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Characterizing Land Cover, physiography and Soils in A Representative Area of diFferent Soil Parent Materials East of River Nile in El Menia governorate, Egypt.

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ABSTRACT

The study area covers 86337.1 hectares representing a vast region east of River Nile in El Minia Governorate. Its spectral signatures were recognized using remte sensing data of satellite TM8 aquiered in the year 2016. Land cover classes were defined as initiative study for detecting and outlying a promising area for agricultural land use, which was allocated as 50933.2 hectares. Physiographic soil units formed under erosion deposition processes are: a) Dissected rock land. b) Bajada with dominant soils of *Sodic Haplocalcids, loamy skeletal, mixed, hyperthermic.* c) Weathered rocky terraces having soils of *Calcic Haplosalids, loamy skeletal, carbonitic, hyperthermic.* d) Alluvial terraces, which are dominared by soils of *Typic Haplocalcids, coarse loamy, mixed, hyperthermic* E) Wadis include dominant soils of *Typic Torrifluvents coarse loamy, mixed (calcareous), hyperthermic.* Physiographic soil units formed by the deposition of meandering River Nile are: a) Point bar includes soils of *Typic Torriorthents, fine loamy over sandy, mixed, hyperthermic.* b) Bow bars having soils of *Typic Torriorthent, coarse loamy, mixed, hyperthermic.* c) Levees with soils of *Typic Torriorthents, fine loamy, mixed, hyperthermic.* d) Alluvial plain includes soils of *Typic Haplotorrerts, clayey (fine), hyperthermic.* Current land suitability of the non cultivated areas were evaluated for cultivating alfalfa, barley, cabbage, green pepper, maize, sesame, sorghum, tomato, potatos, wheat, citrus, date palm, guava and olives. This current suitability can be more profitable after executing the main growth limitations as salinity and sodicity expressing the potential land suitability. Supreme potential land suitability can be realized by shifting each crop to be adapted with certain physiographic unit for giving higher production.

Keywords : Land cover, Physiography, soil classification and Land evaluation.

INTRODUCTION

Study area selection was based on its site and situation potentialities. The site is partly cultivated in the western portion having intensive population adjacent to eastern outskirts still not under use. The case is higly requiered to be assesed for tracing the promising area for agriculutural land use. Afify (2009) considered the land resources in Egypt for agriculutural land use are lmited being the total area is dominated by rocky structures. On other hand these limited areas required non- traditional methods for realizing extra water resourcefull. As the study area is one of these limited land resources, it is highly requiered to introduce the study out put within a collective soil map of Egypt separating lands suitable for agricultural purposes from non suitable ones. These suitable areas should be currently or for ahead future avoided from other unproductive land use.

Economically speaking, whatever the kind of limitation for the agricultural land use, the lands which are not rocky can be managed for agricultural purposes. Their limitations can be improved by advanced metheds in future when more food requierment should be realized. According to Saadeldin *et al* 2015, the site of this study area have water resource as Eocene aquifer that consists of limestone. The ground water depths range between 70 m to 95 m with discharges range between 6 to 30 m^3 / hour. The mean depths for drilling wells range between 180 to 200 m. The transmissivity ranges between 2.47 to 1248.7 m^2 / day. Water salinity ranging between 1000 to 3300 mg/L prevailed by sodium sulphate as 43 % of the total salts. The situation value of this study area based on that a promising area for agriculture development is not only dependant on soils of high qualities but may also depends on soils of low quality that is harmonized with utilizing the existing modern infra-structure that access to the required marketing. The study area is situated east of highly populated region as well as the accessibility of marketing by a good network of infra-structure including corridors from el Shiekh Fadl vilage eastwards to Ras Gharib. This corridor is crossed by another one linking the study area with northeren and southern regions. The situation also is attributed by eastern extensive land of highlands with watershed areas that can be managed to serve the local agricultural development in the study area. This sudy area is representing a vast region in middle Egypt including the local erosion deposition process as wel as the contenital sedimentation of River Nile. Soil attributes in of this representative area are characterized by soil taxonomic units of a high correlation with potentialities of their physiography. The colective data base can be used for the extrapolation assesment concerning the outside land in that big region for agriculture development purposes.

MATERIALS AND METHODS

1- Geography of the study area

The study area was located east of River Nile in El Minia Governorate. Its coordinates in the lower left corner are latitude of 28^{o} 21^{-} $20^{=}$ N and longitude of 30^{o} 48^{-} $38^{=}$ E, while in the upper left corner are latitude of 28^{o} 38^{-} $09^{=}$ N and longitude of 30^{o} 48^{-} $37^{=}$ E. In the upper right corner, the latitude is 28^{o} 38^{-} $09^{=}$ N and the longitude is $31^{o}06^{-}$ $47^{=}$ E, while in the lower right corner, the latitude is 28^{o} 21^{-} $20^{=}$ N and the longitude is 31^{o} 06^{-} $47^{=}$ E (figure 1).

2- Specifications of remote sensing data

Remote sensing data were recorded by Operational Land Imager (OLI) of the satellite TM8 during the year 2016 within the path 176 and row 40. The multispectral bands have spatial resolution of 30 meters and spectral resolutions of Green (530-590 nm), Red (640-670 nm), and Near-Infrared (850-880 nm). These data were merged with panchromatic band of 15 meters spatial resolution with spectral resolution of 500-680nm.

3- Geometric correction of the remote sensing data

The raster display of remote sensing data were geometrically corrected according to the Egyptian Transfer Mercator (ETM) projection defined as Spheroid name of Helmert and Datum Name Old Egyptian 1907. This correction was based on geographic maps (scale 1:50000) publlished by the Land Survey Authority of Egypt (1990) using Erdas Imagine cartographic software. Mask function in Erdas Imagine was used for producing a sub-set by clipping the full scene to cover the study area.

