J. Agric. Sci. Mansoura Univ., 33 (10): 7719 - 7734, 2008

EVALUATION OF HURGHADA SOILS AND ITS SUITABILITY FOR SOME BIOFUEL PLANTS

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ABSTRACT

Hurghada and other several tourism areas at the Red Sea coast are in a great need for agricultural products. Due to the fast increase in tourist number and mining activities at the Red Sea coast; investments in agricultural development could be fruitful. Studies on soil survey and land evaluation are the main steps for any agricultural development programme. Therefore, the aim of this study is to evaluate Hurghada soils in respect to its suitability for certain crops or even biofuel plants.

The studied area is bounded by longitudes 33° 26` 00`` and 34° 00` 00``E and latitudes 26° 45` 00`` and 27° 23` 00``N. Visual interpretations of merged Digital Elevation Module (DEM) and Landsat Enhancemed Thematic Mapper (ETM) image together with knowledge drawn from topography map, ground truth data and soil survey and classification are used to define and evaluate the different soils of the study area. Two land evaluation systems were applied for evaluating the studied soils; Sys and Verhey 1978 and Ahmed 2007. Results indicated that Hurghada soils are almost not suitable for irrigated agriculture according to first system, whilst are differentiated between very good (class I) and extremely poor (class V) according to second system. Coarse texture, stoniness and salinity are the main constrains affecting soil suitability for agriculture. Some biofuel plants such as Jojobe and Jatropha are introduced to be grown in the studied area as these plants can grow in marginal gravelly sand soils and proved to sustain in the harsh desert conditions.

Keywords: DEM, ETM, GIS, Hurghada soils, suitability, biofuel plants.

INTRODUCTION

Desert agricultural expansion, on scientific basis, is considered mainstay of Egypt's national economy to take up and cope with the current economic changes. Hurghada area is a part of the Eastern Desert of Egypt, located at the extreme northern part of the Red Sea coast. It is bounded by longitudes 33° 26` 00`` and 34° 00` 00``E and latitudes 26° 45` 00`` and 27° 23` 00``N, Fig. (1). The total area is about 2249.122 km^2. The aridic climate is prevailing in this area, the mean annual temperature is 23°, the annual rainfall is extremely low over the year (about 3.05 mm/year), the relative humidity is fluctuating between 40.6 and 51 % and evapotranspiration rate ranged from 7.7 to 16.5 mm/day, Egyptian Meteorological Authority (1996).

The sources of water available for agriculture are ground water and treated sewage water. With respect to the first source there are three important ground water aquifers, those are the Quaternary alluvial (EC_w 1.8 – 11.5 dS/m), the Middle Miocene carbonate (EC_w 7.1 – 9.1 dS/m) and the Pre-Cambrian(EC_w 0.24 – 15.2 dS/m), El-Sharbi (1993). Labour force and other environmental conditions (e.g. local or foreign marketing, roads and airport) are good.

Hurghada, as a part of the Red Sea coastal zone, is characterized by a wide diversity of natural resources, such as, coral reefs, mangroves, sandy beaches, clear water and skies, barren terrain and many of rare wildlife species. In the past few decades, Hurghada area has witnessed major changes in tourism industry with an increased rate of building hotels and tourism villages. The area has a vast coastal plain which is promising of establishing sustainable agricultural developmental projects that help and promote other activities like tourism, mining and oil production there and help settle local inhabitants and encourage inflow to the area.

The current study was undertaken to evaluate suitability of Hurghada soils for certain crops, i.e. biofuel plant Jojobe (*Simmondsia chinensis*) and Jatropha (*Jatropha curcas*).

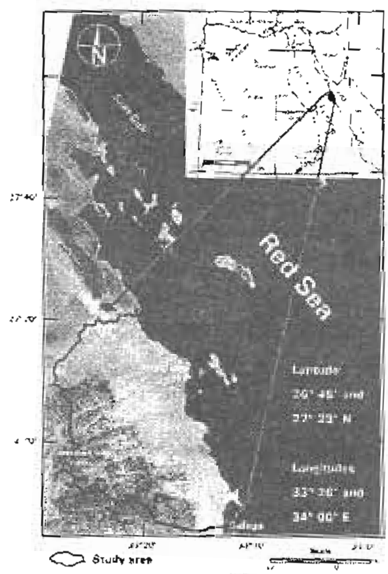

Fig. (1) Location map of the study area

MATERIALS AND METHODS

Digital Elevation Model (DEM) of the study area has been generated from the vector contour lines; ERDAS Imagine 9.2 software was used for this function. Landsat ETM+ image and Digital Elevation Model (DEM) were merged and processed in ERDAS Imagine 9.2 software to define the different landforms of the study area.

Unsupervised soil map for the resultant land forms was produced. Fifty fife soil profiles were taken to represent unsupervised soil map by using the GPS, Fig. (2). These profiles were morphologically described following the guidelines for soil description, FAO (1990). The collected soil samples were subjected to some physical and chemical analyses using the soil survey laboratory methods manual, USDA (2004).

