highly saline for surface layer except for profile No. 1 the soil is extremely saline as ECe is 106 dS/m. Exchangeable sodium percent (ESP) ranged from 1.54 to 11.2 % indicating that the soils are not sodic soils for surface layer, expectations for the surface layer of profile No. 1 where the soils are sodic as ESP is 58.2 . Gypsum percent ranges from 0.12 to 5.65%. The parent material of Chalky plain is limestone and weathering is physical in state chemical, leaching processes are weak thus, the fine fractions are very low.

Peni plain mapping Unit:

The units represented by profiles 4, 5 and 6, and covered about 90565 Feddan (22.16 %). Soil in general clayey texture in profiles 4 and 5, while in profile 6 the texture class is loamy sand. CaCO3 % ranges from 7.5 to 20.25% of the surface layer, Table (3). While OM percentage is limited from 0.07 to 1.34 %. Chemical analyses of the fine fraction (Table 3) reveal that the soil are natural to slightly alkaline as indicated by pH values which range from 7.26 to 7.73.The soils are highly to very highly saline saline where ECe of soil paste extract ranges from 12.5 to 37.6 dS/m (surface layer). Exchangeable sodium percent (ESP) ranges from 17.1 to 29.8 % (sodic soils for surface layer), where gypsum content ranges from 0.12 to 12.01%.

Sand sheets Mapping Unit:

Sand sheet mapping unit is represented by profiles 7, 8 and 9. covering an area about 77386 Feddans (18.94 %). Table (3) showed that texture class varies varies from sand to clay loam. Calcium carbonate content ranges from 3.0 to 9.85 % for surface layer except for profile No. 7 is high 38.0%. OM percentage is very low not exceeds 0.46%. lap analysis of the sand sheet soils, Table (3) reveals that soil reaction varied from7.17 to 7.59 showing that these soils are netural to slightly alkaline, highly to extremely saline ECe of soil paste extract ranges between 18.80 and 48.4 dS/m (surface layer). the soils are sodic as ESP varies from 29.36 to 40.11% for surface layer except the surface layer of profile No. 8 the soil is not sodic as ESP is 13.53, whereas gypsum content is very low and ranged from 0.08 to 3.30%.

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

Unit	Prof. No.	Depth (cm)	Gravels %	Particle size distribution (%) C.S	F.S	Silt	Clay	Texture class	$CaCO_3$ %	OM %	PH (1:2.5)	ECe dSm^{-1}	Gypsum %	ESP %
Chalky Plain	1	0-25	11	45.30	5.08	7.29	42.33	SC	33.75	0.52	7.73	106.0	5.55	58.2
	12	0-30	3	34.00	20.75	20.25	25.00	SCL	1.25	0.88	7.74	4.58	0.12	8.74
		30-70	5	21.10	26.89	18.61	33.40	SCL	1.90	0.46	7.66	0.78	0.24	2.54
		70-120	2	24.80	27.21	18.54	29.45	SCL	1.90	1.00	7.61	2.00	0.33	6.89
	2	0-25	10	31.14	23.71	42.04	3.11	SL	2.00	0.05	7.49	4.66	0.13	4.30
		25-60	8	46.54	14.60	23.40	15.46	SL	4.70	0.12	7.53	4.20	0.84	2.80
		60-80	12	38.73	17.40	36.04	7.83	SL	27.5	0.27	7.54	8.66	5.65	9.97
	18	0-25	10	54.03	16.43	22.29	7.25	SL	7.00	1.79	6.66	19.1	0.83	11.2
		25-70	9	56.08	17.08	16.84	10.00	SL	3.60	0.89	7.97	7.12	0.55	5.46
		70-120	6	24.25	22.15	23.50	30.10	SCL	2.00	0.45	6.79	9.91	0.38	7.61
	11	0-25	3	60.35	9.92	6.23	23.50	SC	1.75	0.91	7.45	1.95	0.28	0.18
		25-70	2	56.71	12.76	11.53	19.00	SL	1.00	0.62	7.72	0.92	0.18	0.11
		70-120	15	51.39	14.81	16.55	17.25	SL	1.50	0.41	7.78	0.98	0.29	0.14
	13	0-20	10	95.58	1.94	1.27	1.21	S	3.25	0.14	7.97	10.18	0.55	1.45
		20-35	5	63.45	6.96	11.16	18.43	SL	14.00	0.03	7.44	37.80	1.40	27.1
	10	0-25	3	11.00	12.67	43.83	32.50	CL	1.00	0.05	8.10	6.43	2.20	5.51
		25-50	9	96.05	1.96	1.24	0.75	S	1.50	0.14	7.48	13.76	0.12	10.8
Peni-Plain	4	0-30	12	2.81	0.20	20.19	76.80	C	10.00	1.34	7.40	12.50	1.60	17.1
		30-75	7	0.83	0.66	16.09	82.42	C	2.15	0.41	7.68	6.15	0.32	11.3
		75-120	11	1.00	1.00	12.30	85.70	C	6.50	0.14	7.57	9.62	12.0	14.6
	5	0-30	19	10.65	1.35	19.50	68.50	C	20.25	0.45	7.33	37.6	3.85	29.8
		30-75	15	11.39	1.76	20.32	66.5368.	C	17.40	0.07	7.73	8.71	3.85	0.10
		75-120	8	6.85	4.87	20.16	12	C	19.25	0.14	7.45	16.82	3.93	19.8
	6	0-30	4	65.33	15.60	13.62	5.45	LS	7.50	0.12	7.26	28.20	1.16	26.8
		30-60	**6**	68.41	9.56	14.71	7.32	LS	2.00	0.14	7.47	30.50	0.12	31.9

