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Land Resources Evaluation of some Soils in the Western Qena Governorate Using Remote Sensing and Gis

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ABSTRACT

The Western Desert outskirt of Qena Governorate, Egypt, i.e., adjacent to the side of Giza – Luxor Western Desert road, Egypt is considered promising area for agricultural utilization as well as a model for representing some landscape features in the Western Desert, Egypt. So, it selected to be identified within the content of soil physiographic units, soil classification, land evaluation for agriculture – irrigated soils and their suitability for specific crops. Based on the visual interpretation of Landsat ETM7 (Enhanced thematic Mapper 7), the main physiographic units in the studied area could be categorized into four units, i.e, rubble terraces, fan and outwash plain, wadi plain and rock land. 120 mini pits were located and studied for setting up the physiographic boundaries and characteristic of soil map legend. Also, the variation of soil characteristics between the main identified physiographic units were represented by sixteen soil profiles which to be full morphologically described and sampled for laboratory analyses. The soils of the study area were classified as, Typic Torriorthents, Typic Torripsamments, Typic Quartzpsamments, Calcic Haplosalids, Typic Haplocalcids, Typic Haplogypsids and Lithic Torripsamments. According to land evaluation system undertaken by Sys and verheye (1978) and Sys *et al* (1991), the current suitability for agriculture irrigated soils could be categorized into two suitability classes, i.e., marginally suitable (S3) and not Suitable (N) beside five sub classes (S3s, N1wsn, N1ws, N1t and N2). Which are suffering from soil properties, i.e., soil texture (S1), soil profile depth, salinity and alkalinity (n) and topography (t) as soil limitations with different intensity degrees (slight to very severe). By applying the improvement practices for achieving the potential condition, the suitable classes would become, moderatly suitable (S2), marginally suitable (S3) and not suitable (N2). Also, Soil suitability for some specific crops of cereal (i.e., maize, wheat, barley and pea) vegetable (cabbage, potatoes, tomatoes and watermelon) and fruit (olives, citrus, mango and guava) were presented for soils developed on the identified physiographic units land suitability guide tables.

Keywords: Remote Sensing (RS), GIS, Soil taxa and Land evaluation for agriculture – irrigated soils.

INTRODUCTTON

Increasing population pressure and changing human needs play a critical role in the competition for different reses for same tract of land. Systematic land use planning is therefore needed to assure not only the improvement of the social conditions of the present but also the conservation of the environment for future generation. Moreover, land evaluation using a scientific process is important to assess the potential and constraints of a given land parcel for agricultural purposes (Rossiter, 1996).

The area of Egypt is about one million km^2 (238 million feddans), of which only about 4% is cultivated. Reclamation and utilization of the desert areas of siliceous and calcareous soils in nature is the only hope for overcome the agriculture needs. The strategy of Qena Governorate for the horizontal expansion in agriculture needs more suitable land resources than the current existent. The Western Desert outskirt of Qena Governorate represents one of the main available land resources. One of the suggested areas for Soil reclamation is South EL-Marashda village west of Qena Governorate. It Comprises a total area of about 50.000 feddans (208 Km^2)

The studied area is located to South of EL-Marashda village adjacent to Giza-Luxor western Desert Road. It is bounded to the west by Qena city and to the North by Giza-Luxor western Desert Rood between Latitudes 25° 55′ 3.01" N and 26° 7′ 43.43" N and Longitudes 32° 23′ 57" and 32° 42′ 36.81" E.(Fig1). The area under investigation is one of the suggested areas for the horizontal expansion in the Western Desert of Egypt Specially adjected to the Nile Valley in the Qena Governorate which has high store of artesian water from multi layers of Nubian Sandstone aquifer system and seepage of the Nile River and near from the Urbanization areas. The studied area covering a total area of 208 Km2 (about 50.000 feddans).

According to Abuo EL-Ezz (2000) the geological construction: in the South of Asyut hard lower Eocene limestone form a distinct plateau above the steep cliffs of the Nile valley, attaining their greatest thickness between Asyut and Nag Hammadi. Further south the lower Eocene gradually thins out to expose Cretaceous formation in the foot slopes of the cliffs. The first in the Cretaceous sequence to show are the so- called Isna shales: they are found abundantly in the region between Luxor and Isna and consist of layers from shales, shaly clay, marls, silt stones and subordinate lime-stones: in the southern part in particular Cretaceous limestone is exposed. South of Luxor –Isna the Cretaceous limestone form a hilly to mountainous country on the east side of the river. Only where a still lower Eocene limestone cap is present has the adjoining rock land a plateau like character Said (2000) added the western Side of the Nile Valley covered by Cretaceans, Eocene (limestone) Clay and sands, Pliocene (gravels and Sands) and Pleistocene (river Silt, Sands, gravels).

Abuo AL-Ezz (2000) reported that the area of Western Desert is one of the most arid regions in the World, it is Surface composed of bar rocky plateau and high-lying Stony and Sand plains, but few distinct drainage line, and even from these drainage Channels extended for a short distance and consequently do not reach the Nile Valley. Said (2000) mentioned the western Desert plateau Surface is marked by various erosional feature and varied lithologic units within the Eocene bedrock that give variable color tones and drainage is poorly developed the surface of the Plateau.

The meteorological data of Luxor station between (2010-2015) reveal that mean annual rainfall about 0.7 mm, rain may fall in April and again in November and December. During the summer months, there is a very significant increase in the daily mean temperature. The mean daily maximum temperature is 34.1C, minimum 17^0 C, while the mean temperature is 25.9^0C. The relative humidity is distinctly lower in summer than in winter and records 22%, while mean annul evaporation is 19.5 mm/day, (CLAC, 2015) Based on Soil Taxonomy (2014), The Soil temperature regime could be defined as Hyperthermic and Soil moisture regime is Torric or Aridic

The only source of water for irrigation and other purposes are the Nile water and ground water. According to NWRC, (1999) Subdivided ground water in the Western Desert into two classes as follows; extensive and moderately to Low productive aquifers insignificant surface recharge and limited Sub-surface recharge deeper highly productive aquifers not excluded and non-auriferous Clays and shales, generally underlain by deeper more productive aquifers.

The objective of this study is to identify the physiographic units in the area under consideration, in the western Nile valley, using remote sensing techniques and evaluation the soil resource for a sustainable agriculture development, and its suitability for specific crops at the desert area adjacent to the desert rood Giza-Luxor west of Qena Governorate.

MATERIALS AND METHODS

Space image interpretation performed using the physiographic analysis as proposed by Burnigh (1960) and Goosen (1967). Landsat ETM + images (ETM+7) of path 176 Row 39 (7,4,2, bands acquired in 2012) was used to add an extra Landscape assessment to the photo interpretation map Figs (1 and 2). The image was helpful for getting a collective overall view of the studied area as well as using the spectral signatures of the used bands in detecting roods and the urban conditians. Digital Elevatian Model (DEM) of the study area has been generated from the elevation points which recorded during the field survey by GPS (Global position systems), and the vector contour lines, Arc. GIS 10.4 Software Were used to produce the physiographic map of the studied area (Dobos *et al* 2002). The physiographic unit were described according to Zink and Valenzuala (1990).