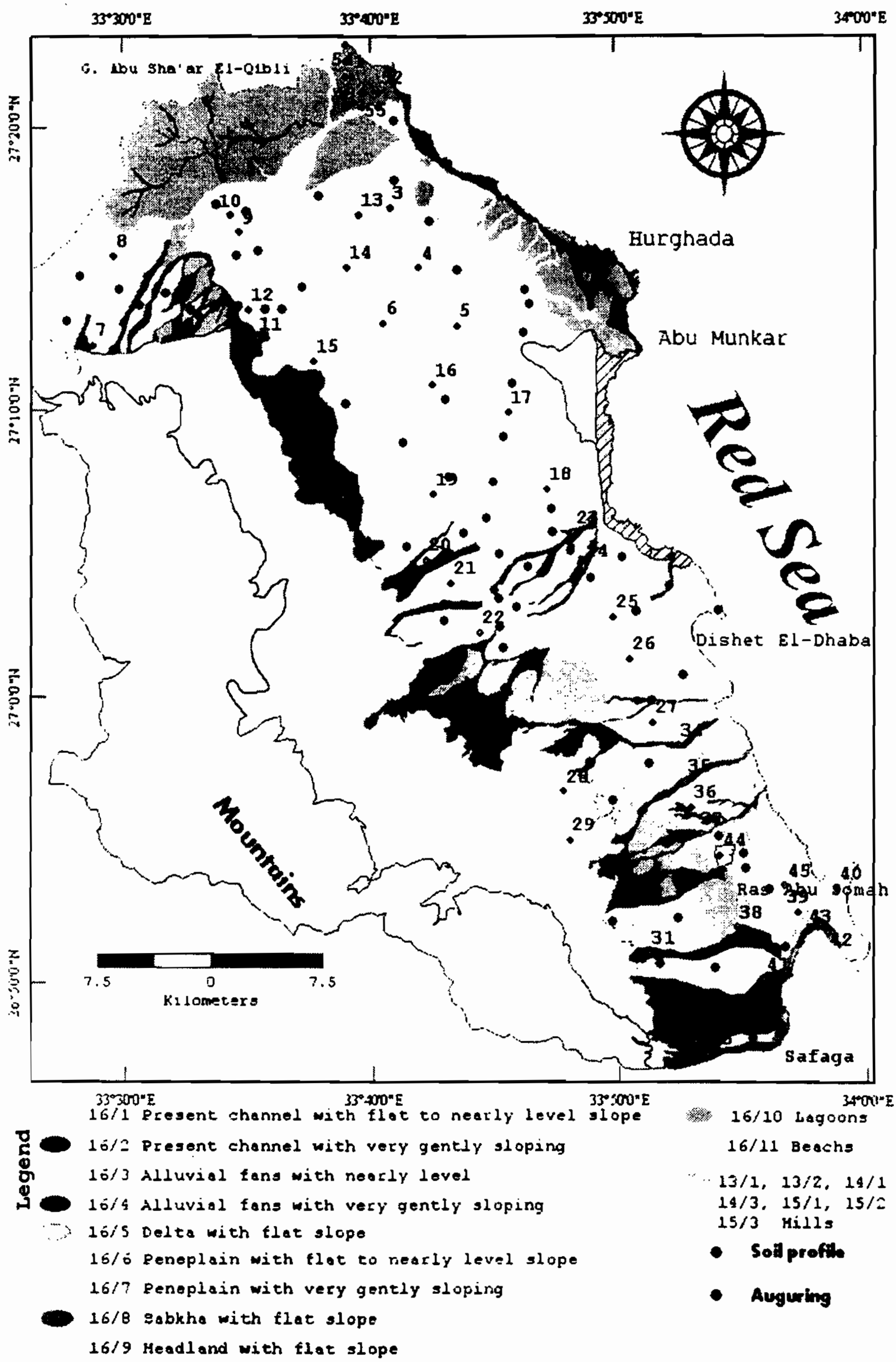

Fig. (2) Landforms and the representative soil profiles at the study area

Soil characteristics were recalculated over a certain depth, some of them by using weighting factors for the different profile sections, Sys and Verheye, (1978), Table (1),

Table (1) The main soil characteristics of the studied soil profiles

Soil Attributes	Unit	Landform: present channel with flat to nearly level slope (EG16/1)									
Profile No		3	6	8	9	12	13	16	17	18	19
Altitude	meter	35	128	190	120	170	50	108	55	55	145
Slope	%	0.3	0.3	0.7	0.7	0.7	0.3	0.7	0.7	0.7	0.7
Drainage	Class	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce
Texture/structure	Class	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS
Coarse fragments	%	23.8	33.9	40.3	40.3	40.7	18.8	44.6	51.3	46.8	42
Soil depth	cm	150	140	150	140	120	150	150	150	150	100
CaCO3	%	5.2	4.9	4.1	3.6	3.68	3.1	3.8	3.8	2.96	3.18
CaSO4-2H$_2$O	%	0	0	0	0	0	0	0	0	0	0
pH in paste		7.9	8.22	8	7.4	7.7	7.8	7.3	7.6	7.8	7.8
O.M	%	0.2	0.07	0	0	0.2	0.11	0.18	0.8	0.14	0.21
ECe	dS/m	4.4	1.8	9.34	1.68	13.9	7.29	3.04	16	1.99	4.7
ESP	%	7.05	16.9	8.6	10.1	11	11	15.6	15.9	14.6	16.2

Soil Attributes	Unit	Landform: present channel with very gentle slope (EG16/2)												
Profile No		11	23	24	28	29	30	31	33	34	35	37	38	41
Altitude	meter	190	30	40	240	215	190	170	105	45	75	80	45	10
Slope	%	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Drainage	Class	Exce	Exce	Exce	Poorly	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce
Texture/structure	Class	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS
Coarse fragments	%	39.7	37.9	29.3	43	30.6	30	42	54	19.79	36	51	31.1	40
Soil depth	cm	125	150	150	40	150	150	130	135	150	150	110	150	150
CaCO3	%	3.95	3.67	3.17	5.1	2.21	2.5	3.35	6.9	3.9	3.7	5.58	5.4	4
CaSO4-2H$_2$O	%	0	0	0	0	0	0	0	0	0	0	0	0.84	0.16
pH in paste		7.9	7.9	7.7	8.3	8.1	8.1	8.1	8	8.9	8	8	7.8	7.6
O.M	%	0	0.14	0.14	0	0	0	0	0	0	0.07	0	0.7	0.07
ECe	dS/m	1.32	2.56	1.4	1.4	0.48	2.9	1.09	4.7	0.8	2.33	5.69	15.2	2.39
ESP	%	5.1	14.9	12.8	12.9	11.1	12.3	11.3	16.5	6.89	12.2	14.72	13.5	15.28

Table (1) cont'd

Soil Attributes	Unit	Landform: delta plain (Umm Duhays basin) with flat (EG16/5)											
Profile No		1	2	46	47	48	49	50	51	52	53	54	55
Altitude	meter	20	23	18	20	23	23.5	22	17	21	21	17	21
Slope	%	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Drainage	Class	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce	Exce
Texture/structure	Class	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS	cS
Coarse fragments	%	22.9	31.4	13	15.4	15.8	29.5	31.8	30.4	18.5	25.3	26	52
Soil depth	cm	140	150	150	120	150	125	150	125	125	130	110	150
CaCO3	%	7.7	10.5	5.7	6.1	6.9	7.9	4.09	5.2	4.52	3.7	6.6	7.6
CaSO4-2H$_2$O	%	0.18	0.45	0.3	0	0	0	1.62	1.5	1.7	1.7	1.8	0
pH in paste		8.3	7.3	8	7.8	7.8	7.9	7.6	7.5	7.8	7.7	7.3	7.7
O.M	%	0.2	0.27	0.03	0.07	0.07	0	0.14	0.07	0.07	0.2	0.2	0.17
ECe	dS/m	4.49	20.6	3.09	10.8	24.6	11.8	22.7	47.7	15.7	9.1	65	6.4
ESP	%	9.9	35	12.2	25	29	19	34	27	31.8	14.5	35	18.2