C= Clay CL= Clay loam S= sand SL= Sandy loam LS= loamy sand SCL= Sandy clay loam

Table 3. Cont.

Physiographic units	Prof. No.	Depth (cm)	Gravels %	Particle size distribution (%) C.S	F. S	Silt	Clay	Texture class	$CaCO_3$ %	OM %	PH (1.25)	ECe dSm^{-1}	Gypsum %	ESP %
Sand sheet	7	0-20	2	24.25	21.43	24.97	29.35	CL	38.00	0.27	7.44	48.40	0.08	40.11
		20-30	10	41.76	14.38	13.72	30.14	SCL	35.25	0.41	7.17	94.70	3.30	41.57
	8	0-25	2	86.52	9.58	1.92	1.98	S	3.00	0.05	7.59	18.80	0.40	13.53
		25-70	5	85.34	5.51	6.83	2.32	S	2.90	0.05	7.47	19.71	0.31	11.14
		70-120	5	91.20	4.73	3.05	1.02	S	3.10	0.05	7.46	19.27	0.34	12.54
	9	0-20	3	55.13	7.30	17.95	19.62	SL	9.85	0.46	7.44	42.00	1.14	29.36
		20-30	5	57.17	7.23	15.80	19.80	SL	10.00	0.24	7.46	30.70	1.60	32.72
Dry Wadis	15	0-30	2	18.18	14.50	26.07	41.25	C	9.60	0.45	7.40	19.20	0.28	23.54
	16	0-35	10	42.68	11.48	3.39	42.45	SC	8.25	0.10	7.54	16.58	0.18	14.87
		35-80	15	63.90	8.66	3.68	23.70	SCL	12.25	0.12	7.27	35.20	0.29	17.91
		80-120	17	67.51	2.85	4.39	25.25	SCL	8.50	0.10	7.39	21.40	5.55	10.98
	17	0-30	12	6.21	28.78	30.00	35.01	CL	15.00	0.52	7.55	42.50	0.55	37.74
		30-70	15	7.40	29.54	28.03	35.03	CL	1.25	0.46	7.74	31.74	1.40	19.51
Playa	3	0-30	5	71.26	16.01	9.01	3.12	S	6.35	0.46	7.16	66.00	0.52	51.54
		30-70	2	69.31	9.00	17.25	4.44	SL	8.70	0.14	7.17	60.50	0.59	44.50
		70-120	2	65.92	20.51	5.41	8.16	S	7.90	0.26	7.23	55.00	0.95	25.61
	14	0-30	2	9.26	15.67	29.36	45.35	C	18.20	0.04	7.79	77.30	2.20	50.42
		30-60	7	5.98	12.71	36.19	45.12	C	1.50	0.03	8.02	7.54	0.12	13.27

d) Dry wadis Mapping Unit:

