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Assessing of Land Resources for Agriculture Development in the Western Side of El-Dakhla Oases, Egypt

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ABSTRACT

The studied area is located between latitudes 26˚ 20` & 25˚ 30` N and Longitudes 27˚ 55` & 28˚ 20` E. covering an area of about 530445 feddans. The area is being reclaimed now to be a link between EL-Dakhla and Abu Mnqar Oases western Desert of Egypt. The present study aims to identify the physiographic futures and evaluating the agricultural potentiality of the soils in the study area to determine the most appropriate land use. To achieve this objective Sentinel 2 images, digital elevation model and data limited to land surveying were used for delineating the region's main physiographic units in the study area are plateau ((pL 11)), Bajada (P13), Solutional depression (P12), Pedi plain (P11), Sand sheets (P21), and sand dunes (P22). Sixteen soil profiles plus a number of auger observations and 120 minipits were selected to represent the different mapping units. A field work and morphological description were carried out and soil samples were collected for demonstrating the physical and chemical soil properties beside six water samples were collected from six wells. The results indicated that the studied soil profiles were classified according to (USDA, 2014) and could be categorized into two orders. Aridisols, Entisols and six sub great groups as follows. i) Aridisols including three sub great groups of Typic Haplosalids, Gypsic Haplosalids and Calcic Haplosalids. ii) Entisols include three sub great groups of Typic Torripsamments, Typic Quartzipsamments and Typic Torriorthents. The water wells in the studied area have a high quality as the salinity is not exceed 0.301 dSm^{-1} and sodium adsorption ratios were less than 1.12 in all water samples. Land capability classes were performed using Sys & Verheye (1978) and Sys etal (1991). The current for agriculture irrigated soils could be categorized into two classes fair soils (III) and poor soils (IV) grades, which are suffering from some soil properties i.e, soil texture, soil profile depth, CaCO3 , Salinity and Alkalinity as soil limitations with different intensity degrees (moderate to severe). By executing the suitable soil improvement practices, the potential suitability classes assessed two classes, i.e good soils (II) and fair soils (III) grades. The severity can be corrected by application of organic and inorganic soil amendments, salt leaching and levelling of undulating surface. Also, Soil suitability for specific crops i. e. (wheat, maize, beans, barley, cabbage, potato, watermelon, onion, olives, citrus, guava and banana) were presented for soils developed on the identified physiographic units in land suitability guide tables.

Keywords: Physiographic units, Remote sensing (RS), GIS, Soil taxonomy, Land evaluation.

INTODUCTION

The desert area extends to about 94 % of the total area of Egypt. The residual area which devoted for agriculture and foundation represents only about 6 % of total area. According to overcrowded annual increasing of the Egyptian population and their fast need for food which decreased as a result of reducing the cultivated lands in the Nile Valley and Delta due to the transgression by building on the fertile lands. The government of Egypt decided to get out from the narrow valley and searching for other areas for food production. The government looked toward desert especially the Western Desert which represent the great majority of the total area of Egypt for invasion due to its area, suitability, flatness, smoothing and its huge amount of underground water.

The New Valley Governorate is located in the southern part of Western Desert, and shares the international borders of Libya to west the Sudan to the south. As for its internal boundaries, it shares the borders with the governorates of EL-Menia, Giza and Marsa Matrooh on the north and Assiut, Suhag, Qena and Aswan on the east. Its considered the biggest governorate in the country in terms of area, which amount to approximately 440098 Km^2, representing approximately 43.6% of the total area of Egypt. The new valley regions has high ground water potentiality, according it is included in the agriculture expansion plane of Egypt and it is an expansion to a reclamation profiles areas.

Dakhla Oasis is one of these markazs in the new valley Governorate and encompasses an area of about 2000 Km^2, it lies 120 Km almost the west of EL-Kharga or about 300 Km^2 west of Erment city in the Nile valley. It is bounded on the northern side by a precipitins escarpment which rises some 300m above the depression floor and marks the edge of the extensive Limestone plateau (EL-Dakhla upland,+400m). The depression floor (+100m) merges gradually into the general desert Level (+200m).

Location.

The study area is located in the north west of EL-Dakhla Oasis between longitudes 27˚ 55` and 28˚ 20` East and latitudes 26˚ 20` and 25˚ 30` North. (Fig 1) with total area about 530445 feddans. It fars south 600 km^2 from Cairo.

Climate

The climate data representing new valley. Governorate (Table 1) are detected at the climatological station of EL-Dakhla Oasis in the period 2010-2015 (CLAC; 2015). The various climate elements at this station indicate that the prevailing conditions are generally characterized by a long dry summer (from 2010 to 2015) and rainfall almost scarce throughout the year, not exceeding 0.5 mm/year.

Temperature region of the study area could be defined as Hyperthermic and soil moisture regime as Torric, (USDA 2014).

Table 1. Mean monthly climatological data of EL-Dakhla Oasis area (2010-2015).

Month	Rainfall mm/day	Relative Humidity (%)	Evaporation (mm/clay)	Temperature (˚C)		
				Max	Min.	Average
Jan.	0.1	35.4	8.8	23.9	4.3	14.1
Feb.	0.2	29.6	11.4	26.8	4.7	15.8
Mar.	0.0	22.8	17.7	31.5	8.4	20.0
Apr.	0.1	19.5	24.4	37.0	12.2	24.6
May.	0.1	18.5	30.4	39.0	17.0	28.5
Jun.	0.0	17.0	37.2	39.9	21.5	30.3
Jul.	0.0	17.7	37.6	41.7	21.5	31.6
Aug.	0.0	18.9	36.8	41.4	22.0	31.7
Sep.	0.0	20.7	31.4	39.6	25.0	32.3
Oct.	0.0	25.8	21.9	35.5	16.0	25.6
Nov.	0.0	30.7	14.0	29.1	9.9	19.5
Dec.	0.0	34.9	10.0	25.3	6.0	15.7
Mean	--	24.3	23.5	34.2	14.04	24.1

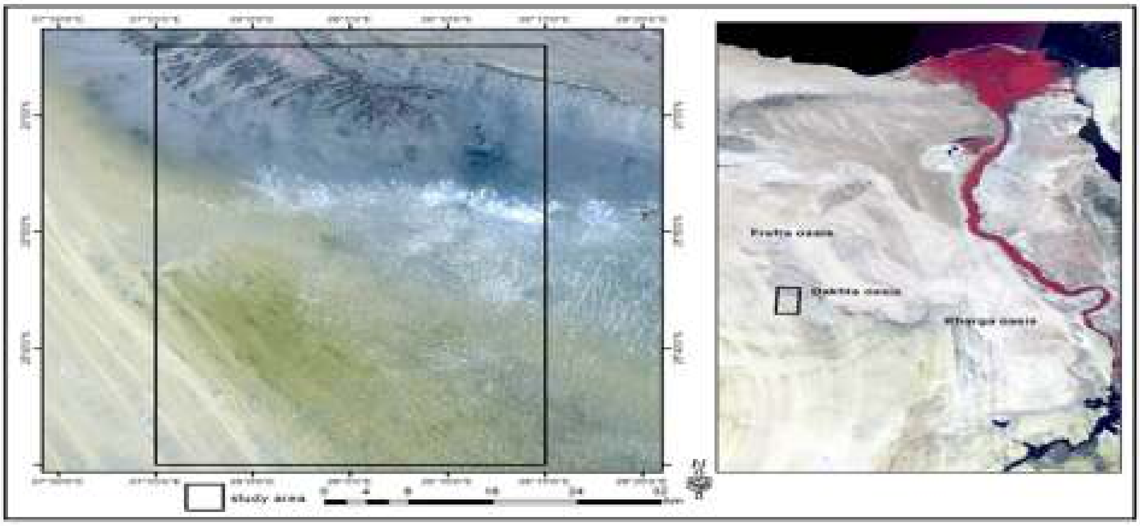

Fig. 1. Location map of the studied area.

Geologic setting

The surface of west EL-Dakhla Oasis area characterized mainly with the Nubian sand stone exposures of Cretaceous and Lower Tertiary sediments.

In the area of west EL-Dakhla Oasis Hermina *et al*., (1961), Hendricks *et al* (1987), New Geologic Map Series (EGPC- CONOCO, 1987-1988) and Ghoubachi (2001) indicated that the sediments of the studied area is essentially occupied by upper Cretaceous Nabian formations made up of cross-bedded sandstones with inter bedded shale. The extrusive rocks, which belong to the Precambrian age, are exposed in scattered patches. On the limestone plateau, Tertiaing Eocene and Paleocene limestone and shale overlie the Nubain formation, which is locally intruded by basalts believed to be the late Tertiary or Early Pleistocene age.

Geomorphology

Egyptian Geological survey (EGSMA, 1981), Ghoubachi (2001), the National Authority for Remote Sensing and Space. Science (NARSS(2004) and Embabi (2004), reported that the region in which the area under investigation was chosen may be classified to five geomorphic units these are :

1- **Platforms.** It is located surrounding low- lying areas with relatively steep compound escarpments and sub divided into two types namely structural platforms and peneplained platforms.

1- The structural platforms are subdivided into to categories

A. The carbonatic platforms (Among these forms the fluvial, Aeolian and structurally forms).

B. The sandstone platforms, It is known also as the peniplaned plateau (include the Aeolian sand dunes, fluvial and the lacustrine forms.

2- Peneplained platforms, this plateau are mostly granite and highly dissected by joints and faults. Its sedimentary cover was eroded gradually exposing its rocky surface.