Soil Attributes	Unit	Landform: peneplain with flat to nearly level slope (EG16/6)						
Profile No		4	5	10	14	25	26	44
Altitude	meter	90	65	110	120	80	85	10
Slope	%	0.7	0.3	0.7	0.7	0.7	0.7	0.7
Drainage	Class	Imp	Imp	Imp	Imp	Exce	Exce	V poorly
Texture/structure	Class	cS	cS	cS	cS	cS	cS	cS
Coarse fragments	%	35.9	51.74	37.9	15.2	18.5	18.9	36
Soil depth	cm	75	83	65	90	150	150	20
CaCO3	%	4.9	6.6	4.1	5.24	4.34	4.36	0.1
CaSO4-2H$_2$O	%	2.1	0	1.67	1.81	0.64	0	37.6
pH in paste		7.5	8.1	7.3	7.7	7.9	8	7.1
O.M	%	0.18	0.07	0	0.11	0.11	0.07	0
ECe	dS/m	44.9	17.9	21.8	22.3	33.3	28.8	4
ESP	%	37.3	10.01	33.6	21.1	31.4	18.6	0

Table (1) cont'd

Soil Attributes	Unit	Landform: peneplain with very gentle slope (EG16/7)						Landform: alluvial fans with nearly level slope (EG16/3)	Landform: alluvial fans with very gentle slope (EG16/4)	sabkha (16/8)	
Profile No		7	20	21	22	27	36	15	32	42	43
Altitude	meter	300	190	190	180	90	108	186	105	0.8	0.8
Slope	%	1.5	1.5	1.5	1.5	1.5	1.5	0.7	1.5	0.2	0.2
Drainage	Class	Exce	Exce	Exce	Exce	Exce	Poorly	Exce	Exce	V poorly	
Texture/structure	Class	cS	cS	cS	cS	cS	cS	cS	cS	mS	fS
Coarse fragments	%	46	36.3	17.6	30.5	31.6	48.5	51.9	48.8	0	0
Soil depth	cm	140	90	100	100	110	50	150	140	60	30
CaCO3	%	5.2	3.27	2.6	3.3	2.41	3.32	4.7	4.3	11.3	17.25
CaSO4-2H$_2$O	%	0	0	0	0	1.67	0	0	1	2.65	1.5
pH in paste		8	7.9	7.7	7.9	8	7.8	8	7.9	8.1	8.1
O.M	%	0	0.18	0.21	0.25	0	0.03	0.11	0	0.5	0.4
ECe	dS/m	2.03	31.8	28.3	1.69	38.6	15.3	4	12.1	132	90
ESP	%	11	20.4	16.4	13.5	39.5	20.3	15.8	28	12.9	12.45

The obtained data were imported in a GIS database; the digital landforms map was used as base map in the database. The spatial analysis function in ArcGIS 9.2 software was used to create the thematic layers of the following soil characteristics: slope gradient, drainage, texture, structure, coarse fragments, soil depth, $CaCO_3$, gypsum, pH, Organic matter, salinity and alkalinity. Two systems for land evaluation were applied; those are Sys and Verheye 1978 and Ahmed 2007.

Soil requirements for certain biofuel plants were cited from the web site internet of General Agricultural Forum – Agric. Experts Form, (2005), Table (2). Different characteristics of the studied soils were compared with soil requirement for Jojobe and Jatropha plants and resultant application was introduced.

Table (2) Land use requirements for Jojobe (Simmondsia chinensis) and Jatropha (Jatropha curcas), General Agriculture Forum – Agric. Experts Forum (2005)

Land Characteristics	Class and degree of limitaion					
	S1		S2	S3	N1	N2
	0	1	2	3	4	
	100	90	75	50	35	20
Topography (t)						
Slope (%)	0-4	4-8	8-16	16-25	-	> 25
Drainage	Good	Good	Moderate	Imperfect	Poor	very poor
Physical soil charachteristics (s)						
Texture/structre	SL, SCL, L,	SiL, Si, SiCL, CL, LS	S	Cm, SiCm. C<60s,SC	C>60s, -	-
Coarse fragment (%)	0-15	15-35	35-55	55-75	-	> 75
Soil depth (cm)	> 150	150-120	120-100	100-80	-	< 80
CaCO3 (%)	any					
Gypsum (%)	0-10	10-15	15-20	20-25	-	> 25
Soil fertility characteristics (f)						
pH (in paste)	6.5-7.5	7.5-8.0	8.0-8.5	8.5-9	> 9	-
Organic matter (%)	>.8	0.4-0.8	<0.4	-	-	-
Salinity and Alalinity (n)						
EC (dS/m)	0-5	5-10	10-15	15-20	20-25	> 25
ESP (%)	0-15	15-25	25-35	35-45	-	> 45

RESULTS AND DISCUSSION

1- Land suitability classification for irrigated agriculture according to Sys and Verheye, (1978).

This system is based on the standard granulometrical and physico-chemical characteristics of soil profile.

The land characteristics influencing the land suitability with regard to irrigation as proposed by Sys and Verheye (1978) are as follows:-

t : topographic limitation

w: wetness limitation, mainly based on drainage condition

s : limitations referring to physical soil condition as:

s1: texture including stoniness

s2: soil depth

s3: calcium carbonate content

s4: gypsum content

n : salinity and alkalinity limitation.

The land suitability indice for irrigated agriculture (Ci) is calculated according to the following formula:-

Ci = t * w/100 * s1/100 * s2/100 * s3/100 * s4/100 *n/100

Based on the value of Ci, (soil index), the suitability classes are defined as follows:

Index	Suitability class
100 – 75	S1: very suitable
75 – 50	S2: moderately suitable
50 – 25	S3: marginally suitable
25 – 12.5	N1 : currently unsuitable
< 12.5	N2 : permanently unsuitable

Concerning to the investigated area, Data in Table 3 reveal that almost all the studied soil profiles can be categorized as not suitable for agriculture, either currently (N1) or permanently unsuitable (N2). Soils belonging to class (N1) have one or more severe limitation factors that can be corrected and currently exclude their use. While soils belong to class (N2) have one or more severe limitations that cannot be corrected either currently or permanently.