This unit is represented by profiles 15, 16 and 17 and unit representing an area of about 12620 Feddan (3.09 %). The Wadi is covered with alluvial material developed through weathering of parent rock structure and transported by floodwater to the lowlands. Table (3) shows that soil texture is sandy clay loam to clay. $CaCO_3$ content ranged from 8.25 to 15.0% (surface layer), while OM is very low not exceeds 0.52%. Lap analysis of the soil saturation extract, Table (3) reveals that soli reaction values ranged from 7.27 to 7.74 (neutral to slightly alkaline), ECe of soil paste extract for surface layer is between 16.58 dS/m (highly saline) and 42.5 dS/m (extremely saline). ESP values ranged from 23.54 to 37.74% (sodic soils for surface layer) except the surface layer of profile No. 16 the soils are not soid as ESP is 14.87. Gypsum content is very low and varied from 0.18 to 5.55%.

e) Playa mapping Unit:

Playa soils represented by profiles 3 and 14. This unit covering about 52807 feddan (12.92 %). The playa deposits are composed of horizontal, alternating bands of soft, friable sand, clay and silt with frequent plant remains. In general, soil texture class is in general sand to clay. $CaCO_3$ content ranges from 6.35 to 18.20% (surface layer). OM percentage ranging from 0.03 to 0.46%. Concerning chemical characteristics of playa Table (3), lap analysis refer that alkaline fluctuating from neutral to moderately with pH values range from 7.16 to 8.02, extremely saline as ECe of soil paste extract ranges from 66 to 77.3 dS/m for surface layer. Exchangeable sodium percent (ESP) is between 50.42 and 51.54% (sodic soils for surface layer). Gypsum percentage is very low and ranged from 0.12 to 2.2%.

Water quality for irrigation purpose:

The quality of water used for irrigation is an important factor for crop productivity and the effect on soil. The amount and type of dissolved salts control the validity of water for irrigation, validity of ground water for irrigation uses depend mainly on salinity (TDS) and (SAR). The classification of the ground water samples according to their EC and SAR values (FAO, 1985). Results of such ground water samples revel that (C1-S1) (samples Nos.1, 2, 3, 5 and 10), (C3-S1) (samples Nos. 4, 8, 9 and 10) and (C4–S1) (samples Nos. 6 and 7) as shown in Table4.

Table 4. Chemical analyses of water samples for the studied areas.

Sample No.	Location	Cations (m mol/L) Na^+	K^+	Ca^{++}	Mg^{++}	Anions (m mol/L) Cl^-	HCO_3^-	$SO_4^=$	$CO_3^=$	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)	PH	TDS (ppm)	EC dSm^{-1}	SAR	RSC
1	Bir Galaw	0.81	0.86	0.95	1.11	2.00	0.4	1.40	-	2.8	0.3	4.51	0.21	8.40	435.2	0.68	1.02	-1.66
2	Bir Abd El Rasol	1.03	0.49	1.17	0.89	1.25	1.24	1.10	-	8.81	1.57	4.25	0.54	7.00	230.4	0.36	1.03	-0.82
3	Bir No. 42	3.66	0.77	3.59	1.20	5.00	2.9	1.20	-	8.98	2.52	4.44	0.23	7.45	486.4	0.76	2.39	-1.89
4	Bir Makafy	6.89	0.88	19.22	3.61	8.50	17.6	4.50	-	9.30	Na	4.64	0.18	7.20	1740.8	2.72	2.04	-5.23
5	Bir el Farafra	1.31	0.42	1.46	0.59	3.00	0.63	1.00	-	9.68	1.48	4.31	0.24	6.50	224.0	0.35	1.36	-1.42
6	Bir Bidny	34.94	2.60	52.01	12.78	44.50	56.6	1.20	-	9.35	5.49	4.11	0.19	7.00	4915.2	7.68	6.12	-8.19
7	Ain El Hatia	19.48	1.28	11.03	14.58	20.00	24.3	1.00	-	11.81	1.79	3.95	0.18	7.00	3187.2	4.98	3.99	-1.31
8	Ain El Wady	15.21	1.26	11.99	10.24	8.50	10.7	4.80	-	8.37	2.30	3.57	0.15	7.45	2048.0	3.20	4.46	-11.53
9	Bir El Berkaa	21.39	1.46	15.77	12.60	14.50	21.7	5.00	-	9.63	1.64	4.30	0.26	7.00	2496.0	3.90	5.70	-6.67
10	Bir El Farafra (East)	0.65	0.01	1.60	0.99	1.69	0.38	0.98	-	4.40	0.50	3.21	0.22	7.25	198.4	0.31	0.57	-2.21