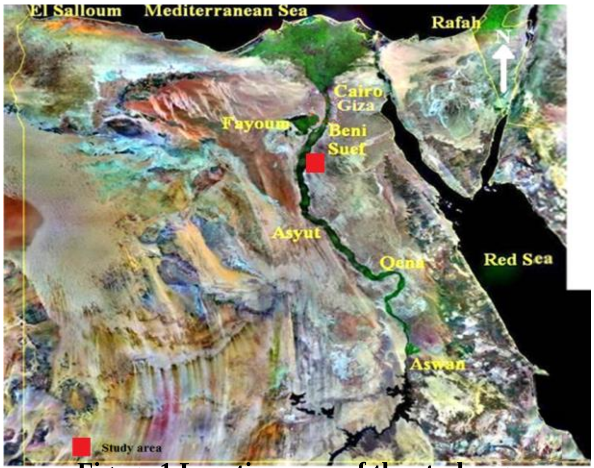

Figure 1 Location map of the study area

4- Physiographic units and linear features delineations

With the aid of merged data, physiographic units of the study area were delineated according to the physiographic approach as proposed by Zinck and Valenzuela (1990). The linear features in remote sensing data projection were manipulated for buffering water canals, railways and roads to be calculated in areas as polygons.

5-Spatial distributions of ground spectral signatures.

Cultivated areas and water body were well recognized by the unsupervised classification that based on the natural groupings of pixels in image data. According to ERDAS (2002), the clustering method is Iterative Self-Organizing Data Analysis Technique (ISODATA). The band combination of green, red and near infrared radiation gave a valid clustering representing the reflectance from the cultivated areas and water body. The out put classes were merged, recoded and converted into a polygon of a vector format.

6- Land cover classes

Land cover classes were defined according to Land Cover Classification System (LCCS) of Di-Gregorio A. and L. J. Jansen (2005)

7- Field work

Ground observations (figure 2) were located to represent the surface types of land cover and the different physiographic units, using the Global Positioning System (GPS). Twenty tree soil profiles were dug to a depth of 150 cm or to bed rock and were described using the nomenclature of the Soil Survey Manual (USDA 2003). Samples of soil layers were collected for the requiered soil analysis.

8- Laboratory analyses

Particle size distribution was carried out using the pipette method as described by (Jackson 1969). Calcium carbonate was measured using the calcimeter (Black *et al*., 1965). Gypsum content was determined by precipitation with acetone. In soil paste extract, salinity was expressed as electrical conductivity (EC). Exchangeable Sodium Percentage (ESP) was carried out using ammonium acetate according (Richards 1954).

9- Soil classification

Soils were classified on the basis of the keys to Soil Taxonomy (USDA, 2014), starting from the soil order to the soil family.

10- Land evaluation

Land evaluation for irrigated agricultural was assessed according to the system of Sys *et al* (1993) for the irrigated agriculture in arid and semi arid regions.

11- Terminology and etymology contemplation:

Terminology and etymology contemplation were traced using the Dictionary of Earth Science (Allaby, 2008) and the Latin English Dictionary (Smith and Locckwood, l996.

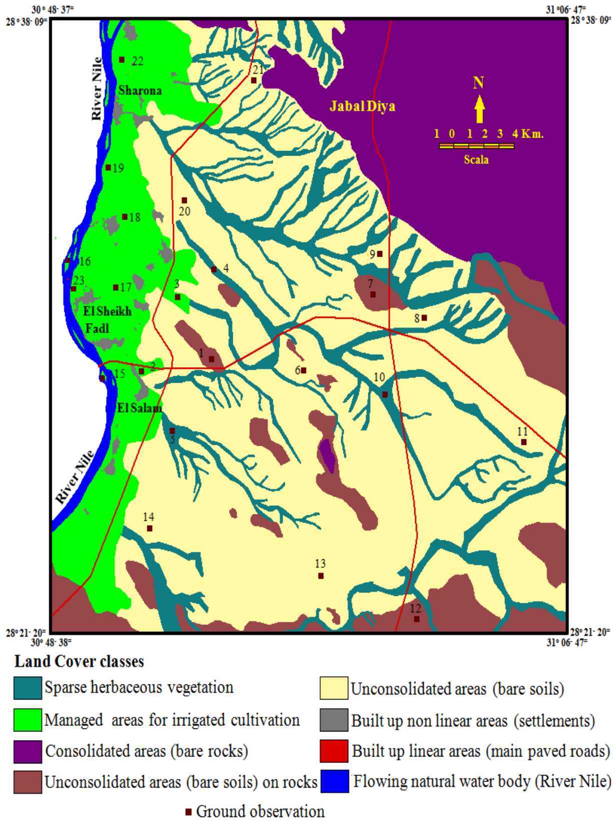

Figure 2 Spatial distributions of land cover classes in the study area

RESULTS

1- The assesment of land cover classes

According to Aspinall and Hill (2008), land cover is a fundamental variable that influences many elements of the natural environment. Changes in land cover, hence land surfaces processes, are inherently dynamic and spatial and could impact the natural environment in a way that could, only, be paralleled to the effects of climate change. In the study area, the surface types were shaped under an arid climate of scarce precipitation resulting in prevalence of non vegatated areas. Drainge patterns of seasonal water runoff that are crossing the bare areas, have very contrasting shpe comparing to the bare areas. Within the bare areas, surface type of rugged rock land can be sucssesfully separated from those of bare soils realizing land cover legend as simple initiative study. This legend help for outlying the promising area for agricultural land use and also reflects some potential attributes of the consequent physiographic soil study resulting in more accuracy for setting up their legends. The land cover classes are descibed as follows:

A- Natural terrestrial vegetation

The areas of this land cover class are covering 8905.6 hectares (21195.3) feddans as one hectare equivalent 2.38 feddans. The life form is adapted with a low content of moisture under the aridic climate to grow as herbaceous sparse vegetation covering 5 to10 % of the land unit within the pass of drainage system.