2- Mega-Depressions :

Dakhla depression is the main mega-depressions of the western Egyptian Desert. It represents the old and final stages of the cycle of development of depressions in the Western Desert. This depression exhibit a variety of structural, erosional and depositional forms of various origins (playas, bajada and Aeolian sand deposional forms of fluvial origin).

3- Sand sea and dunes :

Sand sea and dunes cover wide areas where they spread on the surfaces on the platforms, depressions, slopes and the southern Pedi plain. Dune form varies between transverse and barchans according to dune density and wind action.

Water resources

Water plays an important role in land use especially irrigation water, which is considered the decisive factor for salinization. Ezz EL-Deen (1996) and Ghoubashi (2001) reported that the Nobian sandstone series extends over a very large portion of Egypt and contain the only large body of fresh ground water in the country it extends in considerable thickness throughout the entire Western Desert of Egypt and for into adjoining areas. The Nubian has favorable permeability characteristics and huge reserves of fresh water it therefore, constitutes the basic water source of most of these areas, and is one of the most extensive aquifer systems in the world.

The whole thickness varies from about 230m in the south to more than 750m in the north. This wide variation of thickness could be attributed to the general configuration of the basement, which in turn controlled by the geological structures.

The assessment of agricultural is such area requires evaluation of water and land resources in terms of land suitability for crops cultivation from an economic standpoint FAO (1985) showes that it is necessary to evaluate land and not just soils. The suitability of soils for irrigated crops is useful information but it is in adequate for making decisions about land use development.

Therefore all relevant land characteristics including soils, climate, topography, water resources, vegetation and also economic suitability need to be considered.

The current work has been carried out to give further information about the different land forms covering the area under consideration using remote sensing techniques, and to study the soil properties concerning morphological, physical, chemical and soil taxonomy aspects. Also, has been under taken to provide results and important information, about the land evaluation that is necessary for the promising area in the north western side of EL-Dakhla Oasis for the agricultural land use.

MATERIALS AND METHODS

Remote sensing and GIS works :

Topographic maps of the studied area scale 1: 50000 and geological map scale 1: 2000.000, data of sentinel 2 image taken during 2017 were used in this study for physiographic mapping. The extracted data for topographic maps are contour line. The physiography of the studied area was defined throughout the following steeps:

1- Digital elevation models (DEM) of the study area have been generated from the vector contour lines.
2- Data of sentinel 2 image 2017 and digital elevation model (DEM) was used in ERDAS imagine 2014 software to produce the physiographic map of the study area (Dobos *et al*., 2002).

Field work :

To obtain the broad soil and landscape characteristics a reconnaissance soil survey was made in the investigated area. Sixteen soil profiles were conducted in the study area representing the main physiographic units and 120 pedons were carried out to check the accuracy of mapping units boundary (fig 2). The exact locations of the soil profiles and minipits observation points were precisely defined in the field using the GPS" System cooperation MAGELLAN" GPS NAV DLX-10TM and plotted on (Fig 2). These soil profiles were dug down to 150cm, unless hindered by bedrock or water table.

Detailed morphological description of the studied soil profiles were recorded on the basis outlined by USDA (2017) and abbreviated as shown in Table (2), fifty one soil samples were collected from the studied soil profiles according to the morphological variations and air dried, crushed, sieved and used for physical and chemical analyses .

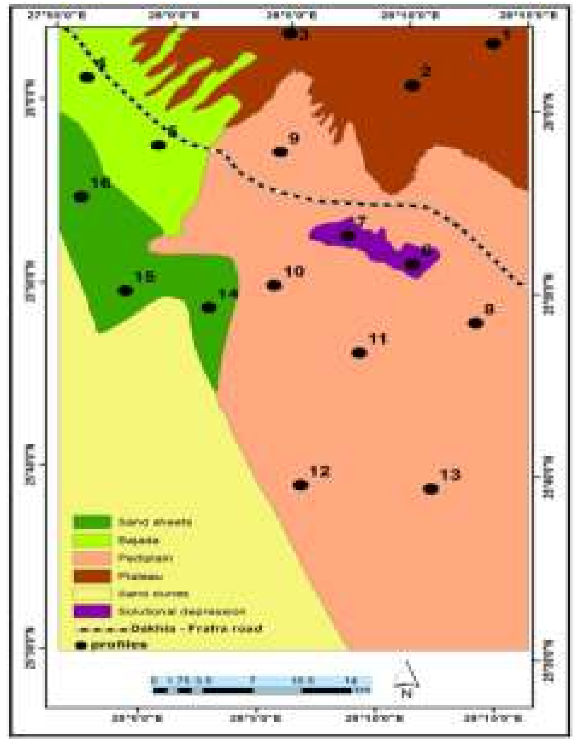

Fig. 2. Location of soil profiles and physiographic units.

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.			
Plateau	1	0-15	7.5YR6/4	7.5YR5/4	20	GSL	m	so.	fir.	ss, sp	++	CS	f.s.lime
		15-40	7.5YR6/4	7.5YR5/2	15	GSL	m	so.	fir.	ss, sp	+	CS	--
		40-80	7.5YR6/4	7.5YR8/4	10	SGSCL	m	so.	v.fir.	ms,mp	+	--	--
	2	0-12	7.5YR7/6	7.5YR5/6	25	SGSL	m	so.	v.fir.	ms, mp	++	CS	f.s.lime
		12-30	7.5YR6/4	7.5YR5/6	20	GSL	m	so.	fir.	ss,sp	++	CS	f.s.lime
		30-70	7.5YR6/4	7.5YR5/6	40	VGSCL	m	so.	v.fir.	ms,mp	+	--	--
	3	0-15	7.5YR7/4	7.5YR6/6	20	GSCL	m	so.	vfir.	ms,mp	++	CS	f.s.lime
		15-40	7.5YR6/4	7.5YR5/4	40	VGSL	m	so.	fir.	ss,sp	++	CS	f.s.lime
		40-55	7.5YR6/4	7.5YR5/4	15	GLS	m	so.	fir.	ns,np	++	--	--
Bajada	4	0-25	10YR7/3	10YR6/6	-5	SGSL	s.g.	lo.	lo.	ss, sp	++	CS	f.s.lime
		25-50	10YR7/4	10YR6/6	10	SGS	s.g.	lo.	lo.	ns,np	+++	CS	m.s.lime
		50-90	10YR8/3	10YR7/3	15	SGLS	s.g.	lo.	lo.	ns,np	+++	CS	m.s.lime
		90-130	10YR8/3	10YR7/3	15	SGSL	m	so.	fir.	ss,sp	++	--	f.s.lime
	5	0-20	10YR6/4	10YR5/3	-5	SGSL	s.g.	lo.	lo.	ns, np	+++	CS	c.s.lime
		20-45	10YR5/3	10YR5/6	15	SGSL	s.g.	lo.	lo.	ss,sp	+++	CS	c.s.lime
		45-85	10YR6/3	10YR6/4	10	SGLS	m	lo.	fir.	ns,np	+++	ds	c.s.lime
		85-130	10YR5/3	10YR5/6	20	GLS	m	s.h.	fir.	ns,np	++	--	f.s.lime
Solution depression	6	0-15	10YR7/6	10YR6/6	-10	SGSL	m	so.	fir.	ss, sp	+++	ds	m.s.lime
		15-40	10YR7/4	10YR6/6	15	SGSL	m	so.	fir.	ss,sp	++++	CS	c.s.lime
		40-90	10YR6/4	10YR5/6	20	GL	m	s.h.	v.fir.	s,p	++++	--	c.s.lime
	7	0-20	10YR5/3	10YR4/2	-15	SGSL	m	so.	fir.	ss, sp	++++	CS	c.s.lime
		20-60	10YR6/2	10YR5/2	10	SGSL	m	so.	v.fir.	ms,mp	++++	Ds	m.s.lime
		60-85	10YR6/2	10YR5/2	40	VGSiL	m	s.h.	v.fir.	ms,mp	++++	--	d.s.lime

Texture: G=Gravels, C= clay, SCL= Sandy Clay Loam, SL=Sandy Loam LS= Loamy Sand, L=loam Consistence: (dry)- lo.=loss so.=soft, s.h.= slightly hard (moist)- lo=loss fir.=friable v.fir.= very friable, (wet)- s =sticky p.=plastic ns=non sticky np= non plastic, ms=moderately sticky, mp.= moderately plastic, ss=slightly sticky sp=slightly plastic Structure: m= massive, w.c..angl.b=weak coarse angular blocky, s.g= single grain Effervescence: += weak, ++= moderate , +++= strong, ++++= very strong, Boundary: c.s= clear smooth d.s= diffuse smooth

Table 2. Cont.