Soil taxonomy units:

Data in Table (5) shows the prevailing taxonomic unit of the studied area award to Keys to soil taxonomy (USDA 2014). Using the obtained data of the morphological description and physio-chemical properties of soil profiles, the soils under investigation could be classified to the family level .The studied soils are mainly encompassing the different deposits. Most of the studied soil profiles characterized by high level of expanding salts, $CaCO_3$ and Gypsum enrichments that satisfy the requirement of Calcic, Gypsic and Calcic-Gypsic horizons adding Aridisols and Entisols (Table 5)

Table 5. Soil classification of the studied soil profiles (according to USDA, 2014).

Order	Sub-order	Great-group	Sub-Group	Soil Families	Profile No.
Aridisols	Salids	Haplosalids	Typic Haplosalids	sandy, siliceous, hyperthermic, deep or moderately deep	3 and 6
				coarse loamy, mixed, hyper thermic, shallow	9
			Calcic Haplosalids	fine loamy, mixed, hyperthermic, shallow or moderately deep	7 and 17
				fine loamy, mixed, hyperthermic, moderately deep	14
			Gypsic Haplosalids	fine loamy, mixed, hyperthermic, deep	16
			Duric Haplosalids	clay, kaolinitic, hyperthermic, very shallow	1
				coarse loamy, mixed, hyper thermic, shallow	13
	Gypsids	Calcigypsids	Typic Calcigypsids	very fine clay, kaolinitic, hyperthermic, deep	5
Entisols	orthents	Torriorthents	Typic Torriorthents	loamy, mixed, hyperthermic	2 and12
				coarseloamy, mixed, hyperthermic,deep	11
			Typic Torriorthents	fine clay, kaolinitic, hyperthermic, deep	4
			Lithic Torriorthents	siliceous, hyper thermic, shallow	10
				clayey, kaolinitic, hyperthermic, very shallow	15
	Fluvents	Torrifluvents	Typic Torrifluvents	clay over fine loamy, mixed, hyperthermic, deep	18
	Psamments	Torripsamments	Typic Torripsamments	siliceous, hyperthermic, deep	8

Land Capability for agriculture

1- Current land capability classification

Present land capability refers to the capability for a defined land in its present condition without major improvement (FAO, 1976). It may indicate to the present use of land, either with existing or improved management practices, or to a different use. The current capability of the studied area is estimated by the present land characteristics and their ratings outlined by Sys *et al*. (1991). Figure (6) shows a detailed description of the current land capability classes in the studied area

Studied soils have 2 orders (S and N), four classes (S2, S3, N1 and N2) were recognize in the studied soils, Table (4) reveals the land capability including rating of the studied soil profiles within different physiographic units. The current capability classes is given as follows.

1- S2: This class occupies about 75807 Feddans, perform 18.55 % of studied area, distributed across soil units. These soils have moderately intensity of topography, texture and a slightly intensity of salinity and $CaCO_3$.
2- S3: This class occupies about 168443 Feddans and representing 41.22% of total area. This value indicates a marginally suitable class. The soils suffer from moderate intensity of profile depth, texture, topography and salinity and alkalinity.
3- N1: this class occupies about 46844 Feddans . It is representing 11.46 % of area. The soils have sever intensity of depth, salinity and texture.
4- N2: This class occupies about 86080 Feddans and representing 21.06 % of total area. This areas is rocky land, shallow, very shallow and extremely saline. These areas are permanent not suitable for agriculture.

2- potential land capability

For this propose, the land utilization is applicable after executing specified major land improvements as proposed in the current study according to their necessity. In the area under studied, increase soil efficiency is required to management the severity of limitations exiting in the area under consideration such as ; Leveling of gently undulating surfaces of high and low land area, high quality irrigation systems such as drip and sprinkler to save irrigation water and prevent the formation or the rise of ground water table, removing of salinity and reclamation of alkalinity, adding organic fertilizers, green manures and soil conditioners to increase soil fertility and improve the physical and chemical soil properties.