Managed terrestrial cultivation

This land cover class is covering 9624.7 hectares as artificially managed agricultural land use using surface irrigation.

Terrestrial non vegetated areas

These areas are either natural features (bare area) or artificial surfaces.

i- Bare area

These areas are not affected by human activities having no artificial cover including the following two classes:

Consolidated areas of bare rocks

This land cover class is charactering areas of high dissected limestone rocks covering 15817.3 hectares, which are not vegetated as the presence of consolidated bed (rock). They are aligning the eastern side of the study area

Consolidated areas paved by unconsolidated materials

This land cover areas include limestone bed rocks covered by thin layers of unconsolidated materials covering 7467.4 hectares. They are not vegetated as either the presence of consolidated bed (rock) or the thin unconsolidated cover is in relatively highe sites out of water runoff. They are mostly distributed in the middle part of the study area.

Unconsolidated areas of bare soils

These unconsolidated areas still as bare soils (42027.6 hectares) and their surface type reflect the severe condition of arid climate as well as the artificial water supply is still out of order. These areas are dominating the land of the study area.

ii- Artificial surfaces

Built up non linear surfaces

These artificial surfaces (867.1 hectares)are characterized by built up non linear areas of settlements.

Built up linear surfaces

These artificial surfaces (320.5 hectares) are characterized by built up linear areas include the main paved roads in the study area.

B- Aquatic non vegetated areas

This area coveres 1306.9 hectares with flowing natural water body that was deliniated as one polygon representing River Nile.

The defined aforementioned land cover classes with the aid of well located ground opservations are shown in figure 2. Their spatial distributions cover total area of 86337.1 hectares. The detectable promising area for agricultural land use is covering 50933.2 hectares including areas of herbaceous sparse natural vegetation and the unconsolidated ones of bare soils.

2- Physiographic soil units

Afify *et al* (2010) stated that using physiographic approach leads to a well understanding of landscape genesis for defining the drainage patterns that link the parent rocks in the highlands and the derived soil parent materials to the relatively lowlands giving a reliable relationship between the physiography and soils. Accordingly, Physiographic features were categorized for the study area in the term physiography rather than that of geomorphology. The traced boundaries are associated with different geomorphic processes that are emphasized by their spectral signature as reflected in the merged multispectral bands with the panchromatic one.

Soil taxa in table 1 were classified and introduced with the physiographic units in figure 3. They are described as follows.

A- Units of regional erosion deposition processes

i- Dissected rock land

These physiographic unit covers 15817.3 hectares, which is mostly situated in the eastern side of the study area consisting of dissected and rugged limestone parent rock.

ii- Bajada

Bajada means descent slope (Spanish). They are covering 5787.9 hectares aligning the western side of the dissected rock land. In this unit , the alluvial parent material was area of derived from limestone parent rocks having gravelly surfaces that are gently sloping weswards forming a coalescing pattern of alluvial fans. The soils developed under an *aridic moisture regime* and a *hyperthermic temperature regime* including the diagnostic horizon of calcic one (*Aridisols*). The layers of calcic horizon "ABk" and "Bk" include $CaCO_3$ of 92.4 to 208.8 g/kg and 5 to 15 % by volume as secondary visible lime. As the soil control section is dominated by very gravelly sandy loams, they are *Loamy skeletal* with layers at least 25 cm thick within 100 cm of the soil surface having an Exchangeable Sodium Percentage (ESP) of 15 or more ranging from 15.1 to 23.8 (*Sodic*). They were classified as *Sodic Haplocalcids, loamy skeletal, mixed, hyperthermic* (profiles 9 and 21). These soils have soil inclusions, which are not sodic to be *Typic Haplocalcids, loamy skeletal, mixed, hyperthermic* (profile 8).