From results in Table 3, it is evident the all soils represented by most of the studied profiles belongs to N1, in other words these soils are not suitable for agriculture currently. However, the dominant limiting constrain is coarse texture. There is along debate between soil scientist whether soil texture is considered as correctable soil characteristic or not. Tremendous amount of research had been carried out in the 70th and 80th of the last centenary toward improving soil texture and consequently soil characteristics relating to it. This was done either by added natural (O.M, taffla, deposit natural adsorbents) or synthetic deposits (polymers and others). The recent techniques in soil technology for reclaiming sandy desert soils pay much attention to the nutritional aspect, this is done through fertigation. However whether the constrains are correctable or not, the end result of the studied soils is considered not suitable for agriculture. Meanwhile few soils (represented by profiles 4, 10, 36, 42, 43 and 54) are considered permanently unsuitable for agriculture (N2) as the main constrain is soil depth beside soil texture and salinity. In summary according to Sys and Verheye (1978), the soils of the studied area are not suitable for agriculture.

2- Land Capability Classification according to Ahmed, (2007).

Ahmed (2007) claimed that all arguments about soil evaluation are directed to soil texture rating, i.e., once soil is sandy this decreases its rank drastically. Most of the previous systems refer to soil texture as uncorrectable properties. In addition, problems related to water and nutrient supply in sandy soils can be corrected effectively. He added that in most system for land evaluation values assigned to high and low limits for some correctable factors such as soil salinity and pH should also be revised.

Table (3) Land suitability classification for irrigated agriculture of Hurghada area, according to Sys and Verheye (1978).

Land form	Profile No.	Land characteristics and their ratings							Suitability index (Ci)	Suitability classes
		t	w	s1	s2	s3	s4	n		
Present channel with flat to nearly level slope	3	100	100	25	100	95	90	100	21,4	N1
	6	100	100	25	100	95	90	95	20,3	N1
	8	100	100	25	100	95	90	90	19,2	N1
	9	100	100	25	100	95	90	100	21,4	N1
	12	100	100	25	100	95	90	85	18,2	N1
	13	100	100	25	100	95	90	90	19,2	N1
	16	100	100	25	100	95	90	95	20,3	N1
	17	100	100	25	100	95	90	95	20,3	N1
	18	100	100	25	100	95	90	95	20,3	N1
	19	100	100	25	90	95	90	95	18,3	N1
Present channel with very gently sloping	11	100	100	25	100	95	90	100	21,4	N1
	23	100	100	25	100	95	90	95	20,3	N1
	24	100	100	25	100	95	90	95	20,3	N1
	28	100	55	25	55	95	90	95	6,1	N2
	29	100	100	25	100	95	90	95	20,3	N1
	30	100	100	25	100	95	90	100	21,4	N1
	31	100	100	25	100	95	90	100	21,4	N1
	33	100	100	25	100	95	90	90	19,2	N1
	34	100	100	25	100	95	90	100	21,4	N1
	35	100	100	25	100	95	90	95	20,3	N1
	37	100	100	25	100	95	90	90	19,2	N1
	38	100	100	25	100	95	90	85	18,2	N1
	41	100	100	25	100	95	90	95	20,3	N1
Alluvial fans	15	100	100	25	100	95	90	95	20,3	N1
Alluvial fans	32	100	100	25	100	95	100	80	19,0	N1
Delta with flat slope	1	100	100	25	100	95	90	90	19,2	N1
	2	100	100	25	100	100	90	80	18,0	N1
	46	100	100	25	100	95	90	95	20,3	N1
	47	100	100	25	100	95	90	80	17,1	N1
	48	100	100	25	100	95	90	75	16,0	N1
	49	100	100	25	100	95	90	85	18,2	N1
	50	100	100	25	100	95	100	75	17,8	N1
	51	100	100	25	100	95	100	58	13,8	N1
	52	100	100	25	100	95	100	80	19,0	N1
	53	100	100	25	100	95	100	85	20,2	N1
	54	100	100	25	100	95	100	45	10,7	N2
	55	100	100	25	100	95	90	90	19,2	N1

t=topography limitations (slope)
w=wetness limitations
s=physical soil limitations   s1=Texture, s2=Soil depth, s3=$CaCO_3$, s4=Gypsum
n=salinity and alkalinity limitaions

Table (3) cont'd

Land form	Profile No.	t	w	s1	s2	s3	s4	n	Suitability Index (Ci)	Suitability classes
Peneplain with flat to nearly level slope	4	100	80	25	75	95	100	45	6,4	N2
	5	100	90	25	90	95	90	85	14,7	N1
	10	100	80	25	75	95	100	75	10,7	N2
	14	100	90	25	90	95	100	75	14,4	N1
	25	100	100	25	100	95	100	58	13,8	N1
	26	100	100	25	100	85	90	80	15,3	N1
Peneplain with very gently sloping	7	100	100	25	100	95	90	95	20,3	N1
	20	100	100	25	90	95	90	80	15,4	N1
	21	100	100	25	90	95	90	80	15,4	N1
	22	100	100	25	90	95	90	95	18,3	N1
	27	100	100	25	100	95	100	58	13,8	N1
	36	100	65	25	55	95	90	80	6,1	N2
Sabkha	42	100	40	30	55	100	100	50	3,3	N2
	43	100	40	30	30	100	100	50	1,8	N2

t=topography limitations (slope)
w=wetness limitations
s=physical soil limitations s1=Texture, s2=Soil depth, s3=$CaCO_3$, s4=Gypsum
n=salinity and alkalinity limitaions

After reviewing many previous systems for land evaluation, Ahmed (2007) concluded that most effective factors determining productivity of sandy soils are slope (a), texture and stoniness (b), profile depth (c), calcium carbonate content and fineness (d), gypsum (e) and salinity and alkalinity (f).

The above soil characteristics are rated according to proposed rates by Ahmed (2007) who used the following equation to find out the capability index of sandy soil (**CISS**).

$$CISS = a * b/100 * c/100 * d/100 * e/100 * f/100$$

Based on the resultant value of the capability index, the capability classes are defined as follows:

Index values for different capability classes according to Ahmed (2007)

Capability index	Soil grade	Definition
100 – 70	I	Very good
70 – 50	II	Good
50 – 30	III	Fairly good (average)
30 – 15	IV	Poor
< 15	V	Extremely poor

Results in Table 4 indicated that soils of investigated area are differentiated between class I and class V. About 20 % of the studied profile are rated as grade I (very good soils), these are soils represented by profiles No. 6, 9, 11, 23, 24, 29, 30, 35, 41, 46, while 15 % belong to soil grade II (good soil), these are soil's represented by profiles 13, 16, 18, 31, 34, 52, 7 and 22. The soils of grade II are affected by slight to moderate limitations. Texture and stoniness and salinity and alkalinity are the main limiting factors. Furthermore, 42.3 % of the studied profiles belong to grade III (fairly good soils or average soils). Soils belonging to this class dominate the majority of the studied area and are affected by moderate to severe limitations.