Potential land capability classification of the studied soils as illustrated in Table 4 and shown in Figure 6 indicated the existing two orders (S and N), four classes (S1, S2, S3 and N2) Figure 7. The remaining area is cultivates area (7.7 % of the total studied are) as follows:

1- S1: This capability class covers an area of about 75807 Feddans represents 18.55% of area. The capability index is 81.2 %, due to land leveling, leaching process of salinity.
2- S2: It is covers 168443 Feddans and representing 41.22 % of total studied area. The soils have slightly intensity of texture, and salinity.
3- S3: This class occupies about 46844 Feddans and representing 11.46 % of total area. Theses were developed from soils of N1 in current capability.

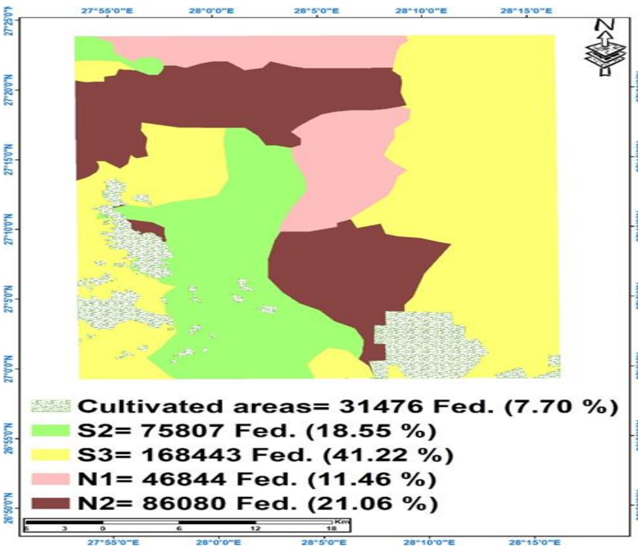

Fig. 6. Current capability map of the studied area

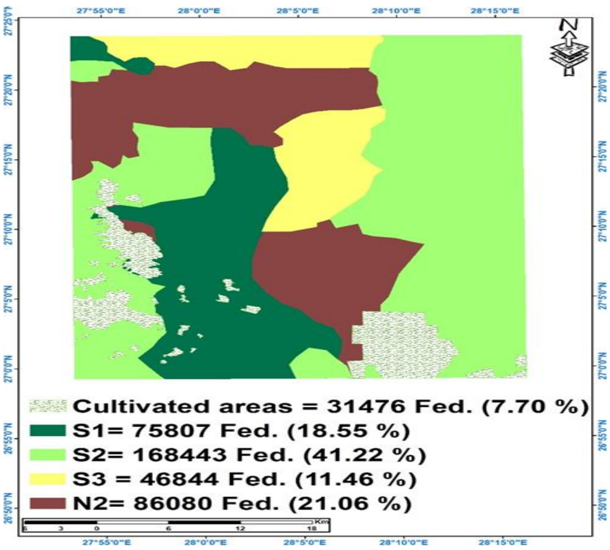

Fig. 7. Potential capability map of the studied area

Land suitability for specific crops:

Land suitability for four several crops, i.e. wheat, barley, sorghum and olive was tested for the soils using Arc GIS 10.x software. The results were imported to Arc GIS to display maps. Soil characteristics of the many mapping units were compared and matched with the crop requirements of each land use type, i.e. crop (FAO, 1976 b). The matching led to the current and potential suitability for each crop using the parametric approach and land index as mentioned by Sys *et. al.* (1993) (Figures 8 to 12).

Present suitability

The data in (Fig. 8, 10 and 12) showed the current suitability classes for the selected studied crops. These data indicate that 18.55 % is highly suitable (S1) for olive. On the other hand, the same area (18.55 %) is moderately suitable (S2) for sorghum. about 43.52 %, (S3) is marginally suitable for wheat and Barley.

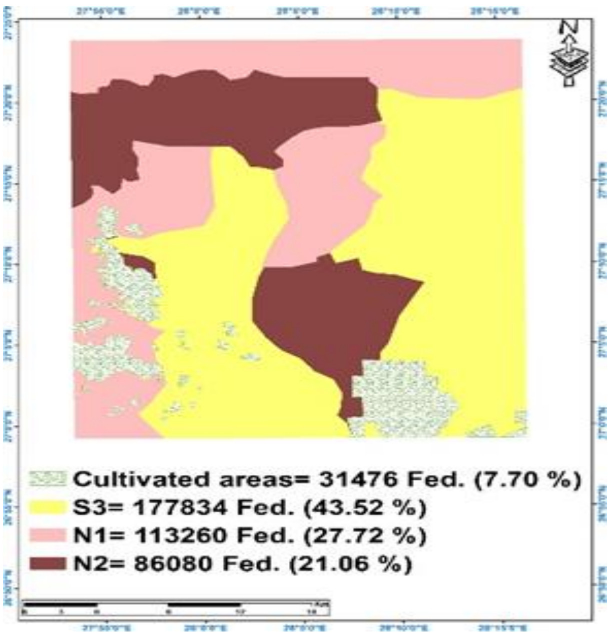

Fig .8. Current land suitability for growing wheat and barley in the studied area.