Physiographic Unit	Prof. No.	Depth (cm)	Color		Gravels %	Texture	Structure	Consistence			Effervescence	Lower boundary	Others
			Dry	Moist				Dry	moist	Wet.			
Pedi Plain	8	0-20	10YR7/6	10YR5/6	5	SGSCL	m	so.	v.fri	ms,mp	+	cs	f.s. lime
		20-50	10YR6/6	10YR5/6	12	SGSCL	m	so.	v.fri	ms,mp	+	ds	--
		50-105	10YR8/3	10YR8/4	15	SGSCL	m	s.h.	v.fri	ms,mp	+	-	f.s.lime
	9	0-20	7.5YR6/6	7.5YR5/8	15	SGSL	m	so.	fir	ss, sP	++	cs	f.s. lime
		20-40	7.5YR6/4	7.5YR5/4	40	VGSL	m	so.	fir	Ss,sp	++	cs	f.s. lime
		40-80	7.5YR6/4	7.5YR5/4	25	GSC	m	s.h.	v.fir	S,p	++	--	f.s. lime
	10	0-25	7.5YR6/6	7.5YR5/8	15	GSL	s.g.	lo.	Lo	nS, nP	++++	cs	c.s. lime
		25-40	7.5YR5/4	7.5YR4/3	22	GSCL	m	so.	v.fir.	ms,mp	++++	cs	m.s.lime
		40-80	7.5YR5/4	7.5YR4/3	15	SGL	m	so.	v.fir.	s,p	++++	cs	m.s.lime
		80-110	7.5YR5/4	7.5YR5/4	35	VGSCL	m	s.h.	v.fir.	ms,mp	++++	--	m.s.lime
	11	0-20	7.5YR6/6	7.5YR5/6	35	GSL	m	so.	Fri.	ss, sP	++	cs	f.s. lime
		20-70	7.5YR7/6	7.5YR6/6	20	GSCL	m	so.	v.fir.	ms,mp	+++	cs	m.s.lime
		70-160	7.5YR6/6	7.5YR5/6	12	SGSL	m	s.h.	fir.	Ss,sp	++	--	f.s.lime
	12	0-20	7.5YR5/8	7.5YR4/4	11	SGSL	.m	so.	Fri.	ss, sP	++	cs	f.s. lime
		20-55	7.5YR6/6	7.5YR4/4	30	GC	w.c.angl.b.	w.c.angl.b.	v.fir.	s,p	++	ds	f.s. lime
		55-75	7.5YR6/4	7.5YR5/6	20	GC	w.c.angl.b.	w.c.angl.b.	v.fir.	S,p	++	--	f.s. lime
	13	0-25	7.5YR5/6	7.5YR5/8	7	SGSL	m	so.	Fri.	ss,s P	+++	cs	c.s. lime
		25-40	7.5YR5/4	7.5YR4/4	12	SGSL	m	so.	Fir.	ss,sp	++++	ds	c.s.lime
		40-70	7.5YR6/6	7.5YR5/6	25	GSL	m	s.h.	Fir.	Ss,sp	+++	--	c.s.lime
Sand sheet	14	0-30	10YR6/3	10YR5/4	-	S	s.g.	lo.	Lo.	ns,np	++	cs	f.s.lime
		30-70	10YR6/4	10YR5/4	2	SL	s.g.	lo.	Lo.	ss,sp	++	ds	f.s.lime
		70-120	10YR6/4	10YR5/4	-	SL	m	s.h.	Fir.	ss,sp	++	--	f.s.lime
	15	0-30	10YR7/6	10YR6/6	-	S	s.g.	lo.	Lo.	ns,np	--	cs	--
		30-80	10YR7/6	10YR6/4	2	S	s.g.	lo.	Lo.	Ss,np	--	ds	--
		80-110	10YR7/6	10YR6/4	2	S	s.g.	lo.	Lo.	ss,sp	--	--	--
	16	0-30	10YR7/3	10YR7/3		S	s.g.	lo.	Lo.	ns,np	++	cs	f.s.lime
		30-70	10YR7/8	10YR6/6	35	GLS	s.g.	lo.	Lo.	ns,np	++	ds	f.s.lime
		70-130	10YR7/8	10YR6/6		LS	s.g.	lo.	Lo.	ns,np	++	--	f.s.lime

Soil analysis:

A-physical analysis

Soil colour in both dry and wet conditions was determined using Mansell soil color charts (2010).

Particale size distribution was determined according to Klute (1986) using hexa-metaphosphate adispersing agent.

B- Chemical analysis

By using the soil Laboratory Methods Manual (USDA,2004), the Laboratory analysis for soil samples were, calcium carbonated percent, gypsum, organic matter, electrical conductivity (ECe), soil reaction (pH) in soil paste, cation exchang capacity (CEC) and exchangeable sodium-percentage (ESP) were determined .

The guideline for land evaluation for irrigated agriculture after FAO (1985) was used for assessing the water quality.

Soil classification

The American soil taxonomy (USDA, 2014) was used to classify the representative soil profiles to the sub great group level.

Land capability classification

Land evaluation assesses the performance of the land for specific purposes, and assesses the current and potential land suitability for irrigation agriculture. The simple approach proposed by Sys and Verheye (1978), modified by Sys *et al* (1991), with guidance of the FAO framework for land evaluation (FAO, 1976) was used.

Land Capability Classification (LCC) was done on basis of land characteristics of the physiographic units of the studied area using the Tables of rating suggested by Sys and Verheye(1978) and Sys *et al* (1991) according to the following equation.

$$Ci = t \times \frac{W}{100} \times \frac{S1}{100} \times \frac{S2}{100} \times \frac{S3}{100} \times \frac{S4}{100} \times \frac{n}{100} \times 100$$

Where :

Ci : Land capability index. t : Slope. w : Drainage.
Si : Texture. S_2 : Soil depth. S_3 : $CaCO_3$ content.
S4 : Gypsum content. n : Salinity & alkalinity.

Soil Suitability Classification for certain Crops (SSCC) was done by selecting twelve (12) crops to assess their convenience for cultivation in the studied area Sys *et al* (1993). Selected crops can be grouped into three categories as follows:

1- Field crops (wheat, maize, Beans and barley).
2- Vegetable crops (Cabbage, Potato, watermelon and onion).
3- Fruit trees (Olives, Citrus, guava and banana).

RESULTS AND DISCUSSION

Physiographic units of the investigated area :

Using the digital elevation model with satellite images verifies that the investigated are includes five main physiographic units , i.e, plateau (90.729 feddans), Pedi plain (240.070 feddans), bajada (42.840 feddans), sand sheets (32.771 feddans), Solutional depression (5.310 feddans), and sand dunes (118.725 feddans).as shown in Table (3) and fig (2). The landscape of the studied area were represented by sixteen soil profiles and fifty one soil samples, the morphological description of these profiles are illustrated in Table(2),while main physical and chemical properties are show in Table (4).

Table 3. The physiographic units Legend of the studied area

Land Scape	Origen	Relief	Land Forms	Mapping Unit	Area (fed.)	%
Plain (P)	Limestone mixed with sand (p1)	A. Flat to gently undulating (P11)	Pedi plain	(P111)	240.070	45.3
		undulating (P12)	Solutional depression	(P121)	5.310	1.0
		Flat to almost Flat (P13)	Bajada	(P131)	42.840	8.1
	Aeolian deposits (sandstone) (p2)	Flat to almost Flat (P21)	Sand sheets	(P211)	32.771	6.2
		Undulating to gently sloping (P22)	Sand dunes	(P221)	118.725	22.4
Plateau (PL)	Limestone With mixed sandstone (pL1)	Almost flat (PL11)	Plateau summit	(PL111)	90.729	17.1
		Undulating (PL12)	Escarpment	(PL122)		

Table 4. Main physical and chemical analysis of the studied soil profiles.

Physiographic unit	Prof. No.	Depth (cm)	Particle size distribution (%) Coarse sand	Fine sand	Silt	Clay	Texture Class	pH	EC_e dSm^{-1}	OM (%)	CEC Cmol kg^{-1}	ESP (%)	$CaCO_3$ (%)	Gyp. (%)
Plateau	1	0-15	17.1	50.7	17.6	14.6	GSL	7.8	20.9	0.11	15.7	12.3	10.4	2.1
		15-40	11.1	48.4	26.1	14.1	GSL	7.1	165.5	0.20	16.5	5.6	3.7	3.5
		40-80	3.5	47.2	26.4	22.9	SGSCL	7.3	160.1	0.35	20.9	8.8	5.5	5.4
	2	0-12	15.3	46.6	21.9	16.2	SGSL	7.7	20.8	0.12	21.1	10.2	10.5	1.5
		12-30	21.5	50.1	22.8	5.6	GSL	7.5	106.6	0.15	10.2	11.7	18.6	1.1
		30-70	7.9	46.7	19.9	25.5	VGSCL	8.1	79.2	0.22	25.3	10.1	4.3	1.3
	3	0-15	13.7	40.5	22.3	23.3	GSCL	7.6	21.6	0.11	22.5	4.8	11.7	2.3
		15-40	22.3	48.7	20.2	8.8	VGSL	7.6	97.5	0.11	11.3	7.7	12.2	2.5
		40-55	27.1	51.2	15.9	5.1	GLS	7.4	72.4	0.20	8.1	12.1	6.3	2.1
Bajada	4	0-25	32.8	38.2	14.7	14.3	SGSL	7.7	20.1	0.17	10.2	5.7	12.9	2.35
		25-50	8.1	80.7	4.1	7.1	SGS	7.8	46.5	0.11	2.5	12.3	16.5	2.6
		50-90	15.7	65.8	10.8	7.7	SGLS	7.8	56.6	0.09	7.3	11.2	18.9	1.8
		90-130	17.8	59.2	8.6	14.4	SGSL	7.6	40.3	0.06	11.3	4.8	14.3	3.1
	5	0-20	20.1	55.5	15.7	8.9	SGSL	7.9	12.1	0.10	5.8	8.9	15.5	1.5
		20-45	36.2	29.8	18.3	15.7	SGSL	7.6	27.4	0.10	12.5	8.7	16.8	2.1
		45-85	41.7	40.9	10.5	6.9	SGLS	7.8	45.5	0.11	6.2	6.4	16.9	2.1
		85-130	18.9	60.9	12.8	7.3	GLS	7.3	50.6	0.12	6.1	10.1	11.2	2.3
Solutation Depression	6	0-15	36.9	25.1	24.5	13.6	SGSL	7.4	7.7	0.18	9.9	9.4	33.2	2.3
		15-40	23.1	37.8	21.1	18.1	SGSL	7.4	100.2	0.15	10.1	11.1	45.5	3.1
		40-90	5.9	25.7	48.3	20.1	GL	7.1	125.0	0.23	10.5	12.3	50.3	4.1
	7	0-20	39.1	19.7	23.4	17.8	SGSL	7.9	61.9	0.21	9.5	7.7	46.4	3.5
		20-60	10.2	4.1	70.9	14.8	SGSL	7.3	20.7	0.13	12.7	3.1	54.6	2.4
		60-85	15.6	5.2	66.2	13.1	VGSiL	7.2	41.8	0.12	12.2	5.3	75.7	2.6