Map Production

Arc Map (Environment System Research Institute) (ESRI, 2004) was used to produce physiographic units and land capability priorities map.

Field work

A rapid reconnaissance survey was mode throughout the investigated area in order to identify the Landforms and to give an appreciation of the brood soil patterns and Landscape characteristics. The primary mapping unit were verified based on the pre-field interpretation and the information gained during the survey.

Sixteen soil profiles were dug to fullill the requirement of the digital soil maps in addition to 120 testing augers for the purpose of recognizing the boundary among the different mapping units. soil profiles were dug to 150 cm unless hindered by bedrock and

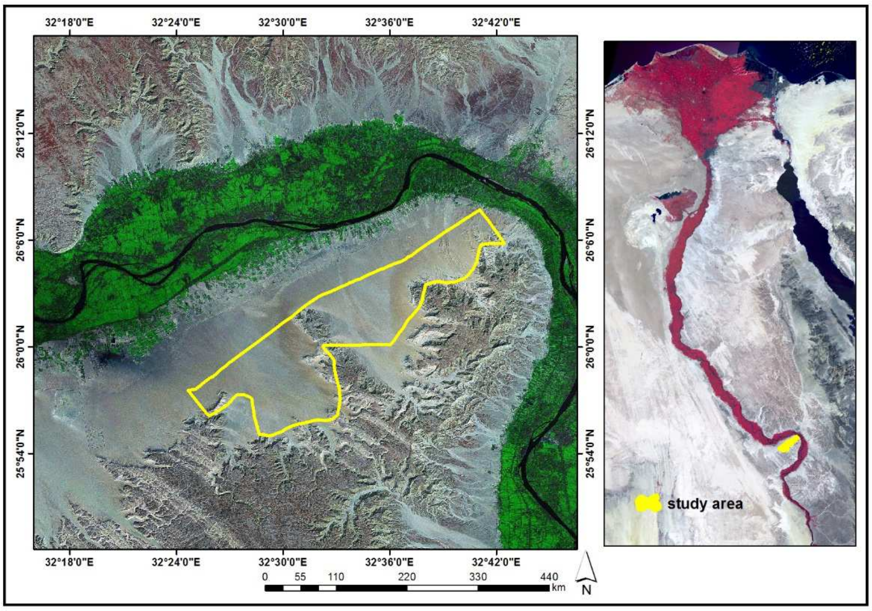

Fig. 1. Location of the study area in Egypt.

Morphological described in the field according to USDA (2017), table (1). longitudes and latitudes of the studied soil profiles as well as their elevation were defined in the field using GPS. Soil samples were collected, air dried, crushed, sieved and used for physical and chemical analyses

Laboratory analysis

Physical analyses: Soil colour (dry) was identified with the aid of Munssel Soil Color Charts (2010)., particle size distribution was determined due to Rowell (1995).

Chemical analyses: chemical analyses were executed for the soils as follows; electric conductivity (ECe), PH, soluble cation and anions, $CaCO_3$%, gypsum content and OM%, were determined according to USDA (2004). Sodium adsorption ratio (SAR) was calculated as follows (Richards, 1954). SAR=Na (meq\L/ [(Ca+Mg) meq\L]$^{0.5}$.

Soil classification and land evaluation:

According to the morphological, chemical and physical properties, the soils under study were classified into taxonomic units according to Soil Taxonomy System (USDA, 1999) and using the keys of soil taxonomy (USDA, 2014). The land suitability evaluation was achieved according the system of Sys and Verheye (1978). The main soil parameters used in this system are climate, soil depth, texture, gravel percent, CaCO3 percent, gypsum content, salinity (EC), sodium absorption ratios (SAR), slope pattern and drainage conditions, Land suitability classification for specific crops was done according to Sys *et al* (1991) and Sys *et al* (1993) by matching the land characteristics with crop requirements.

RESULTS AND DISCUSSION

Physiography:

Interpretation of satellite image and DEM is used to identify the physiography features of an Area. This procedure (which is the most common, economic and versatile advanced technology) offers the reality to the ground observation. Analyzing the main landscape which is extracted from the satellite image through the DEM and field survey enables recognizing and delineating the physiography units in the studied area. The results revealed that the major landscape in the studied area is rubble terraces, fan and outwash plain, wadi plain and rock land as shown in Fig (2) A brief note about the identified physiographic units, which occupied the studied area, was carried out as follows:

1- Soils of rubble terraces

This land form is found in the western and south part of the studied area, covering an area of 4181.4 feddans representing 8.3% of total area and representing by profiles No. 9 and 10. This physiographic unit has almost flat to gently undulating topography. Somewhat gravely surface and including well drained soils. The morphological characteristics of this unit as shown in Table (1) show that soil dry colour ranged between light yellowish brown (10YR6/4) to brownish yellow (10YR6/6), the soils have deep depth, except profile 3 appear moderately deep soils, while rock fragments ranged from 3 to 70 % (by volume) Tables (2 and 3) reveal that soil texture was ranged between extremely gravelly sand to very gravelly loamy sand. CaCO3 content ranged from 5.41 to 30.05% with an increase with soil profile depths, except for the soils of profile 7, where CaCO3 content does not portray any specific pattern with soil profile depth. Gypsum and organic matter contents is very low and varied from 0.1 to 0.7 % and 0.10 to 0.15 %, respectively. Data in Table (3) reveal that soil reaction was slightly alkaline where PH values ranged between 7.39 and 7.81. Soil salinity as indicated by (ECe) were in the range of 1.74 to 33.4 dSm-1 indicating that these soils were non-saline to extremely saline. Soluble cations distribution follows the descending order Na+ and / or Ca++ > Mg++ > K+, while soluble anions followed the order SO4++ and /or Cl-> HCO-3.