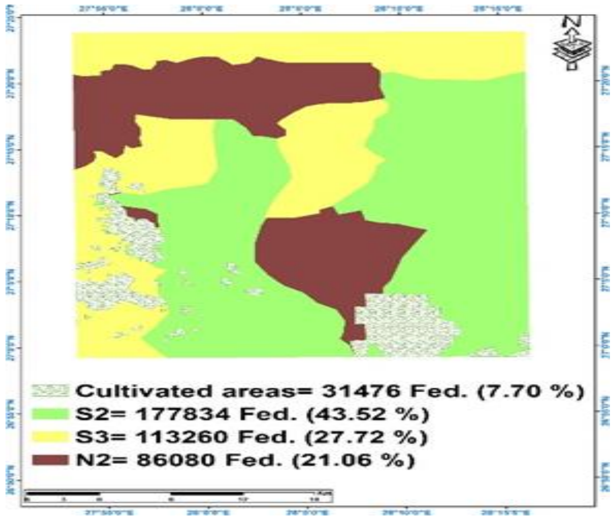

Fig .9. Potential land suitability for growing wheat and barley in the studied area.

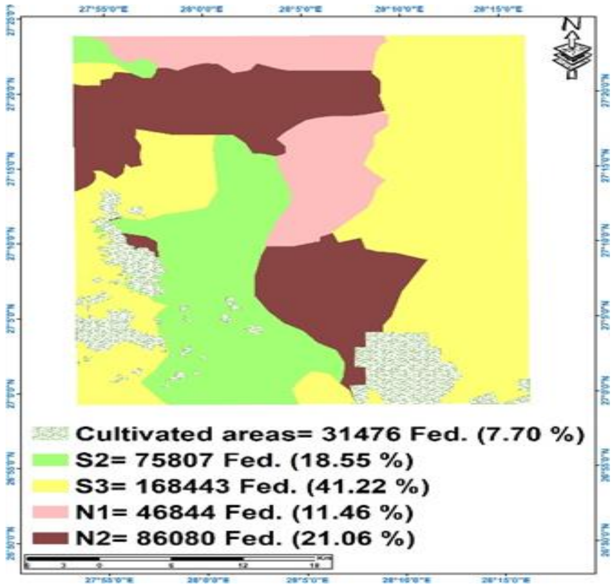

Fig 10. Current land suitability for growing sorghum in the studied area.

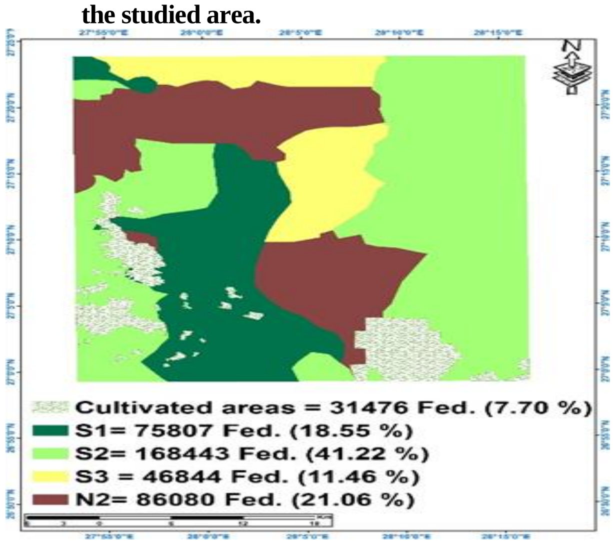

Fig .11. Potential land suitability for growing sorghum in the studied area.