Table 4. Cont.

hysiographic unit	Prof. No.	Depth (cm)	Particle size distribution (%) Coarse sand	Fine sand	Silt	Clay	Texture class	pH	ECe dSm-1	OM (%)	CEC Cmol kg-1	ESP (%)	CaCO3 (%)	Gyp. (%)
Pedi plain	8	0-20	24.5	44.6	9.4	21.5	SGSCL	7.7	65.6	0.18	16.5	4.6	5.3	3.1
		20-50	22.4	39.8	17.5	20.4	SGSCL	7.5	23.5	0.14	16.6	5.9	4.9	2.3
		50-105	17.4	38.9	19.2	24.6	SGSCL	7.5	37.1	0.10	17.4	7.2	5.5	2.5
	9	0-20	43.5	31.9	11.6	12.9	SGSL	7.8	22.2	0.20	11.1	2.1	12.2	0.1
		20-40	35.8	31.2	15.4	17.6	VGSL	7.7	165.1	0.12	12.8	3.5	8.7	1.5
		40-80	25.1	30.1	5.6	39.3	GSC	7.5	143.5	0.29	22.5	11.7	6.5	3.5
	10	0-25	22.4	58.5	7.6	11.5	GSL	7.4	10.1	0.13	6.5	22.0	40.6	2.14
		25-40	14.3	62.1	2.7	20.9	GSCL	7.6	5.6	0.03	9.7	1.6	20.8	1.7
		40-80	30.9	13.5	40.9	14.6	SGL	7.2	110.2	0.23	12.6	6.1	32.9	2.8
		80-110	20.3	40.3	13.2	26.3	VGSCL	7.1	39.9	0.10	13.9	11.4	25.8	2.1
	11	0-20	44.5	30.3	10.2	14.9	GSL	7.9	7.3	0.16	16.3	4.5	14.2	0.6
		20-70	29.3	33.6	13.4	23.6	GSCL	7.8	27.5	0.13	19.8	4.3	17.5	2.5
		70-160	24.9	45.1	10.9	19.1	SGSL	7.5	41.8	0.18	14.5	10.7	11.6	2.5
	12	0-20	48.5	19.8	15.1	15.6	SGSL	7.8	7.9	0.03	14.5	8.4	8.6	2.5
		20-55	38.2	7.4	15.2	45.3	GC	7.4	63.5	0.22	22.2	19.4	7.5	3.2
		55-75	32.2	5.4	15.9	40.3	GC	7.3	45.1	0.12	20.0	14.8	9.3	1.9
	13	0-25	51.2	24.3	6.7	17.9	SGSL	7.7	26.5	0.16	8.8	2.3	37.5	2.4
		25-40	40.9	26.5	23.1	9.5	SGSL	7.8	74.7	0.26	5.5	20.5	40.5	2.9
		40-70	36.2	29.8	18.3	15.7	GSL	7.2	43.3	0.22	12.6	16.9	35.2	3.7
Sand sheet	14	0-30	55.0	34.8	5.9	4.3	S	7.7	1.3	0.12	3.8	12.2	12.2	0.05
		30-70	27.1	54.4	4.6	14.9	SL	7.5	2.9	0.05	10.8	6.2	12.5	0.01
		70-120	26.7	53.2	4.5	15.7	SL	7.6	3.1	0.05	10.9	8.3	14.1	0.06
	15	0-30	69.8	29.1	0.5	0.62	S	8.7	2.3	0.11	1.5	7.6	1.3	0.05
		30-80	37.10	62.25	0.2	0.45	S	8.1	3.7	0.01	1.5	8.1	1.5	0.07
		80-110	28.04	70.67	0.1	1.19	S	7.9	5.4	0.01	1.7	8.5	1.5	0.02
	16	0-30	60.1	27.8	6.5	5.7	S	8.9	4.8	0.08	5.1	8.9	10.6	1.7
		30-70	59.3	20.9	11.3	8.5	GLS	7.8	6.5	0.08	7.6	8.2	10.5	0.50
		70-130	56.4	24.8	11.2	7.6	LS	7.7	3.4	0.05	6.7	6.4	12.6	0.20

Some of these characteristics could be summarized the following lines:

Soils of plateau

Plateau called a high plain or Table land is an area of highland usually consisting of reactively flat terrain that is raised significantly above the surrorwnding area often with one or more sides with steep slopes. Plateau physiographic unit covered about (90.729 feddans) representing 17.1% of the total study area and extended in the north from east to west, which represented by profiles 1.2 and 3. Topography of this unit is almost flat to undulating with moderately deep soils (from 55-80 cm). Soil dry colour varied from light brown (7.5 YR 6/4) to pink (7.5 YR 7/4), while moist colour ranged from dark brown (7.5 YR 3/2) to reddish yellows (7.5 YR 6/6). Texture class varied between gravelly loamy sand to very gravelly sandy clay loam. With massive structure throughout the entire profiles depths. Gravel content ranged from 10 to 40% (fine to coarse). Soil consistence coincides well with soil texture being non sticky to moderately sticky and non-plastic to moderately plastic.

Table (4) pointed out that soil reaction values (pH) indicate that these soils are neutral to moderately alkaline as pH values varied from 7.1 to 8.1. ECe values ranged from 20.8 to 165.5 dSm^{-1} indicating that these soils were strongly to very extremely saline, Salt content in the plateau soils was enough to requirements salic horizon. Organic matter content was extremely low not exceeds 0.35 %. $CaCO_3$ content ranged from 3.7 to 12.2 %. The distribution pattern of $CaCO_3$ does not portray any specific pattern with soil profile depth.

Gypsum content is very low varied from 1.1 to 3.5%. CEC values varied between 8.1to 25.3 Cmole kg^{-1}, while ESP values less than 15% (non sodic soils).

By using to the recent American soil taxonomy (USDA 2014), the studied soil profiles could be classified as (Table 5) and fig (3)

-Typic Haplosalids (profiles 1.2 and 3).

Soils of bajada

Bajada unit is located in the north western part of the study area south to the north plateau.

The sediments of bajada are formed by lateral coalescence of series of alluvial fans which are transported by the action of the flush floods, that ranning through feeder channels, intersecting the mountain front, as pointed by (NSSH, 2001). The surface is nearly level, gently sloping and detritus. This physiographic unit cover about (42.840 feddans) which represent 8.1% of the total area and represented by profiles 4 and 5, soil dry colour varied from brown (10YR 5/3) to very pale brown (10YR 8/3), while moist colour ranged from yellowish yellow (10YR 5/6) to very pale brown (10YR 7/3). Gravel content varied between 5 and 20%. Soil texture raised from slightly gravelly sand to slightly gravelly sandy loam. Soil structure was single grain in the upper most surfaces layers changed into massive in the deepest layers. Soil consistence varied from non-sticky to slightly sticky, non-plastic to slightly plastic, moreover, the top layers were loose and firm in the deepest layers.

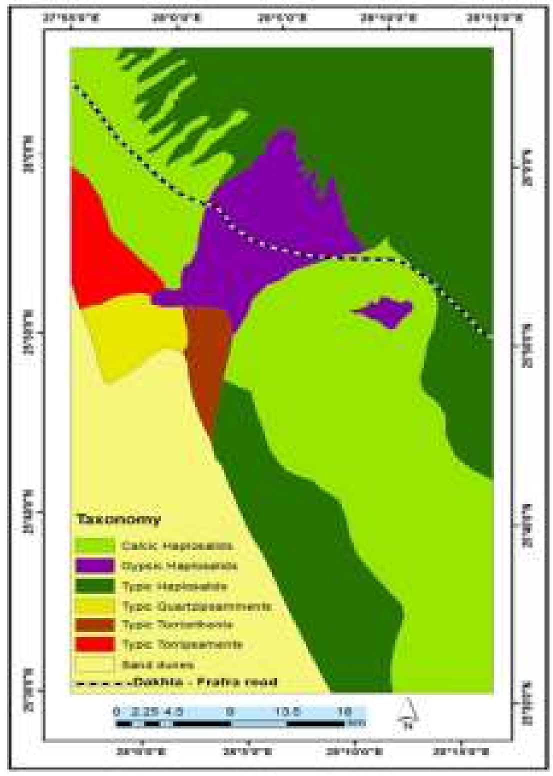

Fig. 3. Soil classification of the studied profiles (according to USDA 2014).

Data in Table (4) reveal that pH values varied from 7.3 to 7.9 indicating that these soils were neutral to moderately alkaline. Soils were moderately to extremely salines where ECe values ranged between 12.1 and 56.6 dSm^{-1}. Organic matter content was very low not exceeds 0.17% due to the prevailing aridity. $CaCO_3$ content ranged from 11.2 to 18.9% with an irregular distribution pattern with depth.

Gypsum content was very low varied from 1.5 to 3.1%. The values of CEC varied from 2.5 to 12.5 Cmole Kg^{-1} while ESP values ranged between 4.8 and 12.3% showing that these soils were non-sodic soils.

The soils of bajada were enriched with expanding salts and $CaCO_3$ enrichments that satisfy the requirments of salic and calcic horizons as well as Aridsols. The soils of bajada unit were classified according to (USDA, 2014) to the sub great groups as (Table 5).