Table (4) Land capability classification accoding to the proposed system by Ahmed (2007)

Land form	Profile No.	Land characteristics and their ratings						Capability index (Ci)	Capability classes
		a	b	c	d	e	f		
Present channel with flat to nearly level slope	3	100	75	100	90	100	70	47,3	III
	6	100	75	100	100	100	95	71,3	I
	8	100	75	100	100	100	50	37,5	III
	9	100	75	100	100	100	100	75,0	I
	12	100	60	100	100	100	60	36,0	III
	13	100	85	100	100	100	80	68,0	II
	16	100	60	100	100	100	100	60,0	II
	17	100	60	100	100	100	60	36,0	III
	18	100	60	100	100	100	100	60,0	II
	19	100	60	90	100	100	80	43,2	III
Present channel with very gently sloping	11	100	75	100	100	100	95	71,3	I
	23	100	75	100	100	100	95	71,3	I
	24	100	75	100	100	100	100	75,0	I
	28	100	60	50	90	100	95	25,7	IV
	29	100	75	100	100	100	95	71,3	I
	30	100	75	100	100	100	95	71,3	I
	31	100	60	100	100	100	95	57,0	II
	33	100	60	100	90	100	70	37,8	III
	34	100	85	100	100	100	80	68,0	II
	35	100	75	100	100	100	95	71,3	I
	37	100	60	90	90	100	70	34,0	III
	38	100	75	100	90	100	60	40,5	III
	41	100	75	100	100	100	100	75,0	I
Alluvial fans	15	100	60	100	100	100	70	42,0	III
Alluvial fans	32	100	60	100	100	100	50	30,0	III
Delta with flat slope	1	100	75	100	90	100	70	47,3	III
	2	100	75	100	90	100	50	33,8	III
	46	100	85	100	90	100	95	72,7	I
	47	100	85	100	90	100	60	45,9	III
	48	100	85	100	90	100	50	38,3	III
	49	100	75	100	90	100	50	33,8	III
	50	100	75	100	100	100	50	37,5	III
	51	100	75	100	90	100	30	20,3	IV
	52	100	85	100	100	100	60	51,0	II
	53	100	75	100	100	100	60	45,0	III
	54	100	75	90	90	100	30	18,2	IV
	55	100	60	100	90	100	80	43,2	III

a=topography limitations (slope)
b=texture and stoniness. c=Soil depth. d=$CaCO_3$ content and fineness, e=Gypsum
f=salinity and alkalinity limitaions

Table 4) cont'd

Land form	Profile No.	Land characteristics and their ratings						Capability index (Ci)	Capability classes
		a	b	c	d	e	f		
Peneplain with flat to nearly level slope	4	100	75	80	100	100	30	18,0	IV
	5	100	60	80	90	100	40	17,3	IV
	10	100	75	80	100	100	50	30,0	III
	14	100	85	80	90	100	50	30,6	III
	25	100	85	100	100	100	25	21,3	IV
	26	100	85	100	100	100	40	34,0	III
	44	100	75	20	100	25	80	3,0	V
Peneplain with very gently sloping	7	100	60	100	90	100	95	51,3	II
	20	100	75	90	100	100	25	16,9	IV
	21	100	85	90	100	100	50	38,3	III
	22	100	75	90	100	100	95	64,1	II
	27	100	75	100	100	100	25	18,8	IV
	36	100	60	50	100	100	60	18,0	IV
Sabkha	42	100	85	50	70	100	25	7,4	V
	43	100	85	50	70	100	25	7,4	V

a=topography limitations (slope)

b=texture and stoniness, c=Soil depth, d=$CaCO_3$ content and fineness, e=Gypsum

f=salinity and alkalinity limitations

Those soils are represented by profiles 3, 8, 12, 17, 19, 33, 37, 38, 15, 32, 1, 2, 47, 48, 49, 50, 53, 55, 10, 14, 26 and 21. Texture, stoniness, salinity and alkalinity are the main limiting factors, however they are fairly good for certain specialized crops. Moreover, 17.3 % of the soil profiles (51, 54, 4, 5, 25, 20, 27, 36 and 28) have grade IV (poor soil); these soils are affected by severe limitations. Texture, coarse fragment, soil depth, salinity and alkalinity are the limiting factors. These soils have a narrow range of agricultural capability and the rest of the studied profile (42, 43 and 44) 5.4 % belong to grade V (extremely poor soil). The soils of grade V are affected by very severe limitations; texture, soil depth, calcium carbonate content, salinity and alkalinity problems are the limiting factors. Those soils are not capable of, any agricultural production.

Applying CISS proposed by Ahmed (2007), It can be concluded that 20 % of the studied area are graded as almost good soils (classes I and II) and about 80 % are either fairy good or poor soils. Modifying the upper and lower limits of the different soil constrains improved the rank of soil class, according to Ahmed (2007). However further intensive studies should be directed in the future to adopt a more convenient system for the sandy soils in Egypt.

Now a day the idea of biofuel occupies the mind of most scientists. And the need to renew and add new sources of energy is a must to meet the over increasing demand for different source of energy. As some developed nations use crops needed for human food to make biofuel, a policy which will increase the number of hungry people and the poverty of poor nations, we propose the use of what we call marginal soils (soils graded as class III, IV and even V) to be cultivated with certain crops suitable for making fuel such as Jojobe and Jatropha, without affected the area of soils suitable for crops needed to human nutrition.

In the following is a proposed plan for utilizing soils ranked as marginal soils for producing biofuel plants:

Suitability of Hurghada soils for biofuel plants

Jojobe (*Simmondsia chinensis*) and Jatropha (*Jatropha curcas*) are the most adaptable industrial crops to the harsh desert circumstances in terms of climate and soil. These plants can well withstand high temperatures up to 50 C° although temperature ranging between 28 – 36 C° during the day and 13 – 18 C° at night produce higher yield, General Agriculture Forum – Agric. Experts Forum (2005). They grow well in gravelly sand soils and that contain calcium carbonates and gypsum of wide range. The plants are tolerant to high salinity that could reach up to 10000 ppm and can tolerate a wide range of alkaline soils. Jojobe and Jatropha plants are tolerant to water-logging as well as drought so that they can withstand lack of irrigation for as long as a year. Treated sewage water could be used for irrigation. The plants can do well in low fertile soils as those prevailing in sandy soils. So these crops suit the desert conditions in Egypt in terms of climate and soils that are not suitable for traditional crops.

Jojobe and Jatropha are considered of high economic value; oil is extracted from their seeds and is valued as a clean alternative source of energy as a biofuel, non pollutant, a substitute to the engine oil, odor free, inexpensive, can be used to generate electricity in charcoal or nuclear-energy plants. The oil is also used in several purposes such as the petrochemicals and medical ones, Agriculture production Forum – Agric. Experts Forum (2005).