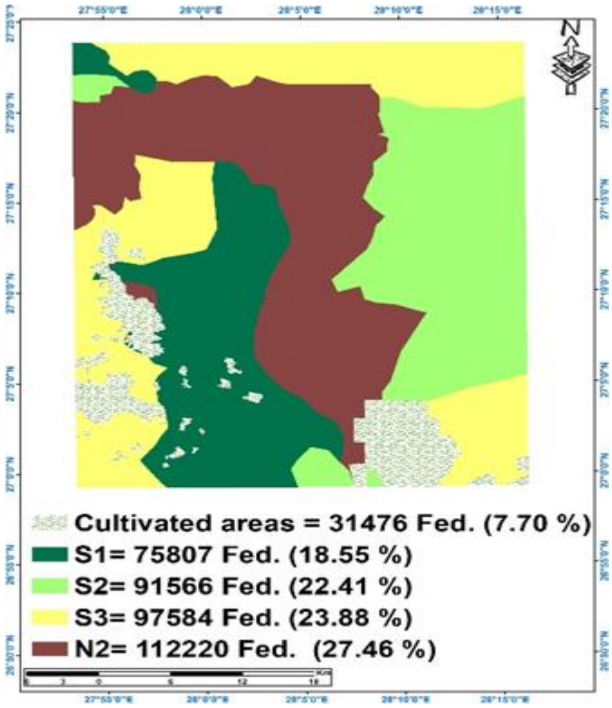

Fig .12 Current and potential land suitability for growing olive in the studied area.

Potential land suitability

From the previous discussion, the main limiting factors were texture and salinity, which can be improved using good management practices such as salt leaching, use of organic matter amendments, construction of a good drainage system and follow good agriculture practices for crops. These improvements will develop the potential suitability.

The results in Figures 9, 11 and 12 showed that 43.52 % of the area is moderately suitable (S2) for wheat and barley , while an area of about 41.22 % is moderately suitable (S2) for sorghum.

REFERENCES

Arafat, S.M. (2003). The utilization of geoiformation techndegy for agricultural development and management in Egypt Diffuse pollution Conference. Dublin.

Burt (2004). Soil Survey Manual. United State, Department of Agriculture, Handbook 18, U.S. Gov. Print Off., Washington, DC., USA.

Daels, L. (1986). Remote sensing fundamentals. Gent. State Univ., Gent., ITC. J., pp.1-19.

DeVries, M. E. (1985). Use of GIS to integrate remote sensing and other natural resources data 18th International Symposium on Remote Sensing of Environment, Arbor, Michigan, International J. Remote Sensing, 31:71-90.

EGSA (Egyptian Geological Survey Authority). (1988). “Egyptian General Petroleum Corporation: Geological Map of Egypt”, Conoco Coral, printed in Germany by Institute fur Angewandte Geodasie, Berlin, Technische Fachhochschule Berlin, Scale 1:500000.

Euroconsult, (1983): Determinatian and evaluation of Lang period economic exploitation of groundwater resources in Dakhla-kharga-farafra development, an internal report G.A.R.P.A.D., PP.320.

FAO (1976). A Framework for Land Evaluation. FAO Soil Bulletin, 32. Rome, Italy.

FAO (1985). Guidelines: Land Evaluation for irrigated Agriculture. FAO Soils Bulletin No. 55, Rome, Italy.

Kalkhan, M.A., T.J. Stohlgren, G.W. Chong, D. lisa and R.M. Reich (2000). Apredictive spatial model of plant diversity integration of remote sensed data, GIS and spatial statisties. 8th Biennial Remote Sensing Application Conference, Albuquerque, NM.

Rossiter, D. G., (2003). Biophysical models in land evaluation. In: Encyclopedia of Life Support Systems (EOLSS), Theme 1.5 Land Use and Land Cover (ed W.H. Verheye), Oxford: EOLSS publishers developed under the auspices of UNESCO. Article 1.5.27. pp: 1–16.

Sanad, S. (1972):"Geology and hydrology of Farafra Oasis, Western Desert, V.A.R. Msc. Fac.of., Assiut Univ

Stein, A. (1998). Integrating spatial statistics and remote sensing. INT. J., 19 (9): 1793-1814

Sys, C. and W Verheye,. (1978). An attempt to the evaluation of physical land characteristics for irrigation according to the FAO Framework for land evaluation. Ghent, Belgium., The Netherlands, ITC. J., pp. 66-78.

Sys, C., E. Van Ranst and J. Debavey. (1991). Land Evaluation. Part I and S2, Ghent Univ., Ghent Belgium.