- Calcic Haplosalids (Profiles 4 and 5).

Soils of solutional depression :

Soils of solution depression is located in the Eastern side of the studied area and covering about 1.0% (5.310 feddans) of the studied area and representing by profiles (6 and 7). The soils of Solutional depression are moderately deep (90-80 an depth). Soil dry colour ranged between brown (10 YR5/3) to yellow (10YR7/6), while moist colour ranged from dark grayish brown (10YR4/2) to brownish yellow (10YR6/6). Soil texture class varied from slightly gravelly sandy loam, to very gravelly silty loam, with massive structure. Gravel content ranged from 10 to 40%, where soil consistence was slightly sticky to moderately sticky, and slightly plastic to moderately plastic, (Table 2).

Table (4) reveals that these soils were neutral to moderately alkaline where pH values varied from 7.1 to 7.9. The electrical conductivity (ECe) varied from 7.7 to 25.0 dSm^{-1} indicating that these soils were slightly saline to very extremely saline and their values of (ECe) is enough to the requirements of salic horizons. Organic matter and gypsum contents varied from 0.12 to 0.23% and 2.3 to 4.1 %, respectively.

Lime content was very high ranged from 33.2 % to 75.7 % and their content is enough to their requirements of calcic horizons profiles (6 and 7). CEC values ranged between 9.5 and 12.7 Cmolc Kg^{-1}. Most soils of solutional depression were non-sodic soils where the values of ESP varied from 3.1 to 12.3%.

According to the USDA (2014), the studied soils of solutional depression could be classified as , (Table 5).

- Gypsic Haplo Salids (profile 6).
- Calcic Haplo Salids (profile No. 7).

Table 5. Soil Taxonomy and Physiographic units of the studied area (According to USDA, 2014).

Order	Sub Order	Great Group	Sub great group	Profile No.	Units
Aridisols	Salids	Haplosalids	Typic Haplosalids	1,2 and 3 8 and12	Plateau Pedi plain
			Gypsic Haplosalids	6 9	Solutational depression Pedi plain
			Calcic Haplosalids	4 and 5 7 10,11 and 13	Bajada Solutational depression Pedi plain
Entisols	Psamments	Torripsamments	Typic Torripsamments	16	Sand sheets
		Quartzipsamments	Typic Quartzipsamments	15	Sand sheets
	Orthents	Torriorthents	Typic Torriorthents	14	Sand sheets

Soils of Pedi plain :

Pedi plain is a plain of low relief formed in aried or semiarid regions at the base of a receding mountain front. A Pedi plain is underlain by bedrock that is typically covered by a thin discontinuous veneer of soils (USGS, 2009). It is Located in the middle and south part of the studied area and extends from south to north exhibit area of about (240070 feddans) representing by 45.3% of the total area and represented by profiles 8, 9, 10, 11, 12 and 13. It is extend in the estern side of the studied area from south to north the suface of this physiographic unit is almost flat to gentely undulating. Soil profiles depth varied from moderately deep to deep (70-110 cm depth). Soil dry colour varied from brown (7.5 YR 5/4) to very pale brown (10YR 8/3), while moist colour ranged from very pale brown (10YR 8/4) to brown (7.5 YR 4/3). Soil texture class was slightly gravelly sandy loam to gravelly clay with massive structure, where soil consistence was slightly sticky to sticky and slightly plastic to plastic, (Table 2).

Data of chemical properties of the studied physiographic unit showed in Table (4), that pH values varied between 7.1 to 7.9 indicating that these soils were natural to moderately alkaline. ECe values ranged from slightly to very extremely saline where ECe values varied from 5.6 to 165.1 dSm^{-1}. Organic matter content was generally very low not exceeded 0.29%. $CaCO_3$ content ranged from 4.9 to 40.6% with an irregular distribution pattern with soil profiles depths. The content of $CaCO_3$ in profiles 10.11and 13 were enough to the requirements of calcic horizons. Gypsum content was mainly less than 3.7% CEC values varied from 5.5 to 22.5 Cmole Kg-1, values of ESP ranged between 1.6 to 22% indicating that the soils of profiles 10.12 and 13 were sodic soils. According to the USDA (2014), the studied soil profiles of Pedi plain could be classified and summarized in Table (5) as follows:

- Typic Haplosalids (Profiles 8 and 12).
- Gypsic Haplosalids (Profile 9).
- Calcic Haplosalids (Profiles 10, 11 and 13).

Soils of sand sheets :

The origin of sand sheets is related to the fluvial erosion of the Nubian sandstone as exposed in the southern part of the Western Desert and transported toward the north. Thus, the hypothesis implies that sand were deposited by water and sculptured by the wind (EL-Baz, 1998).This aeolian plain was deposited in the study area by wind action in the open landscapes. Raning gently undulating surfaces including loose sands. Sand sheets physiographic unit is located between the bajada and sand dunes in the western part of the area under investigation, covering an area of about (32771 feddans) representing 6.2% of the total area and representing by profiles 14, 15 and 16. The soil relief is almost flat to undulating with deep soil profile. Soil dry colour varied from pale brown (10YR6/3) to yellow (10YR7/8), while moist colour varied from yellowish brown (10YR5/4) to very pale brown (10YR7/3). Gravel content was very low and ranged from (2 to 5%). Soil texture varied from sand to very gravelly loamy sand. The soil structure was undeveloped where the single grain type was dominates. Soil consistence varied between slightly sticky to non-sticky and non-plastic to slightly plastic, the grades of soil consistence coincide. Well with soil texture (Table 2).

Table (4) Shows those soluble salts were formed in low amounts as indicated by their electrical conductivity values which varied from 1.3 to 6.5 dSm^{-1} indicating that the soils of sand sheets were non to slightly saline. The soils were slightly alkaline where the values of pH ranged from 7.5 to 7.8. Organic matter content was generally very low, it ranged from 0.03 to 0.11% owing to the prevalence of arid conditions, which facilitate the decomposition of the organic matter. $CaCO_3$ content varied widely from 1.3 to 14.1% with tendency to increase with depth while, Gypsum content was very low and varied from 0.02 to 1.1% . CEC values ranged between 1.5 and 10.9 Cmole Kg^{-1}, while ESP values varied from 6.2 to 12.2% indicating that the soils were non sodic.

The soils of sand sheets were classified to the sub great groups using (USDA, 2014) as follows :

- Typic Torripsamments (Profile 16).
- Typic Quartzipsamments (Profile 15).
- Typic Torriorthents (Profile 14).

Hydrochimical of grownd water :

Water plays an important role in land- use especially irrigation water, which is considered the decisive. Factor of salinization. The regional Nubian sandstone aquifer system occupying much of the studied area and continuing across the border in the westward direction into Libya, in the south and south westward direction into Sudan and Chad (Shata, 1987). The depths of the sediments varies from few hundred meters in the south of 4000 meters west of Abu Monqar Oasis.

Table (6) shows the main chemical analyses of the collected water samples. The data indicate that the electrical conductivity (ECe) is very low in the collected samples as it varied between 0.203 and 0.301 dSm^{-1}. The PH values ranged from 6.3 to 7.8, while TDS values varied from 129.9 to 192.6 ppm. The values of sodium adsorption rats (SAR) in general are less than 1.12, while RSC values for the studied water samples less than (<1.25) meg/L (class 1) while is good quality. So the water quality is considered as high quality as it fit with the requirements of the most of crops (FAO, 1985).

Table 6. Some chemical composition of the ground water samples

Location	Location		pH	ECe (dsm^{-1})	TDS ppm	SAR	RSC
	Latitudes (N)	Longitudes (E)					
West ElMawhob well(1)	25°41′56″	28°9′44″	6.3	0.255	163.5	0.86	-0.62
West ElMawhob well(2)	25°42′15″	28°44′43″	6.5	0.245	156.8	1.12	-0.58
West ElMawhob well(3)	25°53′28″	28°18′25″	6.6	0.237	151.7	0.75	-0.64
West ElMawhob well(4)	25°42′56″	28°54′7″	7.6	0. 203	129.9	0.58	-0.66
West ElMawhob well(5)	25°40′42″	28°58′47″	7.8	0.295	188.8	0.97	-0.75
Abu Monkar	27°6′6″	26°49′9″	7.2	0.301	192.6	0.57	-11.6

Land Capability evaluation

Land evaluation objective is to guide wisely the present land resources and qualifications through appropriate management and plain the future using best land use alternative (Sys & Verheye 1978).

The term land capability is widely used to indicate the inherent potentiality of land to perform at a given level for a general use, while land suitability is the fitness of a given type of land for a defined use to indicate the adaptability of a given area for a specific kind of land use.

The process of land suitability classification is the appraisal and grouping of specific area of land in terms of their suitability for defined land utilization types, while land Capability Classification deals with land productivity classes for general uses corresponding to the major kinds of land use. Some researches regard the terms "Suitability" and "Capability" as interchangeable.

In this system the studied soils are classified according to Storie (1964) and Sys *et al*., (1991) to the following:

Grade	Rate (%)
(I) Excellent soils	80-100
(II) Good soils	60-79
(III) Fair soils	40-59
(IV) Poor soils	20-39
(V) Very poor soils	10-19
(VI) Nonagricultural soils	Less than 10

Current land Capability

The current land *Capability* of the studied soils was estimated by matching between the present soil characteristics and their ratings using the parametric system outlines by Sys and Verheye (1978) and Sys *et al*., (1991) as shown in Table (7) and shown in Fig (4). The results redial that the studied soil profiles are placed between fair soils (III) and poor soils (VI) grades.