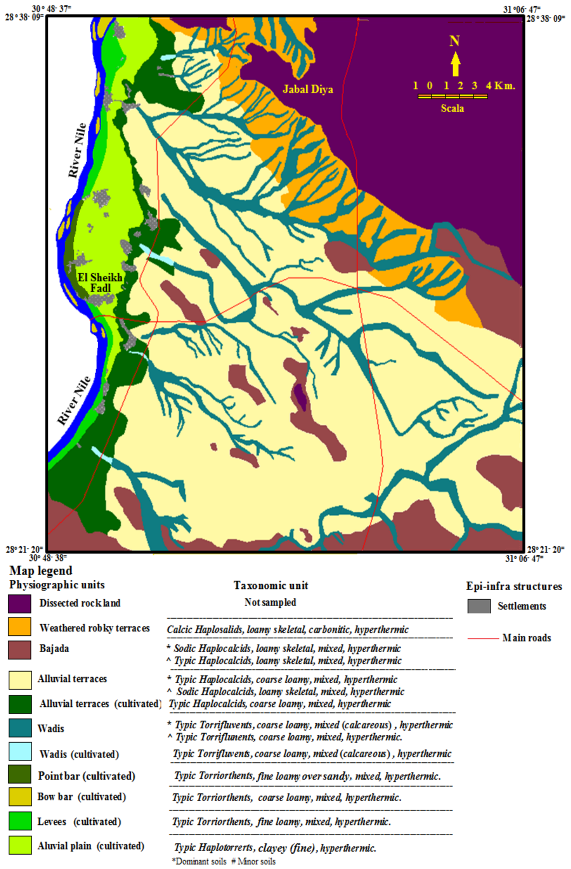

Figure 3 Physiographic soil map of the study area

iii- Weathered robky terrsces

These robky terraces are distributed in the midle part of the study area covering 7467.4 hectares as out cropping areas in relatively high sites comparing to the alluvial terraces. They were most probably left out after regional erosion processes as their resistance kept them in isolation from the stream erosion. They have surfaces of gullied undulating to gently undulating complex slopes. They are covered by stones with local rock outcrops. The soils have residium parent material incliding layers with salic horizon within 100 cm of the soil surface. Salic horizon associates with calcic horizon in the soil surface as ABkz or ABCkz and subsurface layers as BCkz (*Aridisols*). Salinity in the layers of salic horizon range from 33.2 to 57.3 dS/m in the soil paste. The layers of Calcic horizons have $CaCO_3$ contents of 369.0 to 564 .2g /kg and 15 to 25 % by volume as secondary visible lime. In these very gravelly soils, carbonate is collected in the undersides of the fragments coatings them. Soil control section is dominated by very gravelly sandy loams (*loamy skeletal).* Mineralogical class is carbonatic as the soil layers include more than 40 % by weight calcium carbonate plus gypsum (40.2 to 57.4 %) and the carbonates are more than 65 % of the sum of carbonates and gypsum. These soils were categorized as *Calcic Haplosalids, loamy skeletal, carbonitic, hyperthermic.* (profiles 1,7 and 12).

iv- Alluvial Terraces

The alluvial terraces have an alluvial parent material derived from limestone parent rock and transported downwards during the fluvial periods. They are prevailing the landscape of the study area surrounding the weathered robky terraces and adjacent the old cultivated land. They have total area of 40739.0 hectares including limited cultivated ares in the western side covering 4499.2 hectares. The surfaces are rilled, gravelly and gently undulating in relatively low levels with less developed parent material comparing with those of the weathered robky terrsces. The soils have calcic horizon as ABk and Bk including $CaCO_3$ contents of 97.5 to 267.4 g/kg and 5 to 20 % by volume as secondary visible lime. In these soils of less gravel contents, most of carbonate formations are voiding the soil matrix as hard nodules and soft segregations. The soils were classified as *Typic Haplocalcids, coarse loamy, mixed, hyperthermic* (profiles 6,11and13 in bare areaa,while profile 2 in the cultivated ones. These soils have soil inclusions of very gravelly sandy loams (*loamy skeletal*) including layers at least 25 cm thick within 100 cm of the soil surface of ESP range from 15.4 to 30 (*Sodic*). Accordingly, they are classified as *Sodic Haplocalcids, loamy skeletal, mixed, hyperthermic* (profiles 14 and 20).

v- Wadis

Wadi; etymology: Arabic "wadi" = the opening engraved line within high or low lands. They are dry chanells reflecting former water flow during the fluvial periods over limestone rocks. These wadis are confined drainage system within bajada but somewhat opened within the alluvial terraces collecting a seasonal runoff sourced from intermittent rains on the catchment areas. The land of these wadis are subjected to seasonal erosion hazards as a result of annual flush flooding along dentritic and sub-dentritic drainage patterns covering total area of 9087.1 hectares. They are locally having managed cultivation covering 181.5 hectares. The soils are the most recent ones under the order *Entisols* that still affected by seasonal floding agent. According toSmith (1986), Entisols as either are losing material rapidly through truncation or receiving additions rapidly for horizons to form. The suborder level is first sorted out according to the reasons as why they had no subsurface diagnostic horizon. Soils were defined under the suborder *Fluvents* as formed under the deposition and errosion processes having stratified layers of C horizons. Fluvent from Latin "*fluvius*" = river related to *fluere* = to flow express the risk of flooding over the soils within the drainage network. As these soils formed under a *torric moisture regim*, they are *Torrifluvents*. These soils are *coarse loamy* as the control section is dominated by sandy loams. The soil layers effervesce by cold dilute HCl in all parts of the control section (*calcareous*). They are classified as *Typic Torrifluvents coarse loamy, mixed (calcareous), hyperthermic* (soil profiles 4 and 10 in the bare area), while in the cultivated ones by profile 3. These soils have inclusions with very gravelly sandy loams (loamy skeletal) and less calcareousness (profile 5) to be categorized as *Typic Torrifluvents, loamy skeletal, mixed , hyperthermic.*