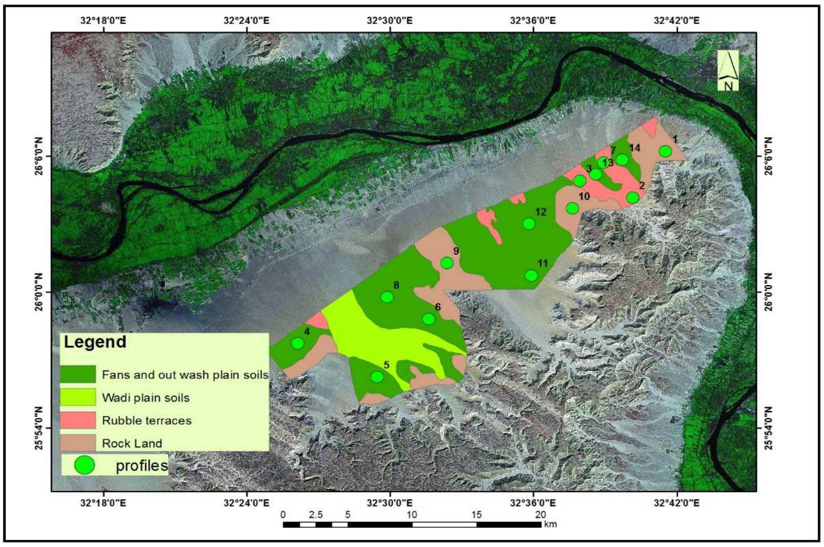

Fig. 2.Physiographic Units and profiles locations of the study area.

Values of sodium adsorption ratios (SAR) varied between 2.34 to 22.16 indicating that the soils of profile 3 have alkalinity problems where SAR values were more than 13. The studied soil of profile (3) was enriched with expanding salts and CaCo3 enrichments that satisfy the requirements of Salic and calcic horizon as well as Aridisols.

According to keys of soil taxonomy (2014) as well as soil morphological, physical and chemical properties, the studied soils belong to "Aridisols" and "Entisols" orders as well as their followed sequence classification levels / up to the family (table 4) as follows:

1. Sandy, mixed, hyperthermic, Typic Torriorthents (profile 1)
2. Skeletal, mixed, hyperthermic, Typic Torripsamments (profile 2)
3. Sandy skeletal, mixed, hyperthermic, Calcic Haplosalids (profile 3)
4. Sand, skeletal, hyperthermic, Typic Haplocalcids(profile 7).

2- Soils of fan and outwash plain:

It is located along the studied soils and extends from south western to the North eastern sides, exhibit an area of about 27475.7 feddans representing by 54.3% of the total area and represented by profiles No. 4,5,6,8, 11,12,13 and 14. The morphological properties of this physiographic unit as show in table (1) showed that the surface having sloping gravelly and stony surfaces they were developed as residual parent material over limestone parent rock and it also haven't any native vegetations. The effective soil depth varied from 100 cm to 150 cm. Soil dry colour ranged from light yellowish brown (1oYR4/6) to yellow (10YR8/6), these soils have single grain soil structure. The soils have a coarse texture classes ranged from sand to gravelly sand texture classes with fine to coarse gravel contents varied from 2% to 35%.

Table 1. Field description for the representative profiles of the studied area.

Physiographic Units	Profile No.	Coordinate	Surface features: Topography	Surface features: Slope	Depth (cm)	Dry colour	Texture	Structure	Dry consistence	Rock fragment %	Effervescence	Lime	Gypsum	Boundary
Rubble terraces	1	32° 38' 57.490" E 26° 5' 51.120" N	AF	NL	0 – 20	10YR 6/6	S	S.g	Lo	15	+	F.S	--	CW
					20 – 100	10YR 6/6	LS	m	Lo	3	++	C.S	--	--
	2	32° 40' 8.566" E 26° 4' 10.376" N	"	"	0 – 35	10YR 6/6	S	S.g	Sh	25	+	F.S	--	CW
					35 – 100	10YR 6/6	S	S.g	Sh	70	+	F.S	--	--
	3	2° 38' 1.223" E 26° 4' 55.168" N	"	"	0 – 20	10YR 6/6	S	S.g	Lo	30	+	F.S	--	CW
					20 – 80	10YR 6/6	S	S.g	Lo	50	+++	M.S	--	--
					80+	Rock								
	7	32° 27' 1.755" E 25° 58' 42.171" N	GU	"	0 – 20	10YR 6/4	LS	S.g S.g	Sh	50	++	C.S	--	CS
					20 – 50	10YR 6/4	LS	m	Sh	50	+++	M.S	--	CS
					50 – 100	10YR 6/4	LS	m	Sh	30	++	C.S		--
Fans and out wash plains	4	32° 25' 37.737" E 25° 57' 13.167" N	AF	NL	0 – 40	10YR 7/4	S	S.g	Lo	2	++	C.S	--	CW
					40 – 100	10YR 7/8	S	S.g	Lo	2	++	C.S	--	--
	5	32° 29' 27.397" E 25° 56' 14.960" N	"	"	0 – 40	10YR 6/4	S	S.g	Lo	8	++	C.S	--	CW
					40 – 100	10YR 8/6	S	S.g	Lo	20	+	C.S	--	--
	6	32° 31' 35.888" E 25° 58' 49.149" N	"	"	0 – 40	10YR 6/4	S	S.g	Lo	10	+	F.S	--	CS
					40 – 120	10YR 6/4	S	S.g	Lo	5	+	F.S	--	--
	8	32° 29' 51.810" E 25° 59' 46.970" N	"	"	0 – 20	10YR 6/6	S	S.g	S	12	+	V.F.S	--	CW
					20 – 60	10YR 6/6	S	S.g	S	35	+++	M.S	--	CW
					60 – 150	10YR 6/6	S	S.g	S	10	++	C.S	--	--
	11	32° 35' 54.154" E 26° 0' 44.791" N	"	"	0 – 20	10YR 6/4	S	S.g	Lo	5	+	C.S	--	CS
					20 – 50	10YR 6/6	S	S.g	Lo	10	+++	M.S	--	CW
					50 - 120	10YR 6/8	S	S.g	Lo	10	++	C.S	--	--
	12	32° 35' 47.730" E 26° 3' 0.991" N	"	"	0 – 30	10YR 6/4	S	S.g	Lo	25	+	F.S	--	GW
					30 – 70	10YR 6/4	S	S.g	Lo	20	+	F.S	--	CW
					70 – 150	10YR 6/4	S	S.g	Lo	15	+	F.S	--	--
	13	32° 38' 53.791" E 26° 5' 3.324" N	"	"	0 – 20	10YR 6/4	S	S.g	Lo	30	+	F.S	--	CW
					20 – 40	10YR 6/4	S	S.g	Lo	25	+	F.S	--	CW
					40 - 120	10YR 6/4	S	S.g	Lo	9	+	F.S	--	--
	14	32° 39' 48.127" E 26° 6' 6.984" N	"	"	0 – 35	10YR 6/6	S	S.g	h	15	++	C.S	--	CS
					35 – 50	10YR 6/4	S	S.g	h	15	+	F.S	--	CW
					50 - 100	10YR 6/4	S	S.g	h	20	+	F.S	--	--
Wadi plain	15	32° 30' 23.241" E 25° 57' 31.871" N	AF	NL	0 – 30	10YR 6/4	S	S.g	h	20	++	F.S	F.S	CS
					30 – 50	10YR 6/4	S	S.g	Sh	25	++	F.S	C.S	CW
					50 - 120	10YR 6/4	S	S.g	Sh	25	+	V.F.S	C.S	--
	16	32° 28' 10.140" E 25° 58' 41.447" N	"	"	0 – 35	10YR 6/6	S	S.g	Lo	4	+	F.S	--	CW
					35 – 80	10YR 6/6	S	S.g	Lo	5	+	F.S	--	CW
					80 – 150	10YR 6/6	S	S.g	Lo	3	+	F.S	--	CW
Rock land	9	32° 32' 22.144" E 26° 1' 16.913" N	AF	NL	0 – 40	10YR 6/6	S	S.g	Sh	50	+	F.S	--	--
					40+	Rock								
	10	32° 37' 36.947" E 26° 3' 42.108" N	"	"	0 - 15	10YR 6/6	LS	S.g	Sh	55	+	V.F.S	--	GW
					15 - 40	10YR 6/4	S	S.g	h	60	+	C.S	--	--
									Rock					