1- **Soils of grade (III)**: this grade of soils occupies an area of about (159.07 feddans) (30%) and capability index values ranged from (40:01 to 46:47). The soils of grade (III) (Fair Soils) are represented by soils of plateau (profile 1), Pedi plain (profiles 9, 11 and 12) and soils of Sand sheets (profiles 14, 15 and 16) These soils have moderate limitations which are different in their kind and degree; as a general three different soil limitations are recognized. The dominant limitations are soil texture, calcium carbonate, salinity and alkalinity.

2- **Soils of grade (IV)**: this grade occupies an area of about (252.647 feddans) (47.6 %). The soils are represented by nine soil profiles which representing the soils of Plateau (profiles 2 and 3), soils of bajada (profiles 4 and 5), soils of Solutional depression (profiles 6 and 7) and soils of Pedi plain (profiles 8, 10 and 13). The soils of these profiles have suitability index ranged from 26.65 to 36.15%. In general these grades of soils are affected by moderate to severe limitations. The dominate soil limitations are soil texture (coarse texture), $CaCo_3$, salinity and alkalinity, while the minor limitation of topography (slope).

Potential Capability

Potential suitability 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). Land improvements are activities which cause beneficial changes in the qualities of the land itself. They are classified as major or minor.

Data of Capability of the studied soils showed that these soils are affected mainly by some soil limitations such as soil depth, texture, soil fertility, $CaCo_3$ as well as salinity and alkalinity. Land improvement is required to correct or to reduce the severity of limitations existing in the investigated area, such as:

1. Leaching of soil salinity and reclamation of alkalinity to get rid of soluble salts outside of the area.
2. Leveling of undulating surface soils.
3. Application of chemical and organic fertilizers, green manure and soil amendments to increase soil fertility to improve the physical and chemical soil properties.
4. Application of modern irrigation systems, such as drip and sprinkler to save irrigation water.

Potential Capability of the studies area after completed required land improvements was estimated by their ratings outlined by Sys *et al*., (1991), using the aforementioned parametric method, Table (7).

The potential land Capability of the studied soils are illustrated in, Table (7) and shown in Fig (5), indicating that the studied soil profiles are placed between good (II) and fair (III) grads.

Table 7. Current and potential suitability of the studied soils.

Profile No.	Topography (t) CS	Topography (t) PS	Wetness (W) CS	Wetness (W) PS	Soil Physical Characteristics: Depth	Texture CS	Texture PS	Lime	Gypsum	Salinity/ alkalinity (n) CS	Salinity/ alkalinity (n) PS	Current Suitability Ci	Current Suitability Grade	Potential Suitability Ci	Potential Suitability Grade
Plateau															
1	90	100	100	100	95	70	80	100	100	75	100	44.89	Fair (III)	76	Good (II)
2	90	100	100	100	85	70	80	100	90	75	100	36.15	Poor (IV)	61.2	Good (II)
3	90	100	100	100	85	70	80	90	90	80	100	34.7	Poor (IV)	55.08	Fair(III)
Bajada															
4	75	100	90	100	100	65	80	90	90	75	100	26.65	Poor(IV)	64.8	Good (II)
5	75	100	90	100	100	65	80	90	90	80	100	28.43	Poor(IV)	64.8	Good (II)
Solutional Depression															
6	100	100	85	100	95	70	80	80	100	75	100	33.92	Poor(IV)	60.8	Good (II)
7	100	100	85	100	95	70	80	80	90	80	100	32.56	Poor(IV)	54.72	Fair(III)
Pedi Plain															
8	75	100	100	100	100	65	80	100	90	80	100	35.1	Poor(IV)	72	Good (II)
9	100	100	90	100	95	65	80	100	90	80	100	40.01	Fair(III)	68.4	Good (II)
10	100	100	90	100	100	65	80	90	90	75	100	35.54	Poor(IV)	64.8	Good (II)
11	100	100	90	100	100	65	80	90	90	85	100	40.28	Fair(III)	64.8	Good (II)
12	100	100	90	100	85	90	100	100	90	75	100	46.47	Fair(III)	76.5	Good (II)
13	100	100	90	100	85	65	80	80	90	75	100	26.85	Poor(IV)	48.96	Fair(III)
Sand sheets															
14	90	100	100	100	100	60	80	90	90	96	100	41.99	Fair(III)	67.8	Good (II)
15	90	100	100	100	100	50	70	100	90	100	100	40.5	Fair(III)	63	Good (II)
16	90	100	100	100	100	60	80	90	90	90	100	39.37	Fair(III)	64.8	Good (II)

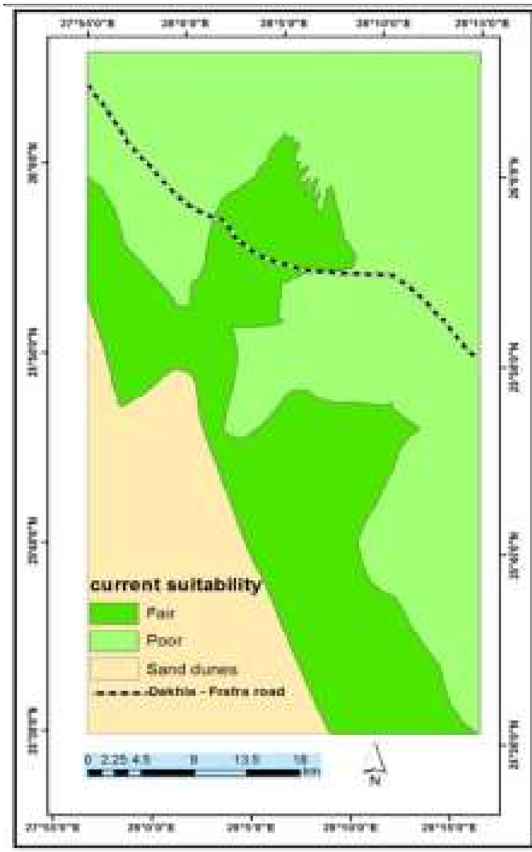

Fig. 4. Current Soil suitability for irrigated agriculture of the studied area.

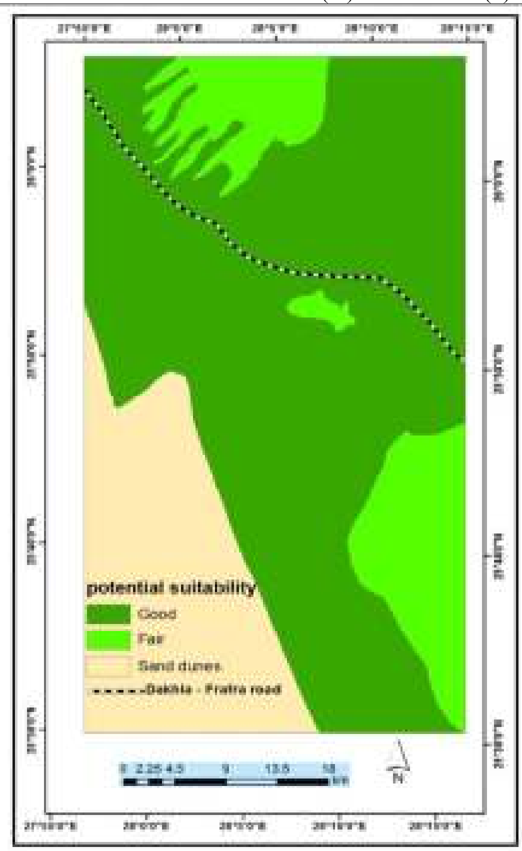

Fig. 5. Potential Soil suitability for irrigated agriculture of the studied area

Soils of grade (II)

The soils of grade (II) (good) occupies as area of about (329.759 feddans) (62.2 %). It represents the soils of Plateau (profiles 1 and 2), soils of bajada (profiles 4 and 5), Solutional depression (profile 6), soils of Pedi plain (profiles 8, 9, 10, 11 and 12) and soils of sand sheets (profiles 14, 15 and 16). Ci values ranged from 60.8 to 76.5%. The increase in such values and improving Ci from III (fair) and IV (poor) to II (good) refer to leveling of undulating surface in addition to leaching of salinity and reclamation of alkalinity of the soils.

Soils of grade(III)

This unit occupies an area of about (81962 feddans) (15.5 %). It represented soils of Plateau (profile 3), soils of Solutional depression (profile 7) and soils of Pedi plain (profile 13). Suitability index (Ci) values range from 48.96 to 55.08%. These soils have moderate intensity of texture and calcium carbonate and slight intensity of soil profile dept.

Land suitability for specific crops

Twelve crops were selected to predict their suitability for cultivation in the study area, prevailing climatic condition taking in consideration. The selected crops are grouped into three categories as follows:

1- **Field crops:** wheat, Maize, Beans and barley.

2- **Vegetable crops:** Cabbage, Potato, watermelon, and Onion.

3- **Fruit trees:** Olives, Citrus, Guava, and banana.

By using the parametric approach of land index as mentioned by Sys et.al. (1991) and (1993), the obtained data through matching soil characteristics together with crop requirements, Table (8) led to the current and potential suitability indices for each of the studied crops.

A- Current land suitability

Data in Table (8) reveal that the studied soil profiles of the investigated area were not suitable (N) for all the studied crops, except few soil profiles of some physiographic units (Plateau, Bajada, Pedi plain and sand sheets) for wheat, olives, guava, and barley.

B- Potential land suitability

Potential land suitability for selected crops could be evaluated according to Sys *et al* (1993) after verifying aforementioned land improvements. The potential land suitability of specific crops is given as follows:

1- Soils of Plateau

- Moderately suitable (S2) for cabbage.
- Marginally suitable (S3) for wheat, maize, barley, potato, watermelon, onion, olives and guave.
- Not suitable (N) for beans, citrus and banana.