Table 1 Required soil analyses for soil classification and land evaluation

hsiographic unit	Profile No.	Horizon	Depth (cm)	EC	ESP	Gravel % (vv)	Grain size distribution (%)			Modified Texture class	$CaSO_4$		$CaCO_3$	
							Sand	Silt	Clay		g/kg.	% (vv)	g/kg.	% (vv)
Weathered rocky terraces	1	ABkz	0-25	56.3	40.9	45	63.9	20.2	15.9	VGSL	17.6	<5	416.4	15
		BCkz	25-49	53.3	18.8	55	57.0	23.1	19.9	VGSL	9.7	<5	564.2	15
		R	49--				Limestone parent rock							
	7	ABk	0-15	27.5	20.2	50	61.8	11.0	27.2	VGSCL	15.1	<5	387.0	20
		BCkz	15-50	57.3	19.7	45	76.6	13.5	9.9	VGSL	17.3	<5	385.2	25
		R	50--				Limestone parent rock							
	12	ABkz	0-20	33.2	35.3	50	74.4	14.5	11.1	VGSL	39.1	<5	378.0	25
		BCkz	20-45	34.8	26.0	55	77.4	12.1	10.5	VGSL	42.1	<5	369.0	20
		R	45--				Limestone parent rock							
Bjada	8	ABk	0-20	11.4	10.3	40	75.2	5.3	19.5	GSL	2.8	<5	202.0	5
		Bk	20-45	9.8	14.2	35	84.2	5.8	10.0	VGLS	1.7	<5	129.4	15
		C	45-120	16.1	14.8	50	79.7	10.4	9.9	VGSL	1.6	<5	128.1	10
	9	ABk	0-20	14.3	16.7	30	63.1	27.6	9.3	GSL	4.0	<5	155.0	15
		Bk	20-50	20.8	15.1	45	63.8	15.8	20.4	VGSCL	12.9	<5	89.7	15
		C	50-120	16.5	20.9	40	62.3	21.2	16.5	VGSL	5.3	<5	208	5
	21	A	0-20	6.5	8.6	10	78.3	11.4	10.3	SGSL	4.0	<5	92.4	5
		Bk1	20-40	16.5	23.8	35	68.2	17.3	14.5	GSL	6.7	<5	101.0	10
		Bk2	40-80	9.0	15.2	35	77.1	12.6	10.3	VGSL	3.5	<5	159.8	5
		C	80-120	8.4	8.3	40	77.4	10.9	11.7	VGLS	1.9	<5	108.2	5
Alluvial terraces	2	ABk	0-30	3.7	3.9	10	77.5	10.4	12.1	SGSL	8.0	<5	230.1	15
		Bk1	30-50	2.1	4.3	25	82.4	4.9	12.7	GLS	9.6	<5	228.4	20
		Bk2	50-100	2.3	2.4	15	70.2	10.0	19.8	GSL	11.5	<5	255.0	10
	6	ABk	0-20	14.4	14.1	10	78.3	11.1	10.6	SGSL	9.0	<5	217.0	15
		Bk1	20-70	20.8	11.9	25	71.4	9.1	19.5	GSL	7.8	<5	235.1	10
		Bk2	70-100	19.8	12.2	25	66.5	9.1	24.4	SCL	7.5	<5	215.3	10
Point bar	23	Ap	0-20	1.1	7.4	-	78.3	11.5	10.2	SL	8.2	-	14.8	-
		C1	20-65	1.0	5.8	-	38.8	28.9	32.3	CL	7.1	-	12.7	-
		C2	65-95	0.9	4.6	-	81.4	9.1	9.5	LS	3.3	-	13.4	
		C3	95-125	0.8	5.1	-	82.7	8.4	8.9	LS	4.3	-	8.9	
Bow bar	15	Ap	0-20	1.2	8.4	-	74.6	11.9	13.5	SL	2.1	-	15.4	-
		C1	20-35	1.1	7.1	-	61.5	16.7	21.80	SCL	3.1	-	17.7	-
		C2	40-110	0.9	2..6	-	83.3	3.5	13.2	SL	5.2	-	11.8	-
		C3	110-150	0.9	6.1	-	81.4	9.1	9.5	LS	4.3	-	11.2	-
	16	Ap	0-15	0.5	2.1	-	73.6	11.9	14.5	SL	6.1	-	10.7	-
		C1	15-45	0.6	3.4	-	70.2	16.7	13.1	SL	4.4	-	16.2	-
		C2	45-60	0.7	4.6	-	62.3	17.5	20.2	SCL	2.3	-	14.9	-
		C3	60-150	0.6	6.1	-	78.2	11.3	10.5	SL	3.9	-	12.6	-
Levees	19	Ap	0-20	1.2	5.2	-	39.8	29.7	30.5	CL	8.1	-	13.8	-
		C1	20-45	1.1	8.3	-	47.5	30.9	21.6	L	7.3	-	20.2	-
		C2	45-110	1.0	2.5	-	37.8	29.7	32.5	CL	8.3	-	19.5	-
		C3	110-150	0.9	5.1		77.7	11.8	10.5	SL	6.9		14.3	-
	22	Ap	0-25	1.5	7.9	-	75.7	11.8	12.5	SL	5.1	-	23.7	-
		C1	25-80	1.3	8.3	-	39.6	28.9	31.5	CL	3.8	-	19.1	-
		C2	80-95	1.4	2.4	-	56.3	20.8	22.9	SCL	4.2	-	17.4	-
		C3	95-150	0.9	3.1	-	75.7	11.8	12.5	SL	6.1	-	22.9	-
Alluvial plain	17	Ap	0-15	2.1	9.3	-	21.5	28.9	49.6	C	7.3	-	9.0	-
		C2	15-40	1.3	8.6	-	33.4	19.8	46.8	C	8.1	-	8.2	-
		C3	45-125	2.0	9.4	-	31.1	20.2	48.7	C	7.1	-	10.7	-
	18	Ap	0-20	1.9	8.0	-	27.4	29.7	42.9	C	5.4	-	11.1	-
		C1	20-45	1.4	7.9	-	34.4	21.3	44.3	C	7.4	-	12.4	-
		C2	45-90	1.2	9.8	-	37.2	19.6	43.2	C	5.8	-	10.7	-
		C3	90-130	1,1	7.3	-	38.1	21.6	40.3	C	4.9	-	9.8	-
Alluvial terraces	11	ABk	0-15	10	9.3	15	74.4	13.8	11.8	GSL	5.2	<5	166.4	10
		Bk1	15-50	16.5	14.8	20	54.0	25.5	20.5	GSCL	7.8	<5	97.5	10
		Bk2	50-120	18.4	13.9	25	75.4	12.5	12.1	GSL	13.6	<5	209.0	5
	13	ABk	0-15	7.2	6.8	25	71.1	17.3	11.6	GSL	4.4	<5	258.0	10
		Bk1	15-50	10.3	11.2	15	73.2	7.0	19.8	SGSL	3.0	<5	267.4	15
		Bk2	50-70	16.4	13.5	30	69.0	13.6	17.4	GSL	1.3	<5	246.0	15
		Bk3	70-120	21.7	14.0	10	77.5	9.4	13.1	SGSL	2.0	<5	235.0	10
	14	ABk	0-25	29.6	15.4	25	46.4	20.2	15.3	GSL	12.8	<5	145.1	15
		Bk1	25-60	25.5	18.0	40	60.1	17.4	10.2	VGSL	14.3	<5	139.0	10
		Bk2	60-120	27.9	11.2	35	73.6	12.9	13.5	VGSL	11.6	<5	154.5	10
	20	ABk	0-25	21.7	30.0	30	70.6	7.3	22.1	GSCL	21.0	<5	175.5	15
		Bk1	20-50	10.5	10.3	40	54.0	19.2	26.8	VGSCL	35.3	<5	160.4	5
		Bk2	50-100	11.5	8.4	45	57.6	30.1	12.3	VGSL	12.0	<5	151.5	10
Wadi	3	Ap	0-15	2.7	4.1	20	79.2	10.9	9.9	GSL	1.4	<5	67.0	<5
		C2	15-40	3.1	3.6	15	82	8.2	9.8	GLS	1.9	<5	95.2	<5
		C3	45-110	1.3	2.1	30	78.6	10.9	10.5	GSL	1.8	<5	125.7	<5
	4	C1	0-30	7.7	5.3	25	79.8	9.9	10.3	GSL	1.5	<5	151.1	<5
		C2	30-60	8.1	1.5	20	76.1	12.7	11.2	GSL	13.3	<5	206.2	<5
		C3	60-150	5.3	3.7	30	53	25.5	21.5	GSCL	11.0	<5	155.0	<5
	5	C1	0-30	9.7	3.8	35	78.1	7.6	14.3	GSL	11.3	<5	278.4	<5
		C2	30-60	10	1.6	40	83.3	7.6	9.1	VGLS	9.0	<5	179.2	<5
		C3	60-100	6.2	4.5	35	68.5	15.2	16.3	GSL	19.3	<5	304.5	<5
	10	C1	0-15	6.7	4.1	15	79.1	10.8	10.1	GSL	1.8	<5	145.3	<5
		C2	15-40	5.1	2.8	15	63.9	14.4	21.7	GSCL	2.3	<5	145.4	<5
		C3	40-70	6.3	4.8	20	69.4	12.0	18.6	GSL	1.8	<5	138.2	<5
		C4	70-120	5.5	3.9	15	81.7	10.4	7.9	GLS	3.2	<5	140.0	<5