Topography: AF: Almost Flat GU: Gently Undulating Slope: NL: Nearly level GS: Gently sloping.
Texture: S: sand LS: loamy sand SL: sandy loam SCL: sandy clay loam Structure: m: massive S.g: Single grain.
Consistence (Dry) Lo: Loose S: Soft Sh: Slight hard h: hard. Effervescence: + = weak ++= moderate +++ = strong.
Lime & Gypsum: V.F.S: Very few soft F.S: Few soft C.S: Common soft M.S: Many soft
Boundary: CW: Clear Wavy CS: Clear Smooth GW: Gradual Wavy

Physical properties of the fine fraction (table 2) reveal that calcium carbonate content ranged widely from 3.53 to 18.5% as soft and hard lime nodules or accumulations (concretions and segregations), and its content is enough to the requirements of Calcic horizons (profiles 8 ,11 and 14). Gypsum content was considerably very low not exceeds 2.6% and their content are not enough to the requirements of Gypsic horizon. Organic matter content is very low and varied from 0.10% to 1.19%.

Table (3) shows that PH values were natural to moderately alkaline. These soils were non-saline to slightly saline as shown by ECe values which varied from 1.57 to 5.73 dsm-1. Soluble cations of the soil saturation extract follow the order Na+ > Ca++ > Mg++ > K+, while soluble anion follows the order SO-4 > Cl-

> HCO-3. These soils are also non-sodic, it has non-alkalinity problems where SAR values are below 13.

Appling the keys of soil taxonomy (2014) as well as soil morphological, physical and chemical properties, the studied soil profiles classified into the order "Aridisols " and "Entisols". Three families can be identified under these orders

1. Sandy, siliceous, hyperthermic, Typic Haplocalcids (profiles 11 and 14).
2. Sandy skeletal, mixed, hyperthermic, Typic Haplocalcids (profile 8).
3. Sandy siliceous, hyper thermic, Typic Quartzipsamments (profiles 4,5,6,12 and 13).

Table 2. Some physical properties of the studied soils.

Physio-graphic Units	Profile No.	Depth (cm)	Particle size distribution				Textural class	O.M %	Gypsum %	$CaCO_3$ %
			C. Sand %	F Sand %	Silt %	Clay %				
Rubble terraces	1	0 – 20	23.8	66.7	6.9	2.6	SGS	0.15	0.4	5.41
		20 – 100	26.8	58.3	5.8	9.1	LS	0.11	0.2	9.32
	2	0 – 35	27.9	64.3	5.3	2.5	GS	0.11	0.3	7.25
		35 – 100	30.6	59.6	5.1	4.7	EgS	0.10	0.1	8.65
	3	0 – 20	40.6	52.7	4.6	2.1	GS	0.14	0.1	6.54
		20 – 80	34.4	58.3	4.8	2.5	VGS	0.12	--	30.05
		80+	Rock							
	7	0 – 20	22.6	58.5	10.1	8.8	VGLS	0.13	0.7	10.02
		20 – 50	26.6	57.7	9.2	6.5	VGLS	0.10	0.5	17.28
		50 – 100	28.2	54.1	10.4	7.3	GLS	0.10	--	10.11
Fans and out wash plains	4	0 – 40	19.6	72.8	4.5	3.1	SGS	0.17	0.1	10.46
		40 – 100	29.5	66.0	1.6	2.9	SGS	0.16	0.1	14.44
	5	0 – 40	30.1	65.3	2.9	1.7	SGS	0.14	--	11.74
		40 – 100	26.7	66.7	5.2	1.4	GS	0.15	0.1	10.25
	6	0 – 40	19.5	74.8	2.6	3.1	SGS	0.13	--	8.27
		40 – 120	21.2	74.2	1.7	2.9	SGS	0.10	--	7.22
	8	0 – 20	17.3	77.7	3.2	1.8	SGS	0.19	--	3.53
		20 – 60	30.6	63.6	3.6	2.2	GS	0.16	--	18.50
		60 – 150	22.4	73.2	2.5	1.9	SGS	0.14	--	10.65
	11	0 – 20	19.7	75.0	1.8	3.5	SGS	0.13	--	8.75
		20 – 50	18.3	75.7	3.3	2.7	SGS	0.12	0.2	17.28
		50 - 120	28.5	65.5	4.2	1.8	SGS	0.12	--	8.32
	12	0 – 30	22.9	71.4	3.1	2.6	GS	0.17	0.8	6.66
		30 – 70	14.2	80.3	3.8	1.7	GS	0.16	0.5	6.90
		70 – 150	16.1	80.8	1.1	2.0	SGS	0.14	--	5.10
	13	0 – 20	21.6	74.5	1.5	2.4	GS	0.16	1.2	7.75
		20 – 40	24.5	69.9	2.6	3.0	GS	0.12	2.6	5.82
		40 - 120	23.0	73.5	2.2	1.3	SGS	0.10	0.1	5.36
	14	0 – 35	16.9	76.6	3.7	2.8	sgS	0.13	0.2	15.56
		35 – 50	27.6	66.7	4.2	1.5	SGS	0.13	0.1	7.00
		50 - 100	25.3	69.3	3.0	2.4	GS	0.11	0.1	6.10
Wadi plain	15	0 – 30	10.2	84.6	2.2	3.0	GS	0.11	4.0	6.95
		30 – 50	15.7	80.2	1.8	2.3	GS	0.18	6.0	7.70
		50 - 120	19.6	74.8	1.5	4.1	GS	0.16	6.0	3.76
	16	0 – 35	21.8	72.2	3.6	2.4	S	0.14	0.1	7.14
		35 – 80	15.4	80.4	2.7	1.5	SGS	0.16	0.1	6.35
		80 – 150	16.9	78.3	3.0	1.8	S	0.13	0.1	7.80
Rock Land	9	0 – 40	18.3	75.2	4.1	2.4	VGS	0.20	0.1	7.45
		40+	Rock							
	10	0 - 15	25.8	55.3	11.6	7.3	VGLS	0.18	0.2	3.60
		15 - 40	24.9	70.2	3.8	1.1	VGS	0.13	0.1	9.15
			Rock							

Textural class: S: sand LS: loamy sand Gravel - SG: Slightly Gravelly (5-15%) G: Gravelly (15-35%)
VG: Very Gravelly (35-60%) EG: Extremely Gravelly > 60%

3- Soils of wadi plain

Wadi, Etymology: Arabic "Wadi" = the opening engraved line within high or low lands. This wadi are dry paths which reflect the old former modes of water runoff over the same path during the paleo drainage action. It is located in the south-western part of the studied area and are sparsely vegetated. Their blow direction starts from southern higher land reaching the margins of River Nile alluvium, recently, these wadi is paths of seasonal run off as a result of short showers and intermittent rams on the catchment areas. Its surface is almost flat covers about 7263.9 feddans which represent 14.3% of the studied area.