Soils of bajada

Moderately suitable (S2) for wheat, maize, barley, cabbage, watermelon, and olives.

Marginally suitable (S3) for potato, onion and guava.

Not suitable (N) for beans, citrus and banana.

Soils of solutional depression

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

Marginally suitable (S3) for wheat, barley, cabbage and potato.

Not suitable (N) for maize, beans, onion, citrus and banana.

Soils of Pedi plain

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

Marginally suitable (S3) for wheat, maize, barley, and onion.

Not suitable (N) for beans, citrus and banana.

Soils of sand sheets

Moderately suitable (S2) for wheat, maize, barley cabbage, potato, watermelon, olives and guava.

Marginally suitable (S3) for beans, onion, citrus and banana.

Table 8. Current and Potential Suitability Classes of the studied soils for specific crops

Profile No.	Wheat				Maize				Beans				Barley			
	Current Suitability		Potential Suitability		Current Suitability		Potential Suitability		Current Suitability		Potential Suitability		Current Suitability		Potential Suitability	
	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class
Plateau																
1	34.47	S3snf	61.92	S2s	29.93	S3snf	51.24	S2s	5.92	N2	12.64	N2	34.45	S3snf	61.92	S2s
2	26.67	S3snf	48.5	S3s	22.3	N1snf	39.29	S3s	8.48	N2	20.46	N2	26.58	S3snf	48.5	S3s
3	24.67	N1snf	44.99	S3s	17.33	N1snf	29.85	S3s	6.22	N2	12.78	N2	24.47	N1snf	44.99	S3s
Bajada																
4	24.73	N1snf	59.95	S2s	27.81	S3snf	51.39	S2s	8.33	N2	20.25	N2	24.55	N1snf	59.95	S2s
5	24.3	N1snf	59.58	S2s	26.94	S3snf	50.68	S2s	8.49	N2	21.16	N2	23.99	N1snf	53.62	S2s
Solutional Depression																
6	20.39	N1snf	63.54	S3s	13.23	N1snf	25.56	S3s	2.39	N2	5.74	N2	20.48	N1snf	36.54	S3s
7	16.49	N1snf	30.11	S3s	13.25	N2	22.74	N2	5.01	N2	10.36	N2	16.32	N1snf	27.1	S3s
Pedi Plain																
8	25.38	S3snf	60.81	S2s	31.57	S3nf	56.95	S2	12.57	N2	24.09	N2	25.23	S3snf	60.81	S2s
9	20.82	N1snf	47.84	S3s	23.33	N1snf	40.59	S3s	11.26	N2	23.07	N2	20.61	N1snf	43.06	S3s
10	19.24	N1snf	43.58	S3s	13.59	N1snf	26.86	S3s	3.96	N2	10.16	N2	19.33	N1snf	43.58	S3s
11	21.2	N1snf	44.26	S3s	23.63	N1snf	42.31	S3s	9.38	N2	20.19	N2	20.05	N1snf	44.26	S3s
12	33.43	S3snf	61.71	S2s	24.19	N1snf	44.88	S3s	6.58	N2	18.15	N2	33.17	S3snf	61.71	S2s
13	16.44	N1snf	37.91	S3s	10.51	N2	18.57	N2	3.21	N2	7.68	N2	16.32	N1snf	37.91	S3s
Sand Sheets																
14	34.52	S3snf	76.7	S1	42.19	S3n	70.11	S2	16.82	N1snf	52.41	S2sf	35.98	S3sn	76.7	S1
15	13.57	N1snf	49.31	S3sn	22.84	N1sn	62.09	S2sn	12.16	N1snf	48.31	S3snf	14.63	N1sn	49.31	S3sn
16	17.72	N1snf	59.15	S2sn	18.64	N1nf	54.49	S2s	8.82	N1snf	28.64	S3snf	22.85	N1sn	59.15	S2sn

S1: Ci is more than 75; **N: not suitable for irrigation (Ci is less than 25).** **CS: current suitability.**
S2: Ci between 50- 75 **N1: with limitation which can be corrected** **Ps: potential suitability**
S3: Ci si between 25-50 **N2: with limitation which cannot be corrected**

Table 8. Cont.

Profile No.	Cabbage				Potato				Watermelon				Onion			
	Current Suitability		Potential Suitability		Current Suitability		Potential Suitability		Current Suitability		Potential Suitability		Current Suitability		Potential Suitability	
	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class
Plateau																
1	43.23	S3sf	64.7	S2s	33.54	S3snf	60.02	S2s	25.61	S3snf	44.49	S3s	20.09	N1snf	32.05	S3s
2	33.4	S3sf	51.84	S3s	24.17	N1snf	44.11	S3s	16.96	N1snf	30.39	S3s	21.87	N1snf	35.54	S3s
3	24.06	N1sf	37	S3s	18.56	N1snf	34.39	S3s	13.28	N2	24.31	N2	13.1	N2	21.26	N2
Bajada																
4	38.77	S3sf	63.44	S2s	21.07	N1snf	43.29	S3s	37.21	S3nf	68.45	S2	15.25	N1snf	27.55	S3s
5	36.7	S3snf	62.57	S2s	19.96	N1snf	42.09	S3s	34.76	S3nf	67.69	S2	15.65	N1snf	29.54	S3s
Solutional Depression																
6	17.85	N1sf	27.19	S3s	15.61	N1snf	27.48	S3s	29.29	S3snf	51.52	S2s	10.02	N2	17.75	N2
7	18	N1sf	27.77	S3s	14.4	N1snf	26.88	S3s	25.88	S3snf	48.25	S3s	10.74	N2	17.43	N2
Pedi Plain																
8	44.21	S3f	70.31	S2	33.68	S3nf	68.13	S2	35.19	S3nf	62.29	S2	23.59	N1snf	41.91	S3s
9	36.96	S3sf	56.94	S2s	24.19	N1snf	47.51	S3s	21.46	N1snf	37.96	S3s	19.21	N1snf	32.78	S3s
10	19.27	N1sf	29.84	S3s	14.45	N1snf	26.86	S3s	34.79	S3snf	59.09	S2s	12.39	N2	23.35	N2
11	31.78	S3snf	52.24	S2s	17.45	N1snf	34.98	S3s	31.93	S3snf	59.29	S2s	13.56	N2	24.91	N2
12	35.42	S3sf	58.67	S2s	27.25	S3snf	51.4	S2s	20.1	N1snf	37.62	S3s	16.57	N1snf	28.09	S3s
13	17.4	N1snf	27.23	S3s	13.02	N1snf	25.46	S3s	22.5	N1snf	39.6	S3s	10.53	N2	18.11	N2
Sand Sheets																
14	35.69	S3s	69.24	S2s	30.57	S3sn	57.92	S2s	46.95	S3n	80.84	S1	25.2	S3sn	43.88	S3s
15	29.26	S3sn	69.85	S2s	22.41	N1sn	62.03	S2sn	29.57	S3n	62.28	S2n	26.84	S3nf	68.93	S2n
16	43.23	S3sf	64.7	S2s	21.25	N1snf	56.3	S2sn	29.74	S3nf	72.42	S2n	13.03	N1snf	34.41	S3sn

Table 8. Cont.

Profile No.	Olivers				Citrus				Guava				Banana			
	Current Suitability		Potential Suitability		Current Suitability		Potential Suitability		Current Suitability		Potential Suitability		Current Suitability		Potential Suitability	
	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class	Ci	Class
Plateau																
1	31.44	S3snf	56.18	S2s	8.16	N2	15.67	N2	31.79	S3snf	57.91	S2s	11.78	N1snf	25.72	S3sf
2	23.13	N1snf	41.95	S3s	4.7	N2	9.05	N2	23.75	N1snf	44.46	S3s	8.38	N2	21.03	N2
3	20.75	N1snf	37.93	S3s	3.53	N2	6.81	N2	23.55	N1snf	43.03	S3s	5.42	N2	11.69	N2
Bajada																
4	38.77	S3nf	74.58	S2	11.93	N2	21.73	N2	33.36	S3nf	65.02	S2	4.83	N2	15.2	N2
5	39.65	S3nf	66.46	S2	12.75	N1snf	26.5	S3s	31.88	S3nf	64.25	S2	4.94	N2	15.74	N2
Solutional Depression																
6	33.89	S3snf	60.11	S2s	4.27	N2	8.21	N2	32.36	S3snf	59.99	S2s	5.66	N2	13.8	N2
7	31.88	S3snf	52.63	S2s	4.88	N2	9.29	N2	32.56	S3nf	59.22	S2	7.03	N2	13.92	N2
Pedi Plain																
8	38.40	S3snf	68.19	S2	15.82	N1snf	29.06	S3s	33.99	S3nf	64.71	S2	11.85	N1snf	30.69	S3sf
9	26.37	S3snf	43.5	S3s	8.91	N2	16.03	N2	27.2	S3snf	49.41	S3s	7.48	N2	18.41	N2
10	34.64	S3snf	61.66	S2s	6.39	N2	12.82	N2	30.46	S3snf	57.4	S2s	5.73	N2	15.19	N2
11	35.54	S3snf	61.95	S2s	14.78	N1snf	27.72	S3s	28.79	S3snf	56.27	S2s	5.4	N2	13.88	N2
12	26.77	S3snf	49.81	S3s	4.5	N2	11.1	N2	29.65	S3snf	58.01	S2s	7.19	N2	22.9	N2
13	29.58	S3snf	54.26	S2s	2.58	N2	4.61	N2	31.08	S3nf	57.94	S2	3.66	N2	11.32	N2
Sand Sheets																
14	59.59	S2n	89.74	S1	23.91	N1snf	39.05	S3s	35.32	S3sn	71.02	S2s	12.55	N1snf	31.76	S3s
15	34.09	S3n	62.2	S2n	26.38	S3snf	50.35	S2s	21.46	N1snf	62.58	S2sn	12.34	N1snf	47.01	S3sn
16	39.41	S3n	72.07	S2n	15.43	N1snf	32.56	S3s	18.46	N1snf	55.5	S2sn	7.28	N2	23.72	N2