EC= Electrical conductivity as ds/m, ESP= Exchangeable Sodium Percentage, VG= very gravely, G=gravely, SG= slightly gravely, S= sand, LS= loamy sand, SL=sandy loam SCL= sandy caly loam, vv = volume of void-space. CL= clay loam, L= loam, C= clay

B- Units of meandering River Nile deposition

Water flow through meandering course encourages undercutting of banks on the outside of bends and deposition on the inside of bends. The resultant is an alteration of the course through cut offs and channel diversion (Huggett 2007). In the study area, the River Nile is characterized by meander shape. The sediments of this meandering River Nile have relatively coarser parent material aligning its meandering belt (point bar, bow bars and levees) compared to those in the alluvial plain. After High Dam construction, the land scape features and deposited alluvium became under protection and their soils should be classified eithe under Orthents (sub order of Entisols) or *Vertisols* rather than *Fluvents* (sub order of Entisols). These managed soils that have Ap horizon and are not subjected to the flooding hazard, using the term *Fluvents* is most probably not adequate. Physiographic soil units of meandering River Nile are defined as follows:

i- Point bar

This point bar is a curved polygon aligning the bend of River Nile course clossed to the inside line of the River in the meandering site including an alluvial material with relatively coarse one. It was deposited on the inside of river curve after an erosion process fron the outside bend covering 228.6 hectares. Soil control section includes two contrasting texture classes (clay loams over loamy sands) fitting the taxonomic unit of *Typic Torriorthents, fine loamy over sandy, mixed, hyperthermic* (profile 23).

ii- Bow bar

These bars appear inside meander bends as asymmetrical islands surrounded by water, by narrow channels in a side and wide one in the other side. They are cultivated covering 181.2 hectares. The soils are dominated by sandy loams (coarse loamy) fitting the taxonomic unit of *Typic Torriorthent, coarse loamy, mixed, hyperthermic.*(profiles 15and 16).

iii- Levees

Levees were deposited alignimg the River Nile coarse in relatively high level comparing to the alluvial plain. They include coarser parent material than those in the alluvial plain as the loded materials suddenly washed out due to the frequent flow reduction. These levees are cultivated covering 973.5 hectares. The soils are recnt (*Entisols*) that formed under a *torric moisture regim*, (*Torriorthents*) fitting the central concept of this category to be *Typic*. The control section is dominated by loams and clay loams (fine loamy). At the level of soil family the taxonomic unit is *Typic Torriorthents, fine loamy, mixed, hyperthermic* (profiles 19 and 22).

iv- Alluvial plain

This alluvial plain was deposited by the former periodic flooding of the River Nile as a low-lying flat plain closed to River Nile meandering belt. This alluvial plain is cultivated covering 3560.7 hectares. The mode of these clayey soils is turning upside down as a result of shrinkage under drynes caosing wide deep cracks that are filled by soil matrix from soil surface. Under the status of soil wetness, soil swells and the filling materials under pressure are compacted slice that is defined as *slickensides.* As soil volume increases, the surfce somewhat goes up shaping soil gilgai fitting the order of *Vertisols.*[Vert.; etymology: Latin "verto" = to turn]. All soil layers have less than 60 percent by weight clay that range from 40.3 to 49.6 to be *clayey (fine)* fitting the soil taxonomic unit of *Typic Haplotorrerts,clayey (fine), hyperthermic* (profiles 17 and 18).