It was represented by profiles 15 and 16, the morphological description of the representative soil profiles is shown in Table (1). The effective soil depth varied from 120 cm to 150 cm. soil dry colour ranged from light yellowish brown (10YR6/4) to brownish yellow (10YR6/6), these soils have a coarse texture classes varied from sand to very gravelly sand, while gravel fine to coarses content ranged between 3% and 50%.

Table (2) reveals that the secondary formation of CaCO3 varied from 3.76 to 7.80 %. with an irregular distribution pattern with soil profile depths. Gypsum content ranged from 0.1% to 6.0% and their content is enough to the requirements of Gypsic horizon (profile 15). Organic matter is very low not exceeds 0.18%.

With regard to the chemical composition of the soil extracts, data in Table (3) indicate that the soils have slightly alkaline reaction (PH varied from 7.6 to 7.7), non-saline to very slightly saline, where ECe of soil past extract ranged from 1.76 to 3.73 dSm-1. The low salinity may be attributed to the leaching and washing effects of water where those profiles are located with the braided channels. The cationic composition of the soil saturation extract was dominated with Na+ followed by Ca++ and Mg++, while K+ was the least abundant soluble cations.

The anions composition was dominated by SO=4 followed by Cl-, while HCO-3 is the least abundant soluble anions.

Sodium adsorption ratios (SAR) varied from 3.34 to 6.5 (non-sodic soils).

Table 3. Some chemical properties of the studied soils.

Physio-Graphic Units	Profile No.	Depth (cm)	pH	EC *dS*/m	Anions (meq L^{-1})				Cations (meq L^{-1})				SAR
					$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na^+	K^+	
Rubble terraces	1	0 – 20	7.81	2.43	--	2.5	5.5	16.50	11.1	4.27	6.50	2.63	2.34
		20 – 100	7.63	7.19	--	1.5	44.0	33.73	21.4	9.80	42.85	5.18	10.85
	2	0 – 35	7.50	2.0	--	2.5	6.0	11.70	8.5	3.97	6.38	1.35	2.56
		35 – 100	7.39	1.74	--	1.5	5.5	10.60	7.6	2.98	5.76	1.26	2.50
	3	0 – 20	7.42	29.9	--	2.5	210	206.5	132.4	61.22	218	7.38	22.16
		20 – 80	7.33	33.4	--	2.0	220	212.4	143.4	68.40	218	4.60	21.18
		80+	Rock										
	7	0 – 20	7.64	2.25	--	2.5	8.0	12.10	8.96	2.3	7.48	3.86	3.15
		20 – 50	7.72	3.64	--	1.5	19.0	18.0	10.23	5.62	18.70	3.95	6.64
		50 – 100	7.69	4.25	--	1.0	20.0	23.50	14.41	7.31	19.01	3.77	5.77
Fans and out wash plains	4	0 – 40	7.66	3.50	--	3.0	15.0	18.0	13.6	5.26	15.58	1.56	5.07
		40 – 100	7.33	2.50	--	1.5	10.0	14.5	10.6	3.61	10.23	1.56	3.84
	5	0 – 40	7.60	2.88	--	2.0	15.0	13.0	9.61	3.32	14.33	2.74	5.64
		40 – 100	7.63	5.73	--	1.0	33.0	26.0	17.2	6.11	32.4	4.29	9.49
	6	0 – 40	7.65	2.26	--	3.0	7.0	13.6	9.50	5.20	7.32	1.58	2.70
		40 – 120	7.73	2.01	--	1.5	7.5	12.10	8.41	3.41	7.79	1.49	3.20
	8	0 – 20	7.50	3.13	--	3.0	14.0	15.30	11.40	6.11	13.04	1.75	4.41
		20 – 60	7.89	2.41	--	2.0	12.0	11.10	7.40	4.30	11.84	1.56	4.90
		60 – 150	7.40	2.13	--	1.0	8.0	15.0	9.57	4.80	8.10	1.63	3.02
	11	0 – 20	7.72	2.96	--	3.0	9.0	12.24	7.10	3.49	9.35	4.3	4.06
		20 – 50	7.73	5.57	--	2.0	28.0	26.63	18.14	10.10	23.83	4.56	6.34
		50 - 120	7.70	5.53	--	1.0	25.0	31.30	18.14	12.22	22.90	4.04	5.85
	12	0 – 30	7.69	2.22	--	2.5	8.0	12.80	9.34	3.54	7.16	3.16	2.82
		30 – 70	7.72	2.13	--	1.5	8.0	12.80	8.54	3.13	8.88	1.75	3.68
		70 – 150	7.72	1.87	--	1.0	8.5	10.20	7.10	3.10	8.10	1.40	3.59
	13	0 – 20	7.80	3.66	--	2.0	16.5	20.64	15.30	6.39	15.58	1.13	4,73
		20 – 40	7.68	3.47	--	1.0	15.0	20.70	13.61	7.32	14.02	1.75	4.33
		40 - 120	7.65	1.57	--	1.0	8.5	7.20	4.31	2.20	8.88	1.31	4.92
	14	0 – 35	7.67	4.24	--	3.0	17.0	24.40	17.21	24.40	17.00	3.00	4.83
		35 – 50	7.70	3.89	--	2.5	20.0	22.40	16.32	6.34	18.38	3.86	5.46
		50 - 100	7.74	4.21	--	1.5	19.50	23.10	15.40	6.31	18.70	3.69	5.68
Wadi plain	15	0 – 30	7.65	2.31	--	3.0	10.50	11.0	8.31	3.06	9.97	3.16	4.18
		30 – 50	7.66	3.72	--	2.0	17.00	17.20	12.40	5.60	17.45	1.75	5.81
		50 - 120	7.60	3.60	--	1.0	19.00	16.90	11.22	5.33	18.7	1.65	6.50
	16	0 – 35	7.70	2.34	--	2.5	8.00	14.90	9.32	4.22	8.70	3.16	3.34
		35 – 80	7.65	3.73	--	2.0	19.00	19.00	13.20	5.40	17.45	3.95	5.72
		80 – 150	7.63	1.76	--	1.0	9.00	8.60	6.60	3.33	7.48	1.19	3.36
Rock Land	9	0 – 40	7.75	1.33	--	2.5	5.00	6.80	5.60	2.73	4.67	1.30	2.29
		40+	Rock										
	10	0 - 15	7.65	3.46	--	2.50	14.00	19.10	11.10	5.02	15.27	4.21	5.38
		15 - 40	7.50	5.22	--	1.5	23.00	31.70	19.30	12.04	20.56	4.30	5.19
			Rock										