CONCLUSION AND RECOMMENDATION

According to the soil properties, natural and environmental circumstances at the study area the following agricultural development plane can be suggested:

1- The currents study produced a physiographic soil map to be used as a base map for rather later on mapping of land use, land cover and land suitability for certain cropping pattern.
2- Shallow soils will be cultivated by shallow rooted fodder crops, while deep and moderately deep soils will be cultivated by common known plants in the adjacent areas to the study one.
3- Cultivation of some cash crops that can adapt the environmental circumstances such as medicinal and aromatic plants.
4- All cultivated plants should be tolerant to salinity, drought and have low evapotranspiration and water requirements.
5- Cultivation of the wind breakers to combat sand dunes encroachment.
6- Construction of some livestock industrial profiles to supply soils with organic manure.
7- Recycling of plant an animal west's to be resupplied to the soil for improving their chemical, physical and fertility properties.
8- Applying the agricultural biotechnology to avoid environmental contamination.

REFERENCES

CIAC (2015). Central Laboratory for Agricultural Climate (CLAC) Web site http://w.w.w. clac.edu.eg/.

Dobos, F.; B.; W. Bruee; M. Luca; Chris, J. and M. Enka (2002). The use of DEM and satellite images for regional scale soil database. 17th word congress of soil science (WCSS) 14-21 Bangkok, Thailand.

EGSMA (1981). Geological Map of Egypt scale 1:200:000, Ministry of Industry and Mineral Resources, Cairo, Egypt.

Egyptian General Petroleum Corporation Staff (1987). Geological map of Egypt 1:500.000. The Gocene and Miocene rock _Stratigraphy of the Egyptian general petroleum corporation, Cairo, Egypt.

El-Baz,F. (1998):Sand accumulation and ground water in the eastern Sahara, Episondes.2: (3), 147-151.

Embobi, N.S. (2004). The geomorphology of Egypt, part I (The Nile Valley, Delta and the Western Desert). Cairo, Egypt.

Ezz El-Deen, H. M. (1996).Uses of Geophysical, hydrogeological method and application of geographic information system for evaluation the development of Paris area. New Valley, Egypt. Ph.D. thesis, Ain Shams Univ., Egypt.

FAO (1976). A framework for land evaluation, Soil Bull., No. 32, FAO. Rome, Italy.

FAO (1985). Guide lines: Land evaluation for irrigation agriculture, FAD, Rome, ISBN 92-5-105521-10.

Ghoubachi, S. Y. (2001). Hydro geological chrematistics of Nubia Sandstone a quifen system in Dakhla Depression, Western Desert, Egypt. M.Sc. Foc. Of Sci, Ain Shams Uni. Cairo, Egypt.

Hendriks, F., P.; J. B. Luger and B. Kallen (1987). Evolution of the depositional environments of SE Egypt during the Cretaceous and Lower Tertiany. Berl. Geowiss. Abh. 75 (A) : 49-82.

Hermina, M.H.; M.G. Ghobrial and B. Issawi (1961). The geology of the Dakhla area. Geol. Surv. Egypt, 33P.

Klute, A. (ed) (1986) Methods of soil analysis (Part 1) physical and mineralogical methods. American Society of Agronomy and soil science, Society of American, Madison, WI.

Munsell Soil Color Charto (2010). Munsell Soil Color Chents Baltimore, Marylands (U.S.A).

NSSH, (2001). U.S. Department of Agriculture Natural Resources Conservation Service, 2001, National Soil Survey, Handbook http://w.w.w. stablab.iastate ,edu/soils/nessh/.,

Shata, A. (1987). "Management problems of the Major Regional Aquifer in N.E Africa " UN Tech Workshop. Khactoum.

Storie, R. E. (1964). Handbook of soil Evaluation "Assogated student Bookstore Univ. of California, Berkeley, California

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.; Van, R. E. and J Debavey. (1991). Land Evaluation. Part I and S2, Ghent Univ., Ghent Belgium., the Netherlands, 291 p.

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

USDA (2004). Soil Survey Laboratory Methods Manual "Soil Survey investigation report No. 42 ersion 4.0 November 2004

USDA (2017). Soil Survey Manual. Soil science Division staff. United state Department of Agriculture, Handbook No. 18.

USDA. (2014). "Keys to Soil Taxonomy" United States Deparment of Agriculture, USA.

USGS, (2009) Pediments and alluvial fans, Western Region Geology and Geophysics Science Center, World Wide Web.URL:<http// pubs.usgs.gov. /o8/2004/ 1007/faushtml.

تقييم الموارد الأرضية للتنمية الزراعية في المنطقة الواقعة غرب واحة الداخلة بالصحراء الغربية – مصر

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تقع منطقة الدراسة بين خطي عرض ‎-20 26^{O} & ‎-30 25^{O} شمالاً وخطى طول ‎-55 27^{O} & ‎-20 28^{O} 20 شرقاً حيث تشغل مساحة وقدرها 530445 فدان و هذه المنطقة من المناطق الواعدة والتي تجري بها بعض عمليات الإستصلاح بغرض الربط بين الواحات الداخلة وواحة أبو منقار بالصحراء الغربية وتهدف الدراسة لتحديد الوحدات الفيزوجرافية و تقييم الإمكانيات الزراعية لهذه المنطقة لتحديد أفضل الإستخدامات الزراعية بها.ولتحقيق هذا الهدف إستخدمت صور الأقمار الصناعية سينتينال 2 ونموذج الإرتفاع الرقمي ثلاثي الأبعاد والبيانات الجيولوجية وحصر الأراضي لتحديد الوحدات الفيزيوجرافية الرئيسية بمنطقة الدراسة حيث يتضح بأن الوحدات الفيزيوجرافية السائدة هي الهضبة والبهادة والمنخفض والسهل التحاتي والفرشات الرملية والكثبان الرملية وقد تم عمل 16 قطاع أرضي بالإضافة لعدد من أواجر الملاحظة وعدد 120 حفرة صغيرة لتحديد الحدود الفاصلة بين هذه الوحدات الفيزيوجرافية وقد وصفت القطاعات الأرضية وصفاً مورفولوجياً وجمعت عينات التربة من هذه القطاعات وإجرى عليها التحاليل الطبيعية والكيميائية، ولتقييم جودة مياه الأبار تم أخذ عدد 6 عينات من مياه الآبار المنتشرة حول منطقة الدراسة ومن نتائج الوصف المورفولوجي والخواص الطبيعية والكيميائية لأراضي منطقة الدراسة أُجريت عملية تقسيم لهذه الأراضي طبقاً لنظام التقسيم الأمريكي (2014) حتى مستوى تحت المجاميع الكبرى وقد تبين أن تلك الأراضي تقع تحت رتبتي الأراضي الجافة Aridisols والأراضي الحديثة الـ Entisols وقد تم تحديد ستة تحت المجموعات الكبرى التالية: , Typic Haplosalids , Gypsic Haplosalids, Calcic Haplosalids Typic Torriorthents , Typic Quartzipsamments , Typic Torripsammentsوقد وجد أن مياه الآبار في منطقة الدراسة صالحة لري جميع أنواع المحاصيل حيث لا تزيد درجة الملوحة (EC_{W}) لهذه المياه عن 0.301 ملليموز/سم كما أن نسبة الصوديوم المدمص (SAR) لم تتعدى 1.12 في جميع عينات المياه الجوفية.وقد أجريت عملية تقييم لأراضي الوحدات الفيزيوجرافية بإستخدام نظام التقييم المتبع بواسطة Sys & Verheye (1978) ,(1991) ,.Sys *et al* بغرض تحديد ملائمة أراضي تلك الوحدات للزراعات المروية بصورتها الحالية والكامنة (المستقبلية) بعد التعرف على محددات التربة ومعالجتها وتشير أدلة الملائمة الحالية Current أن أراضي هذه الوحدات تنتمي إلى رتبتين هما الأراضي الهامشية الصلاحية (III) والأراضي الفقيرة (IV) وهذه الأراضي بها بعض معوقات التربة وهي القوام الخشن وعمق قطاع التربة الفعال والملوحة والقلوية لمحددات التربة وبدرجات شدة مختلفة (من متوسطة إلى شديدة). وبإجراء عمليات الإستصلاح وتحسين تلك الأراضي لرفع القدرة الإنتاجية لها والتغلب على محددات التربة تكون درجات الصلاحية الكامنة (المستقبلية) لهذه الأراضي هي أراضي متوسطة الصلاحية (II) وأراضي هامشية الصلاحية (III).وبإستخدام نظام (1993) ,.Sys *et al* لتقييم أراضي الوحدات الفيزيوجرافية من حيث ملائمتها لزراعة المحاصيل المختلفة (حقل – خضر – أشجار فاكهة) وذلك لتحديد درجة الصلاحية لكل محصول في كل وحدة فيزيوجرافية بالنسبة لظروف التربة الحالية أو المستقبلية حيث قدمت هذه الموائمات بين هذه المحاصيل المختارة وأراضي الوحدات الفيزيوجرافية في صورة جداول لتكون دليلاً للإستخدام الأمثل لأراضي منطقة الدراسة.