Characteristics of the studied soils listed in Table (1) are compared with land requirements for both Jojobe and Jatropha plants according to General Agriculture Forum (2005), Table (2), results are shown in Tables (5) and (6).

From the above mentioned tables, it can be concluded that:

1- Half of the studied area are either (S2) moderately suitable for biofuel plant (≈ 85679 feds), or (S3) marginally suitable (≈ 36230 feds) for the same crops. Soil constrains in both classes (S2 and S3) are one or two of the following: coarse texture, stoniness, salinity, alkalinity and fertility level.
2- The other half of the studied soils ≈ 122613 feds are not suitable to be cultivated with either Jojobe or Jatropha plants. This is due to presence of more than one severe constrains (together) such as coarse texture, stoniness, high salinity and alkalinity, very low fertility, shallow depth to bedrock and shallow water table.
3- The obtained results was not expected as some soils of the studied area according to Ahmed (2007) were rated in class I, and those soils are

ranked as moderately suitable (S2) for biofuel plants, according to parameters mentioned by FAO (2007) for different crops.

4- We believe that FAO parameters over estimate the effect of soil constrains on land suitability for Jojobe and Jatropha plants, i.e. as mentioned in Table (5) two constrains soil texture (s1) and fertility (f2) affect each other, so one of them (i.e. soil texture) would be enough for land evaluation. Also soil pH and ESP are chemically having the same effect. So pH is the constrain considered, especially ESP in sandy soil has very low values and practically is not very precisely estimated.

5- It is noticed that the pH range considered highly suitable for Jojobe and Jatropha plants is 5 – 8, and this range is believed to be narrow for those plants especially in sandy soils. Therefore this range is increased to reach from 5 to 8.5.

6- Neglecting the constrains O.M, ESP and using a pH range from 5 to 8.5, The following table is proposed to estimate Hurghada soil suitability for biofuel plants, Table (7).

Table (5) Land suitability evaluation for **some biofuel plants (Jojobe and Jatropha) at Hurghada area**

Land form	Profile No	Characteristics, limitation level, ratings and max. land class																						Current Suitability		Land improvements	Potential suitability	
		t		d		s1		s2		s3		s4		s5		f1		f2		n1		n2		limitation	LI		low	high
Present channel with flat to nearly level slope	3	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V.F	S2 (s1)	S1
	6	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S2 (s1, f)	56.3	V.F	S2 (s1)	S1
	8	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1
	9	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S1	100	S1	100	S2 (s1, f, s2)	56.3	V.F	S2 (s1, s2)	S1
	12	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S2	75	S1	100	S3 (s1, f, n n1)	47.5	V.L.F	S2 (s1, s2)	S1
	13	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V.F	S2 (s1)	S1
	16	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S1	100	S1	100	S2 (s1, f, s2)	56.3	V.F	S2 (s1, s2)	S1
	17	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S2	75	S1	100	S3 (s1, f, n n1)	47.5	V.L.F	S2 (s1, s2)	S1
	18	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1
	19	S1	100	S1	100	S2	75	S2	75	S2	75	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S3 (s1, f, s2, s3)	47.5	V.F	S2 (s1, s2, s3)	S2 (s3)
Present channel with very gently sloping	11	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1
	23	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1
	24	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V.F	S2 (s1)	S1
	28	S1	100	N1	35	S2	75	S2	75	N2	35	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	N2	11.6			
	29	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V.F	S2 (s1)	S1
	30	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V.F	S2 (s1)	S1
	31	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1
	33	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1
	34	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S2 (s1, f)	56.3	V.F	S2 (s1)	S1
	35	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V.F	S2 (s1)	S1
	37	S1	100	S1	100	S2	75	S2	75	S2	75	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S3 (s1, f, s2, s3)	47.5	V.F	S3 (s1, s2, s3)	S2 (s3)
	38	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S2	75	S1	100	S2 (s1, f, n)	54.8	V.L.F	S2 (s1)	S1
	41	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V.F	S2 (s1, s2)	S1

t- topographic limitations (slope)
d- drainage
s- physical soil limitations
f- soil fertility limitations
n- salinity (and or alkalinity) limitations

s1- Texture structure, s2- Coarse fragment, s3- Soil depth, s4- $CaCO_3$, s5- Gypsum
f1- pH, f2- Organic matter
n1- EC, n2- ESP

LI- Land index by Square Root Method (Khiddir, 1986)
D- Drainage
V- Physical characteristics
F- Fertilization
L- Leaching requirement

Table (5) cont'd

Land form	Profile No.	Characteristics, limitation level, ratings and max. land class																					Current Suitability		Land	Potential suitability	
		t		d		s1		s2		s3		s4		s5		f1		f2		n1		n2		limitation	LI	improvements	low	high
Alluvial fans	15	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S1	100	S1	100	S2 (s1, f, s2)	56.3	V,F	S2 (s1, s2)	S1
Alluvial fans	32	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S2	75	S3 (s1, f, n, s2)	47.5	V,L,F	S2 (s1, s2)	S1
Delta with flat slope	1	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S2 (s1, f)	56.3	V,F	S2 (s1)	S1
	2	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	S3	50	S2	75	S3 (s1, f, n)	39.8	V,L,F		
	46	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f)	63.3	V,F	S2 (s1)	S1
	47	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S2	75	S1	100	S2 (s1, f, n)	54.8	V,F	S2 (s1)	S1
	48	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	N1	35	S2	75	N1 (s1, f, n)	22.2	V,L,F		
	49	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S2	75	S1	100	S2 (s1, f, n)	54.8	V,F	S2 (s1)	S1
	50	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	N1	35	S2	75	N1 (s1, f, n)	22.2	V,L,F		
	51	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	N1	35	S2	75	N1 (s1, f, n)	22.7	V,L,F		
	52	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S2	75	S2	75	S2 (s1, f, n)	47.8	V,L,F	S2 (s1)	S1
	53	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	S1	90	S1	100	S2 (s1, f)	60.1	V,F	S2 (s1)	S1
	54	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	N1	35	S2	75	N1 (s1, f, n)	22.7	V,L,F		
	55	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S1	100	S1	100	S2 (s1, f, s2)	56.3	V,F	S2 (s1, s2)	S1
Peneplain with flat to level slope	4	S1	100	S3	50	S2	75	S1	100	S3	50	S1	100	S1	100	S1	100	S2	75	N1	35	S2	75	N1 (s1, f, n, s3, d)	11.4	V,D,L,F		
	5	S1	100	S3	50	S2	75	S2	75	S3	50	S1	100	S1	100	S1	95	S2	75	S3	50	S1	100	N1 (s1, f, n, s3, d, s2)	19.4	V,D,L,F		
	10	S1	100	S3	50	S2	75	S2	75	N1	35	S1	100	S1	100	S1	100	S2	75	N1	35	S2	75	N2	8.1			
	14	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	95	S2	75	S1	100	N1	35	N1 (s1, f, n, s3)	22.2	V,F	S3 (s1, s3)	S2 (s1)
	25	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	N1	35	S2	75	N1 (s1, f, n)	22.2	V,L,F		
	26	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	95	S2	75	N1	35	S1	100	S3 (s1, f, n)	25.6	V,L,F		
	44	S1	100	N2	20	S2	75	S1	100	N2	20	S1	100	S1	100	S1	100	S2	75	S1	100	S1	100	N2	6.7			