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

Physiographic Units	Area (Fed.)	Percentage of total area %	Profile No.	Soil Taxonomy
Rubble Terraces	4181.4	8.3	1	*Sandy, mixed, hyperthermic, Typic Torriorthents*
			2	*Skeletal, mixed, hyperthermic, Typic Torripsamments*
			3	*Sandy-skeletal, mixed, hyperthermic, Calcic Haplosalids*
			7	*Sandy-siliceous, hyperthermic, Typic Haplocalcids*
Fans and out wash plains	27475.7	54.3	4	*Siliceous, hyperthermic, Typic Quartzipsamments*
			5	*Siliceous, hyperthermic, Typic Quartzipsamments*
			6	*Siliceous, hyperthermic, Typic Quartzipsamments*
			8	*Sandy-skeletal, mixed, hyperthermic, Typic Haplocalcids*
			11	*Sandy, siliceous, hyperthermic, Typic Haplocalcids*
			12, 13	*Siliceous, mixed, hyperthermic, Typic Quartzipsamments*
			14	*Sandy, siliceous, mixed, hyperthermic, Typic Haplocalcids*
Wadi Plain	7263.9	14.3	15	*Sandy, siliceous, hyperthermic, Typic Haplogypsids*
			16	*Siliceous, hyperthermic, Typic Quartzipsamments*
Rock Land	11715.9	23.1	9	*Sandy-skeletal, mixed, hyperthermic, Lithic Torripsamments*
			10	*Sandy-skeletal, mixed, hyperthermic, Lithic Torripsamments*

Soil taxa of the studied soil profiles (Table 4) could be classified into "Aridisols" and "Entisols" orders as well as their sequence classification levels up to family one (two families) as follows:

1. Sandy, siliceous, hyperthermic, Typic Haplogypsids (profile 15)
2. Sandy, siliceous, hyperthermia, Typic Quartzpsamments (profile 16).

4- Soils of rock land

It is located in the north and south parts of the studied area and covered about 11715.9 feddans representing 23.1% of total area and represented by profiles 9 and 10. This rock land includes soils that have lithic contact at 40 cm.

From the surface overlayed by extremely to very gravelly sand, where gravels content ranged from 50 to 60%.

Table (1) reveals that soil dry colour ranged from light yellowish brown (10R6/4) to brownish yellow (10YR6/6). Soil structure varied from single grain to massive.

Physical properties (Table 2) reveal that the soils are non-calcareous where calcium carbonate content ranged from 3.6 to 9.15%. gypsum and organic matter contents were very low ranged from 0.1 to 0.2% and 0.13% to 0.20 %, respectively.

Concerning chemical characteristics of rock land (Table3), the soils has slightly alkaline reaction (PH from 7.5-7.75).

The soils were non-saline to slightly saline where ECe values varied between 1.33 and 5.22 dSm-1. Distribution of soluble cations is generally showed the descending trend Na+ > Ca++ > Mg++ > K+, while soluble anions showed SO=4 > Cl-> HCO-3. SAR values varied from 2.29 to 5.38 (non-sodic soils).

According to keys to soil taxonomy (2014) the studied soils belong to "Entisols" order as well as their followed sequence classification levels up to the family as follows:

1- Sandy skeletal, mixed hyperthermic, lithic Torripsamments. (profiles 9 and 10).

Land capability for irrigation agriculture.

The parametric soil evaluation system, undertaken by Sys *et al.* (1991) is applied to identifying soil limitations and their intensities as well as soil suitability classes according to the current and potential suitability ratings. The method aims to provide a method for suitable evaluation for irrigation purposed based on the standard physical and chemical characteristics of soil profiles and their symbols used as follows: topography (t), wetness (W), soil depth (S1), soil texture (S2), CaCO3 (S3), gypsum (S4) and salinity and alkalinity (n).

The irrigation suitability index (Ci) is calculated as follows:

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

The order and classes as follows:

Index	Suiability
>75	S1: Highly suitable
75-50	S2: Moderatly suitable
50-25	S3: Marginally suitable
25-0	N: Not suitable
	(N1= Current not suitable)
	(N2= Permanent not suitable)

Current land suitability

By matching between the present land characteristics and their ratings outlined by Sys and verheye (1978), the current suitability of the studied soils was estimated. Suitability indices and classification of the studied soils developed on the studied different physiographic units are show in Table (5) and Fig (3) and revealed that two suitability classes, i. e marginally suitable (S3) and not suitable (N), besides five subclasses (S3s, N1wsn, N1 ws, N1ts, and N2) were recognized in the studied area. These subclasses representing some soils suffering from soil limitation, i.e some soil properties, i.e., soil texture, wetness, salinity, alkalinity (n) and topography (t) as soil limitations with different intensity degree (slight to very severe).

Potential land suitability

For raising the suitability potential of these soils, soil improvement practices should be carried out such as land leveling and removing the excess of soluble salts through applying the leaching requirements under an efficient drainage ditches for soils suffering from salinity and continuous application of organic manure to improve soil physio-chemical properties and fertility status beside application of modern irrigation system, i.e drip and sprinkler in the newly reclaimed desert soils to save pronounced amount of irrigation water as well as to rise the irrigation efficiency. Such agro-management practices will be corrected.

The rating of soil potential suitability, and it is ranged from 19.28 to 70. Potential soil suitability becomes as follows. (Table 5 and Fig 4).

1. Moderately suitable soils (S2): The rating of this class varied from 53.87 to 70 and represented by soils profiles 1 and 2 (rubble terraces), profiles 5,6,8,11,12 ,13 and 14 Fans and Outwash plain) and profiles 15 and 16 (wadi plain).
2. Marginally suitable soils (S3). The rating of this soils ranged from 38.78 to 49.25 and represented by the soil of profiles 3 and 7 (Rubble terraces, and profiles 4 (fans and Outwash plain).
3. Not suitable soils (N2). The rating of this class is less than 25 and represented the soils of profiles 9 and 10 (Rock land).