3 Land evaluation of the non cultivated area

In this study, each physigraphic unit was evaluated for certain land utilization type in order to allocate the most productive utilization in certain physiographic unit for maximizing the productivity in all the land units. The land qualities were matched with the crop requirements according to Sys *et al*. (1993) considering the main soil characteristics. They are c = CaCO3 rating, d = Drainage rating, n = alkalinity rating, p = Depth rating, s = salinity, t = slope rating, x = texture rating, rating, y = gypsum rating. Land suitability was established as orders of suitable (S) and not suitable (N). The orders are sub-categorized as classes of highly suitable (S1) moderately suitable (S2) and marginally suitable (S3), currently not suitable (N1) and potentially not suitable (N2). Suitability sub-classes that reflect kinds of limitations are indicated in symbols using lower-case letters indicating such limitations. Land utilization types were mainly proposed to satisfy the requierments in Egypt for edible and fodder crops as well as oil seed crops considering the mode of irrigation as follows:

- Alfalfa, barley, sesame, sorghum and wheat using sprinkler irrigation.
- Cabbage, Green pepper, maize, tomato, potatos, citrus, date palm, guava and olives using drip irrigation

A- Gross current and potential land suitability

For current land suitability, the virgin land qualities were matched to the crop requirements without major improvements. The main limiting factor in the study area is salinity associated in some cases with sodicity. They are mainly inhibiting the growth of the proposed utilization types except in wadis. In these wadis, the lands are mostly marginally suitable (S3) for alfalfa, cabbage, maize, sorghum tomato. For olive growth, these wadis and bajada are moderately suitable (S2), while are marginally suitable (S3) in alluvial terraces. This current land suitability for certain cropping patterns can be more profitable after improving limitations of salinity and sodicity (potential land suitability). These improvements realize the ability of extra crops to be more suitable. The land of bajada improved to be highly suitable (S1) for olives but moderately suitable (S2) for barley, maize, sesame, tomato, wheat and guava, while become marginally suitable (S3) for alfalfa, cabbage, green pepper, potatos. sorghum, citrus, date palm and mango. The land of alluvial teraces become highly suitable (S1) for olives but moderately suitable (S2) for alfalfa, barley, cabbage, maize, sesame, sorghum and guava, while become marginally suitable (S3) for green pepper, potatos, tomato, wheat, citrus, date palm and mango. The land of wadis improved to be highly suitable (S1) for olives but moderately suitable (S2) for alfalfa, barley, cabbage, maize, sorghum, wheat and guava, while become marginally suitable (S3) for green pepper, potatos, sesame, tomato, citrus, date palm and mango. Table 2 and 3 include those gross current and potential land suitability at the level of suitability units versus each physigraphic unit.

Table 2. Gross current and potential land suitability for seasonal crops

Physiographic unit	Suitability status	Alfalfa	barley	Cabbage	Green pepper	Maize	Potatos	Sesame	Sorghum	Tomato	Wheat
Dissected rock land	CS					N1p					
	PS					N2p					
Weathered robky terrsces	CS	N1c, s	N1s	N1c, s	N1c, s	N1c, s	N1c, s	N1c, s	N1c, s	N1c, s	N1c, s
	PS	N2c, g, p	N2c, g	N2c, g	N2c, g	N2c, g	N2c, g	N2c, g	N2c, g	N2c, g	N2c, g
Bajada	CS	N1s	N1s	N1s	N1s	N1s	N1s	N1s	N1s	N1s	N1s
	PS	S3c, g	S2c, g	S3c	S3c	S2g	S3g	S2g	S3g	S2c, g	S2m
Alluvial Terraces	CS	N1s	N1s	N1s	N1s	N1s	N1s	N1s	N1s	N1s	N1s
	PS	S2c, g	S2g	S2c, g	S3c	S2c	S3c	S2g	S2c, g	S3c	S3g, x
Wadis	CS	S3g, s	S2g	S3s	N1c, s	S3s	N1s	N1c, s	S3g, s	S3c, s	N1s
	PS	S2g	S2g	S2c, g	S3c	S2c, g	S3g	S3c	S2g	S3c	S2g, x

CS: Current suitability PS: Potential suitability. Soil limitations [c : calcium carbonate %, g : gravel%, m : accumulation of minor limitations,
p : soil depth, s : salinity (Electrical conductivity as ds/m), x : soil texture,] S1; higly suitable, S2: moderately suitable, S3; marginally suitable,
N1:Currently notsuitable, N2: potentially not suitabile.

B- Supreme potential land suitability

The supreme potential land suitability can be realized by the alternatives of shifting each crop to be more adapted with certain physiographic unit for giving higher production. Listed land utilization types are considered the maximum land suitability level in all physiographic units. For the promising units it is only considered when the physiographic units are highly or moderately suitable for certain land utilizations dropping the marginally and not suitability levels. The remaining limiting factors, which include soil depth, coarse fragments, calcium carbonates and soil texture, inhabit the growth of other crops at different suitability levels. Accordingly, the study area is potentially promising as the most profitable utilization at the following two suitability levels:

i- High suitability (S1)

Bajada, alluvial trraces and wadis are highly suitable for olive cultivation.

Moderate suitability (S2)

Bajada are moderately suitable for guava and sesame (S2g); barley and tomato (S2c,g). Alluvial trraces are moderately suitable for maize (S2c); barley, guava and sesame (S2g); wheat (S2m); alfalfa, cabbage, guava and sorgum (S2c,g). Wadis are moderately suitable for alfalfa, barley sorgum (S2g); guava (S2m); cabbage, maize(S2c,g); wheat (S2g,x). These alternatives of cultivating each physiographic with certin crops are shown in Table 4 and Figure 4.