t = topography limitations (slope)
d = drainage
s = physical soil limitations
f = soil fertility limitations
n = salinity (and or alkalinity) limitations

LI = Land index by Square Root Method (Khiddir, 1986)
s1 = Texture structure, s2 = Course fragment, s3 = Soil depth, s4 = $CaCO_3$, s5 = Gypsum
f1 = pH, f2 = Organic matter
n1 = EC, n2 = ESP
D = Drainage
V = Physical characteristics
F = Fertilization
L = Leaching requirement

Table (5) cont'd

Land form	Profile No.	Characteristics, limitation level, ratings and max. land class																					Current Suitability		Land	Potential suitability	
		t		d		s1		s2		s3		s4		s5		f1		f2		n1		n2		limitation	LI	improvements	low	high
Peneplain with very gentle sloping	7	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S2 (s1, f, s2)	54.8	V,F	S2 (s1, s2)	S1
	20	S1	100	S1	100	S2	75	S2	75	S3	50	S1	100	S1	100	S1	95	S2	75	N1	35	S1	100	N1 (s1, f, n, s3, s2)	15.7	V,L,F		
	21	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	95	S2	75	N1	35	S1	100	N1 (s1, f, n, s3)	22.2	V,L,F		
	22	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	95	S2	75	S1	100	S1	100	S3 (s1, f, s3)	54.8	V,F	S2 (s1, s3)	S2 (s1)
	27	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	95	S2	75	N1	35	S3	50	N1 (s1, f, n, s3)	15.7	V,L,F		
	36	S1	100	N1	35	S2	75	S2	75	N1	35	S1	100	S1	100	S1	95	S2	75	S2	75	S1	100	N2	11.4		.	.
Sabkha	42	S1	100	N2	20	S2	75	S1	100	N1	35	S1	100	S1	100	S1	95	S2	75	N2	20	S1	100	N2	3.9			
	43	S1	100	N2	20	S2	75	S1	100	N1	35	S1	100	S1	100	S1	95	S2	75	N2	20	S1	100	N2	3.9			

t = topography limitations (slope)
d = drainage
s = physical soil limitations
f = soil fertility limitations
n = salinity (and or alkalinity) limitations

LI = Land index by Square Root Method (Khiddir, 1986)
s1 = Texture structure, s2 = Coarse fragment, s3 = Soil depth, s4 = $CaCO_3$, s5 = Gypsum
f1 = pH, f2 = Organic matter
n1 = EC, n2 = ESP
D = Drainage
V = Physical characteristics
F = Fertilization
L = Leaching requirement

Table (6): Summary of suitability classes of the studied soils for Jojobe and Jatropha plants at Hrghada area.

Actual sutability class	subclass	area (fed.)	Profile No.
S2	S2 (s1, f)	16070	3, 6, 13, 24, 29, 30, 34, 35, 1, 46, 53
	S2 (s1, f, n)	3704	36, 47, 49, 52,
	S2 (s1, f, s2)	63905	8, 9, 16, 16, 11, 23, 31, 33, 41, 15, 55, 7
S3	S3 (s1, f, s3)	8100	22
	S3 (s1, f, s2, s3)	8672	19, 37
	S3 (s1, f, n, s2)	17255	12, 17, 32
	S3 (s1, f, n)	2203	2, 26
	Total	121908	
N1	N1 (s1, f, n)	10130	48, 50, 51, 54, 25
	N1 (s1, f, n, s3)	51007	14, 21, 27
	N1 (s1, f, n, s3, d, s2)	41116	4, 5, 20
N2	N2	20360	26, 10, 36, 42, 43, 44
	Total	122613	
	All area (S2, S3, N1, N2)	244521	

Table (7) Land suitability evaluation for **some biofuel plants (Jojobe and Jatropha) at Hurghada area**

Land form	Profile No.	t		d		s1		s2		s3		s4		s5		f		n		Current Suitability limitation	LI
Present channel with flat to nearly level slope	3	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	6	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2	95	S1	100	S2 (s_1)	73
	8	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	9	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	12	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S2 (s_1, n s_2)	56
	13	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	16	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1,s_2)	65
	17	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S2 (s_1, n s_2)	56
	18	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1,s_2)	65
	19	S1	100	S1	100	S2	75	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2 s_3)	56
Present channel with very gently sloping	11	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	23	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	24	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	28	S1	100	N1	35	S2	75	S2	75	N2	35	S1	100	S1	100	S2	90	S1	100	N1	15
	29	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	30	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	31	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	33	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	34	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2	75	S1	100	S2 (s_1, f)	65
	35	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	37	S1	100	S1	100	S2	75	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2 s_3)	56
	38	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	S2 (s_1, n)	65
	41	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65

t=topography limitations (slope)
d=drainage
s=physical soil limitations
f=soil fertility limitations (pH)
n=salinity limitaions (EC)