It is noteworthy to mention that the similarity of suitability classes recognized in the studied area for both current and potential condition are mainly attributed to most of the identified soil limitation are not able to be corrected. So, it could be recommended that the severity of soil texture (coarser in nature) can be corrected by application of organic and inorganic soil amendments as well as applying modern irrigation systems to sustain a soil moisture content at a favorable condition for grown plants and biological activity in the soil.

Table 5. Land suitability classes for the studied soil profiles.

Profile No	Topography (t)		Wetness (w)		Soil Physical Characteristics (s)					Salinity/alkalinity (n)		Current Suitability		Potential Suitability	
	CS	PS	CS	PS	Depth	Texture CS	Texture PS	Lime	Gypsum	CS	PS	Ci	Class	Ci	Class
Rubble terraces															
1	100	100	100	100	95	60	80	100	90	90	100	46.17	S3s	68.4	S2s
2	100	100	100	100	95	50	70	100	90	100	100	42.75	S3s	59.85	S2s
3	100	100	70	90	95	50	70	90	90	58	80	15.62	N1wsn	38.78	S3sn
7	55	80	90	100	95	60	80	90	90	100	100	22.85	N1ts	49.25	S3ts
Fans and out wash plains															
4	90	100	90	100	95	50	70	90	90	100	100	6.93	N1ws	43.09	S3ws
5	75	100	90	100	95	50	70	90	90	96	100	24.93	N1ts	53.87	S2s
6	90	100	90	100	100	50	70	100	90	100	100	36.45	S3s	63	S2s
8	100	100	90	100	100	50	70	90	90	100	100	36.45	S3s	56.7	S2s
11	100	100	90	100	100	50	70	100	100	100	100	45	S3s	70	S2s
12	100	100	100	100	100	50	70	100	90	100	100	45	S3s	63	S2s
13	100	100	90	100	100	50	70	100	90	100	100	40.5	S3s	63	S2s
14	100	100	90	100	95	50	70	90	90	98	100	33.93	S3s	53.87	S2s
Rock Land															
9	20	60	50	85	60	85	90	80	100	30	100	1.224	N2	22.032	N2
10	20	60	50	85	60	50	70	100	90	98	100	5.29	N2	19.28	N2
Wadi plain															
15	100	100	90	100	100	50	70	100	100	100	100	45	S3s	70	S2s
16	100	100	100	100	100	50	70	100	90	100	100	45	S3s	63	S2s

CS=Current Suitability PS= Potential Suitability CI= Current Index

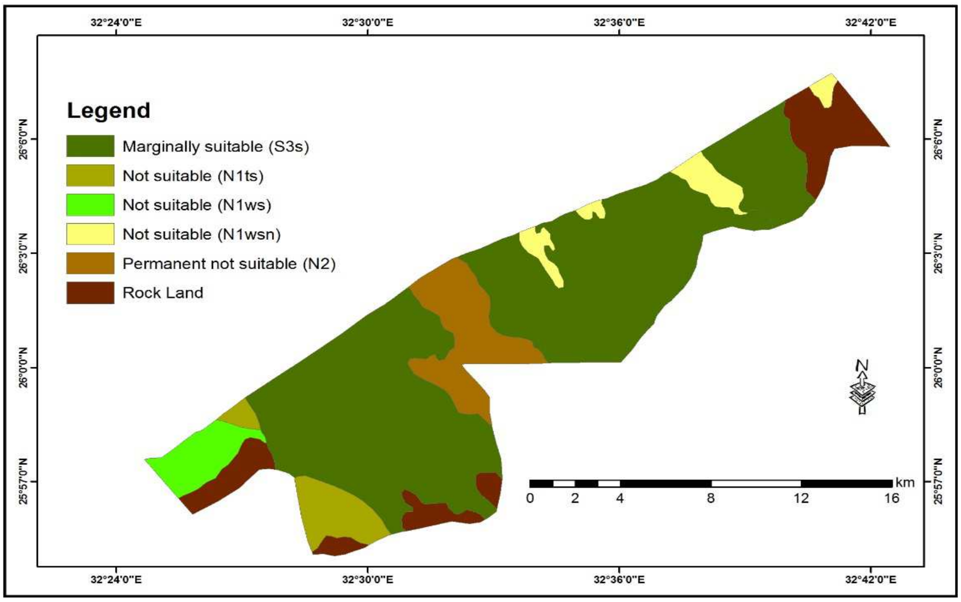

Fig. 3. Current Soil suitability for irrigated agriculture of the studied area.

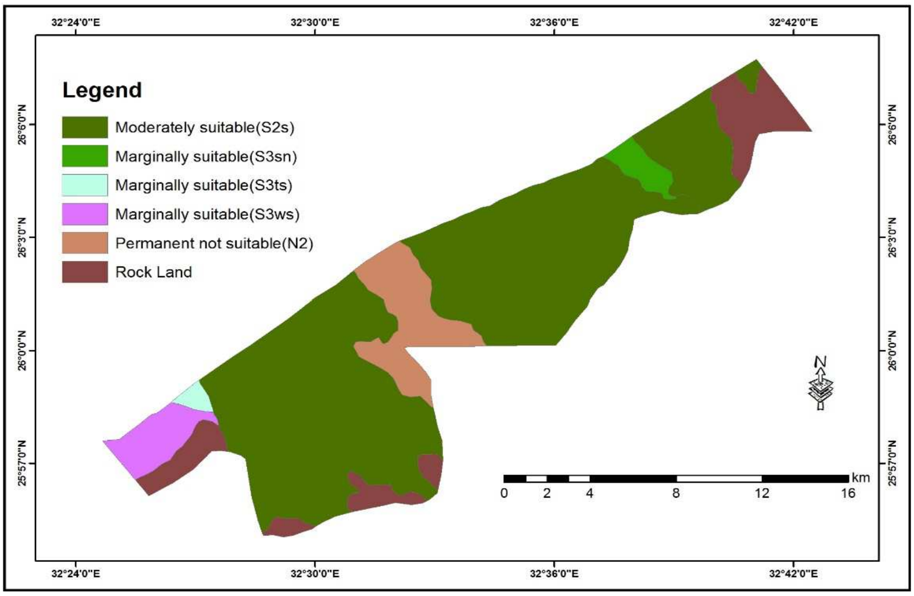

Fig. 4. Potential Soil suitability for irrigated agriculture of the studied area.