Sys, C., E. Van Ranst, J. Debavey and F. Beeranert. (1993). Land_ Evaluation. Part III Crops Requirements, Ghent Univ., Ghent Belgium., The Netherlands, 190 p.

USDA (1975). "Soil Taxonomy". A basic System of Soil Classification for Making and Interpreting Soil Survey Handbook 436. U.S. Gov. Print Off., Washington, D.C, USA.

USDA (2014). Keys to Soil Taxonomy. U.S.D.A., Soil Cons Serv. Washington.

Van Benthem, E. (2013). Land evaluation for rain fed agriculture in the Mediterranean Peyne area, Southern France. Master Thesis, Utrecht University Faculty of Geosciences.

Zinck, J. A. (1988). Geomorphology and Soils. Internal Publ., ITC., Enschede, The Netherlands.

تقييم بعض أراضي واحة الفرافرة بمحافظة الوادى الجديد ـ مصر

عبد اللطيف دياب عبد اللطيف[1] ، محمود سليمان محمد[1] ، يوسف قطب الغنيمى[1] و أحلام سيد علام[2]
[1]معهد بحوث الأراضي والمياة والبيئة- مركز البحوث الزراعية
[2]كلية الزراعه- جامعة الفيوم

تقع منطقة الدراسة في محافظة الوادي الجديد جنوب غرب القاهرة بحوالي 700 كم وتقدر بمساحة 408649 فدان ويهدف هذا البحث الي دراسة الخصائص الفيزيوجرافيه لأراضي منطقة الفرافرة القديمة بإستخدام تقنيات الإستشعار عن البعد ونظم المعلومات الجغرافية بالإضافة الى دراسة الخواص الطبيعيه والكيميائيه. وقد أختير 18قطاعا أرضيا ممثلا لأراضي واحة الفرافرة بالإضاقه إلي 72 حفرة صغيرة (Aguer) ، وقد جمعت من هذه القطاعات الأرضيه عينات تمثل الإختلافات الرأسية لإجراء للتحليلات المعملية المختلفه. بإستخدام التقنيات الحديثة تم إنتاج خريطه فيزيوجرافية بإستخدام التفسير المرئي لصورة القمر الصناعي سينتنال 2 مع بيانات التركيب الجيولوجي ونموذج الإرتفاعات الرقمي لمنطقة الدراسة. ودرست الصفات الطبيعيه والكيميائيه المميزة لوحدات خريطة التربة وأوضحت الدراسة ان هناك 7 وحدات واقعه داخل منطقة الفرافره القديمة وهي كالتالي: 1- مناطق منزرعة Cultivated areas 2- السهل الطباشيري Chalky plain 3- اشباه السهول Peni plain 4- الفراشات الرملية Sand sheet 5- الوديان الجافة Dry wadis 6- البلايا Playa 7- أراضي صخرية Rocky Area. وأوضح تطبيق نموذج تقييم الاراضي .Sys *et al* أن أراضي المنطقة تقع في أقسام متوسطة الصلاحية (S2) وحدية الصلاحية (S3) وغير صالحة للزراعة بصفة مؤقتة (N1) وأراضي غير صالحة للزراعة بصفة دائمة (N2). وتبين النتائج أن حوالي 18,55 % من اجمالي منطقة الدراسة هي أراضي متوسطة الصلاحية (S2) وأن العامل المحدد هو قوام التربة. أما الأراضي حدية الصلاحية (S3) فهي تغطي مساحة 41,22% من اجمالي منطقة الدراسة وحدية الصلاحية فيها ترجع الى عمق القطاع الأرضي وقوام وملوحة التربة. بينما كانت الأراضي غير الصالحة للزراعة بصفة مؤقتة (N1) تمثل مساحة 11,46%. وكانت الغير الصالحة للزراعة بصفة دائمة (N2) تمثل مساحة 21,06%. تمثل الأراضي المنزرعة بمنطقة الدراسة مساحة حوالي 7.7 % من إجمالي المساحة. تم إختيار أربعة محاصيل لتقييم درجة صلاحيتها للزراعة طبقا لطريقة Sys وهي والقمح والشعير والذرة الرفيعة والزيتون، وتبين من النتائج أن الزيتون هو أفضل هذه المحاصيل حيث تجود زراعته بدرجة أعلى من باقي المحاصيل