LI= Land index by Square Root Method (Khiddir, 1986)

s1=Texture/structure. s2=Coarse fragment. s3=Soil depth. s4=$CaCO_3$. s5=Gypsum

Table (7) cont'd

Land form	Profile No.	t		d		s1		s2		s3		s4		s5		f		n		Current Suitability limitation	LI
Alluvial fans	15	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
Alluvial fans	32	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	75	S2 (s_1, n s_2)	56
Delta with flat slope	1	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2	90	S1	100	S2 (s_1, f)	71
	2	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S3	50	S3 (s_1, n)	43
	46	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	100	S1 (s_1)	75
	47	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	S2 (s_1, n)	65
	48	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	N1	35	S3 (s_1, n)	30
	49	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	S2 (s_1, n)	65
	50	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	N1	35	S3 (s_1, n)	30
	51	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	N1	35	S3 (s_1, n)	30
	52	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2	75	S2 (s_1, n)	65
	53	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S1	90	S2 (s_1)	71
	54	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	N1	35	S3 (s_1, n)	30
	55	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
Peneplain with flat to nearly level slope	4	S1	100	S3	50	S2	75	S1	100	S3	50	S1	100	S1	100	S1	100	N1	35	N1 (s_1, n, s3, d,)	15
	5	S1	100	S3	50	S2	75	S2	75	S3	50	S1	100	S1	100	S1	100	S3	50	N1 (s_1, n, s3, d, s2)	19
	10	S1	100	S3	50	S2	75	S2	75	N1	35	S1	100	S1	100	S1	100	N1	35	N2	11
	14	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S2 (s_1, f, n, s_3)	65
	25	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	N1	35	S3 (s_1, n)	30
	26	S1	100	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	N1	35	S3 (s_1,n)	30
	44	S1	100	N2	20	S2	75	S1	100	N2	20	S1	100	S1	100	S1	100	S1	100	N2	8

t=topography limitations (slope)
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s1=Texture/structure. s2=Coarse fragment. s3=Soil depth. s4=$CaCO_3$. s5=Gypsum

Table (7) cont'd

Land form	Profile No.	Characteristics, limitation level, ratings and max. land class																		Current Suitability	
		t		d		s1		s2		s3		s4		s5		f		n		limitation	LI
Peneplain with very gently sloping	7	S1	100	S1	100	S2	75	S2	75	S1	100	S1	100	S1	100	S1	100	S1	100	S2 (s_1, s_2)	65
	20	S1	100	S1	100	S2	75	S2	75	S3	50	S1	100	S1	100	S1	100	N1	35	N1 (s_1, n, s3, s2)	19
	21	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	100	N1	35	S3 (s_1, f, n,s_3)	26
	22	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	100	S1	100	S3 (s_1, s_3)	65
	27	S1	100	S1	100	S2	75	S1	100	S2	75	S1	100	S1	100	S1	100	N1	35	S3(s_1, n,s_3)	26
	36	S1	100	N1	35	S2	75	S2	75	N1	35	S1	100	S1	100	S1	100	S2	75	N1 (s1, n, s3, s2)	13
	[redacted]																				
Sabkha	42	S1	100	N2	20	S2	75	S1	100	N1	35	S1	100	S1	100	S1	100	N2	20	N2	5
	43	S1	100	N2	20	S2	75	S1	100	N1	35	S1	100	S1	100	S1	100	N2	20	N2	5

t=topography limitations (slope)
d=drainage
s=physical soil limitations
f=soil fertility limitations (pH)
n=salinity limitaions (EC)

LI= Land index by Square Root Method (Khiddir, 1986)

s1=Texture/structure, s2=Coarse fragment, s3=Soil depth, s4=$CaCO_3$, s5=Gypsum

From the comparison between results of land evaluation by FAO system, 2007, (Table 5) and the proposed modification, (Table 7), it can be concluded that:

About 80 % of the studied area are either suitable (20 % of the studied area) or moderately suitable (60 % of the studied area) for biofuel plants, according to the proposed modified FAO system. And about 12 % and 8 % are either marginally suitable or not suitable for biofuel plants (**Jojobe** and Jatropha). In other words, most of the studied soils can be cultivated with either Jojobe and Jatropha plants, as ≈ 80 % of the studied soils are either suitable or moderately suitable for biofuel plants, that means the soils of the studied area could contribute in increasing land resources to produce the fuel.

Conclusion

This study was undertaken to evaluate soil resources at Hurghada area where tourist and mining activity are in sever need for agricultural production. Choused area is studied pedologically using advanced modern technique (remote sensing and GIS).

To evaluate the studied area for agriculture production two land evaluation systems, Sys and Verhey 1978 and Ahmed 2007, were tested.

According to these systems, all the studied soils are not suitable for agriculture production (Sys and Verhey, 1978) while only 20 % of the investigated area is suitable for certain crops (Ahmed, 2007). As there is urgent need calling for renewing source of energy, biofuel plants are suggest to be cultivated in such soils, leaving better soils for traditional crops. Some modifications are introduced to land use requirement system of FAO 2007, after those modification, Hurghada soils could be cultivated by Jojobe and Jatropha plants.

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يبم أراضى منطقة الغردقة ومدى صلاحيتها للنباتات الوقود الحيوى

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ان منطقة الغردقة وغيرها من المناطق السياحية على ساحل البحر الاحمر فى حاجة كبيرة للمنتجات الزرعية. ونظرا للزيادة المستمرة فى عدد السياح بالاضافة الى الانشطة التعدينية فى مناطق ساحل البحر الاحمر فأن عملية الأستثمار والتنمية الزرعية فى مثل هذه المناطق قد تصبح أمرا مثمرا. ان الدراسات الخاصة بحصر وتقييم الاراضى هى الخطوات الرئيسية لعمل برامج التنمية الزراعية ولذلك استهدفت الدراسة الحالية تقييم أراضى منطقة الغردقة من حيث ملائمتها لزراعة بعض المحاصيل أو نباتات الوقود الحيوى.

تقع منطقة الدراسة بين خطى طول ٢٦ ٣٣ الى ٠٠ ٣٤ شرقا، وخطى عرض ٤٥ ٢٦ الى ٢٣ ٢٧ شمالا. ان التفسير البصرى للمرئية الفضائية Landsat ETM+7 (2007) و المدمجة مع نموذج الارتفاع الرقمى DEM بالاضافة الى المعلومات المستمدة من الخرائط الطبوغرافية وبيانات التحقق الأرضى وحصر وتصنيف الأراضى قد استخدمت لتحديد وتقييم الأراضى المختلفة بمنطقة الغردقة.

وقد استخدم نظامين لتقييم الاراضى فى المنطقة تحت الدراسة لكلا من Sys and Verhey 1978و ،Ahmed 2007 وقد أشارت النتائج الى أن أراضى منطقة الغردقة غير ملائمة للزراعة المروية طبقا للنظام الاول فى حين صنفت الاراضى ما بين جيده جدا الى فقيرة جدا طبقا للنظام الثانى . وقد كان القوام الخشن وارتفاع نسبة الحصى مع وجود الملوحة هى أهم صفات التربة المؤثرة على مدى ملائمتها للزراعة وينصح بزراعة بعض نباتات الوقود الحيوى مثل الجوجوبا والجاتروفا حيث يمكن لهذه النباتات أن تنمو فى مثل هذه الأراضى الرملية الحصوية الهامشية حيث أنها أثبتت تحملها للظروف الصحراوية القاسية.