Land suitability for specific crops:

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

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

Certain crops	Rubble terraces		Fan and Out wash plain		Rock land		Wadi plain	
	Ci	Pi	Ci	Pi	Ci	Pi	Ci	Pi
Field crops								
Maize	N1	S3	N1	S2	N1	S3	N1	S3
Wheat	N1	S3s	N1	S2	N1	S3	N1	S3
Barley	N1	S3	N1	S2	N1	S3	N1	S3
Pea	N1	S3	N1	S3	N1	S3	N1	S3
Vegetables								
Cabbage	N1	S3	S3	S2	N1	N1	N1	S3
Potato	N1	S3	N1	S2	N1	N1	N1	S2
Tomato	N1	N2	N1	S3	N2	N2	N1	S3
Watermelon	N1	S3	S3	S2	N1	N1	S3	S2
Fruits								
Olives	S3	S3	S3	S2	S3	S3	S2	S1
Citrus	N2	N2	N1	S3	N2	N2	S3	S3
Mango	N2	N2	N1	S3	N2	N2	S3	S3
Guava	N1	S3	S3	S2	N1	S3	S3	S2

Classes S1: Ci is more than 75, S2: Ci is between 50 and 75
S3; Ci is between 25 and 50, Order N: suitable for irrigation (Ci is less than 25), classes N1: with limitations which can be corrected
N2: with limitations which cannot be corrected.
C= Current, P= Potential

Current suitability

Not suitable (N) for all the studied crops, except some scattered areas developed on the different physiographic units for olives.

Potential suitability

1-Soils of rubble terraces

Marginally suitable (S3) for maize, wheat barley, pea, cabbage, potato, watermelon, olives and guava; not suitable (N) for tomato, citrus and mango.

2-Soils of Fan and Outwash plain

Moderately suitable (S2) for maize, wheat, cabbage, potato, watermelon, olives and guava, marginally suitable (S3) for pea, tomato, citrus and mango.

3-Soils of rock land

Marginally suitable (S3) for maize, wheat. parley, pea, olives and guava; not suitable (N) for cabbage, potato, tomato, watermelon, citrus and mango.

4-Soils of wadi plain

Highly suitable (S1) for olives; moderately suitable (S2) for potato, watermelon and guava; marginally suitable (S3) for maize, wheat, barley, pea, cabbage, tomato, citrus, and mango.

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تقييم الموارد الأرضية لأراضي غرب محافظة قنا بالصجراء الغربية – مصر بإستخدام معلومات الإستشعار عن بعد ونظم المعلومات الجغرافيه

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تعتبر أراضي الظهير الصحراوي غرب محافظة قنا – مصر – والمتاخم لطريق الجيزه – الأقصر الصحراوي الغربي من المناطق الواعده في مجال التنمية الزراعية حيث يمثل نموذج يشتمل علي العديد من الملامح الفيزيوجرافيه الممثله للصحراء الغربيه في مصر حيث إختيرت منطقة الدراسة وتحليل صور الأقمار الصناعيه فيزيوجرافياً لتحديد الوحدات السائده وتصنيف وتقسيم تربتها وكذلك تقييمها من وجهة إستغلالها زراعياً في الزراعات المرويه ومدي ملائمتها لزراعة بعض المحاصيل المقترح زراعتها. وبإستخدام التفسير المرئي لصور الأقمار الصناعيه Land sat TM 7 أمكن التعرف وتحديد وحصر الملامح الفيزيوجرافيه لمنطقة الدراسه في أربعة وحدات فيزيوجرافيه رئيسه وهي fan and out wash plain, rubble terraces, wadi plain, rock land وقد تم حفر مائه وعشرون نقطه ملاحظه أرضيه لتحديد وضبط حدود الوحدات الفيزيوجرافيه وكذلك تم تحديد الإختلافات في خصائص الوحدات الفيزيوجرافيه الرئيسيه من خلال عمل 16 قطاع أرضي حيث درست تفاصيلها من الوجهه المورفولوجيه بدقه وجمعت منها عينات التربه لإجراء التحليلات الطبيعيه والكيميائيه ومن النتائج المتحصل عليه من الدراسه المورفولوجيه للتربه ونتائج التحليلات المعمليه الطبيعيه والكيميائيه إجري تقسيم لهذه الأراضي طبقاً للنظام الأمريكي وتعديلاته (2014) حتي مستوي العائلات حيث تبين أن الأراضي المكونه لمختلف الوحدات الفيزيوجرافيه تحت الدراسه تتبع رتبتين رئيسيتين هما رتبة الأراضي الجافه Aridisols ورتبة الأراضي الحديثه Entisols وكذا سبعه تحت المجموعات الكبري كالتالي: Typic Torripsamments, Typic Torriorthents, Typic Haplocalcids, Calcic Haplosalids, Typic Quartzpsamments, Lithic Torripsamments, Typic Haplogypsids. وطبقاً لنظم تقييم الأراضي والمقترحه بواسطة Sys and Verheye (1978), Sys et. Al (1991) إجريت عملية تقييم لأراضي مختلف الوحدات الفيزيوجرافية بغرض تحديد ملائمتها للزراعات المرويه بصورتها الحاليه أو بعد معالجة محددات التربه الإنتاجيه المختلفه للحصول علي أفضل عائد إقتصادي من هذه الأراضي. ونتائج أدله ملائمة التربه المتكونه تشير الي أن القدره الإنتاجيه الحاليه تنتمي الي رتبتين هم أراضي هامشيه الصلاحيه (S3) وأراضي غير صالحه بظروفها الحاليه (N) بالإضافه الي وجود خمسه تحت رتب الأراضي موضع الدراسه وهي $(S3s, N1_{wsn}, N1_{ws}, N1_t, N2)$ وهذه الأراضي بها بعض محددات التربه سواء الدائمه (القوام الخشن، عمق قطاع التربه) أو محددات غير دائمه (الطبوغرافيه، الملوحه والقلويه، وذلك بدرجات شده مختلفه (من خفيفه الي شديده جداً). وبإجراء عمليات إصلاح وتحسين لهذه الأراضي عن طريق غسيل الأملاح من التربه وإجراء عمليات التسويه وإستخدام نظم الري الحديثه (رش، تنقيط) وكذلك إضافة الماده العضويه ومحسنات التربه تصبح درجة الصلاحيه الكامنه لهذه الأراضي ثلاث رتب وهي أراضي متوسطه الصلاحيه (S2)، أراضي هامشية الصلاحيه (S3)، أراضي غير صالحه دائماً (N2). كما تم تقييم أراضي الوحدات الفيزيوجرافيه من حيث ملائمتها لزراعة المحاصيل المختلفه وذلك لتحديد درجة الصلاحيه الحاليه لكل محصول في كل وحده فيزيوجرافيه سواء بالنسبه الي صفات التربه الحاليه أو بعد إصلاحها وتحسينها وقد إختير المحاصيل التاليه للتقييم: محاصيل حقل (ذره، قمح، شعير، بسله) محاصيل خضر (كرنب،بطاطس، طماطم، بطيخ) أشجار فاكهه (زيتون، موالح، مانجو، جوافه) حيث قدمت هذه الموائمات بين هذه المحاصيل المختاره وأراضي الوحدات الفيزيوجرافيه تحت الدراسه في صوره جداول لتكون دليلاً للإستخدام الأمثل لأراضي منطقة الدراسه.