Table 3 Gross current and potential land suitabilityfor trees

Physiographic unit	Suitability status	Citrus	Date palm	Guava	Mango	Olives
Dissected rock land	CS			N1p		
	PS			N2p		
Weathered rocky terraces	CS	N1c,p,s	N1c,s	N1s	N1c,p,s	N1p,s
	PS	N2c,p	N2c	N2c,g,p	N2c,p	N2p
Bajada	CS	N1s	N1s	N1s	N1s	S2m
	PS	S3c,g	S3c	S2g	S3c,g	S1
Alluvial Terraces	CS	N1s	N1s	N1s	N1s	S3s
	PS	S3c	S3c	S2g	S3c	S1
Wadis	CS	N1c,s	N1s	N1s	N1c,s	S2m
	PS	S3c	S3c	S2m	S3c	S1

Table 4 Supreme potential land suitability for specific crop cultivations.

Physiographic unit	Land suitability unit	Crop
Dissected rock land	N2p	all crops
Weathered rocky terraces	N2c,g	all crops
Bajada	S1	olives
	S2g	guava and sesame
	S2c,g	barley and tomato
Alluvial terraces	S1	olives
	S2c	maize
	S2g	barley, guava and sesame
	S2m	wheat
	S2c,g	alfalfa, cabbage, guava and sorgum
Wadis	S1	olives
	S2g	alfalfa, barley and sorgum
	S2m	guava
	S2c,g	cabbage and maize
	S2g,x	wheat

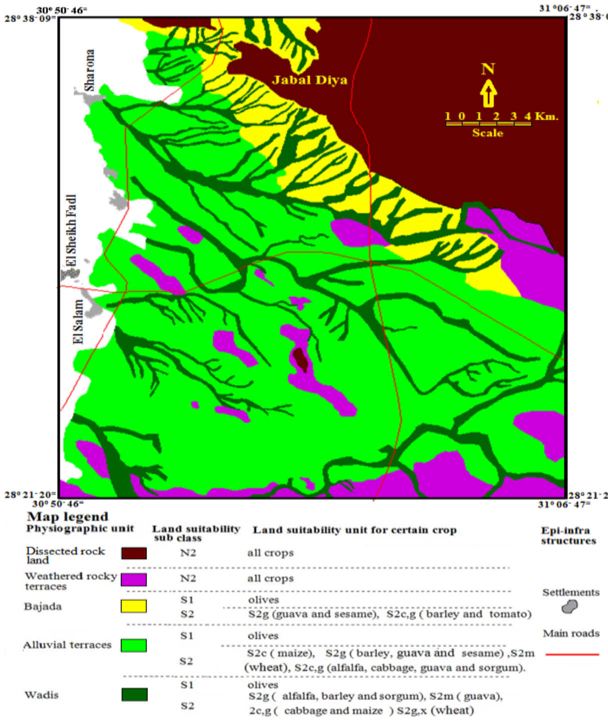

Figure4.Supreme potential land suitability for specific crop cultivations

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توصيف الغطاء الارضى , الفيزيوجرافية واالتربة فى منطقة ممثلة لاراضى ذات مادة اصل مختلفة شرق نهر النيل بمحافظة المنيا فى مصر

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تمتد منطقة الدراسة فى مساحة مقدارها 86337.1 هكتار ممثلة لاقليم متسع شرق نهر النيل بمحافظة المنيا وقد تم تمييز بصماتها الطيفية باستخدام بيانات الاستشعار من البعد للقمر الاستطناعى TM8 والتى التقطت فى عام 2016 حيث حددت اقسام الغطاء الارضى كدراسة اولية لتحديد مساحة واعدة للاستخدام الزراعى قدرت مساحتها ب 50933.2 هكتارا كما وجد ان الوحدات الفيزيوجرافية والاراضى التى تكونت تحت عمليات النحر والترسيب هى : (ا) اراضى صخرية متقطعة (ب) الباجادا والتى تسود فيها الحدة التصنيقية للتربة *Sodic Haplocalcids, loamy skeletal, mixed, hyperthermic.* (ج) الشرفات الصخرية المجواة ذات تربة وحدتها التصنيفية *Calcic Haplosalids, loamy skeletal , carbonitic, hyperthermic.* (د) الشرفات الرسوبية يسود بها الوحدة التصنيفية للتربة *Typic Haplocalcids, coarse loamy, hyperthermic* (ه) الوديان تسود فيها الوحدة التصنيقية للتربة *Typic Torrifluvents coarse loamy, mixed (calcareous), hyperthermic.* بالنسبة للوحدات الفيزيوجرافية والاراضى التى تكونت من ترسيبات نهر النيل ذو المحنيات هى :(ا) قواطع المنحنيات ذات الوحدة التصنيفية *Typic Torriorthents, fine loamy over sandy, mixed, hyperthermi c* (ب) القواطع المنحنية ذات الوحدة التصنيفية *Typic Torriorthent, coarse loamy, mixed, hyperthermic.* (ج) اكتاف النهر ذات الوحدة التصنيفية *Typic Torriorthents, fine loamy, mixed, hyperthermic* (د) السهل الرسوبى ذات الوحدة التصنيفية. *ypic Haplotorrerts, clayey (fine), hyperthermic* تم تقييم الصلاحية الحالية للاراضى الغير منزرعة لزراعة البرسيم الحجازى , الشعير,الكرنب , الفلفل , الذرة , السمسم , الذرة الرفيعة , الطماطم , البطاطس , القمح , الموالح , نخيل البلح, الجوافة و الزيتون. هذه الصلاحية الحالية يمكن ان تكون اكثر ربحية بازالة محددات رئيسية للنمو وهما الملوحة والقلوية لتعكس الصلاحية الكامنة والتى يمكن بدورها ان تكون الافضل عن طريق ازاحة كل محصول ليكون متوافقا مع وحدة فيزيوجرافية معينة من اجل انتاج اكثر