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SOIL TAXONOMY AND EVALUATION OF SOME PROMISING AREAS FOR AGRIGULTRE UTILIZATION IN THE WESTERN DESERT OF EGYPT

Hagag, A.A.* and A. A. Awadalla **
*** Soils, Water and Environ. Res. Inst., Agric. Res. Center, Giza.**
**** Soils and water Dept., Fac. of Agric. at El Fayoum, Cairo Univ.**

ABSTRACT

The magnificence of the studied desert soils has been increased fast due to scale efforts to bring additional areas under the agricultural utilization projects in recent decades. This target will be achieved throughout identifying the soil limitations and the possible adverse environmental effects, and then executing a suitable technique to correct them as well as that has become associated with increasing soil supplying power for soil nutrients or moisture and maximizing the productivity of the grown plants. So, the current work has been undertaken to evaluate the constraints for ameliorating these desert soils under the prevailing environmental conditions of the Western Desert region. The proposal scheme should be overcome three aspects, i.e., soil taxonomy, soil evaluation and soil suitability for certain crops. The studied area is commonly found as desert outskirts at the northern-east side of Wadi El Natrun, and it is situated between latitudes 31º 15⁻ and 31º 40⁻ N, and longitudes 30º 00⁻ and 30º 20⁻ E. With special reference to set up the soil characteristics of the studied area, the technique of space images interpretation plays an important role for tracing the prevailing geomorphic units as well as identifying the promising sites for agricultural purposes.

The obtained data of the Images of Landsat interpretation, using Thermatic Mupper (TM 5, SPOT 90), revealed that the area under consideration is occupied by four main landforms or geomorphic units namely Deltalic stages, Wind blown sand deposits, River terraces and Wadi El Natrun complex. Also, these soils are surveyed, according to Taxonomic system of USDA (1999 and 2001), and mapped into five taxonomic units: a. Typic Torriorthents (Deltaic stages), b. Gypsic Aquisalids (Wind blown sand deposits), c. Typic Haplocalcids (River terraces), d. Typic Calcidgypsids and e. Typic Haplogypsids (Wadi El Natrun complex). According to land evaluation system undertaken by Sys and Verheye (1978), the studied soils are affected by many of limiting factors, i.e., topography, wetness, soil texture and salinity/alkalinity, with variable intensity degrees. Also, the current suitability of the studied soils assessed three classes of *moderately suitable soils (S2,* Deltalic stages*)*, *marginally suitable soils (S3*, River terraces and Wadi El Natrun complex*)* and *unsuitable soils (N1*, Wind blown sand deposits*)*. By executing the suitable soil improvement practices, the potential suitability classes assessed two classes, i.e*., moderately suitable (S2,* Deltalic stages, River terraces and Wadi El Natrun complex*)* and *marginally suitable soils (S3*, Wind blown sand deposits*)*. Land suitability for certain crops can be achieved by matching the ratings of land characteristics with the crop requirements in different suitability levels as proposed by Sys *et al.* (1993). It could be identified both supreme and subsequent prior potential suitability for specified utilizations with the representative soils developed on the different geomorphic units of the studied area for the selected twenty one different crops (field crops, vegetables and fruits).

Keywords: Wadi El Natrun soils, soil taxonomy, soil limitations, Soil evaluation and suitability for certain crops.

INTRODUCTION

Nowadays,sustainability through improving land properties as natural resources,has become a key concept to describe its successful managements for agriculture development to satisfy incrementing human needs. On the same trend, the agriculture utilization projects of the virgin extremely desert lands at the Egyptian Deserts should be executed by using newly approach techniques in order to improve as well as to sustain their potentialities. This technique depends on the economical aspects of land use during the reclamation steps, declining soil reclamation period, increasing soil supplying power for plant nutrients and minimizing the possible adverse fears of environmental risks, maximizing profitability and threats to human health.

The soil potentiality survey of the Western Desert fringes of the Nile Delta between Alexandria and point zone 40 km north-west of Cairo, was carried out by Veanenbos and Westerveld (1963). They mentioned that the bottom of Wadi El-Natrun has largely filled with the former lakes of which only vestiges remain. Thus. these soils formed have ground water from 1.5 m to 2.5 m depth, or sometimes even within 1.0 m. Wind-blown sands are equally abundant in the lee of depression of Wadi El-Natrun where they form sheet dunes, some of which are barkhan shaped. Predominately, moderately deep over clay loam sub-soil, partly with coarse sandy loam, with contents of calcium carbonates are occurred. The same authors studied the soils of Wadi El-Natrun and found that there were different geomorphic features, i.e., windblown sand soils, lacustrine soils, miscellaneous soils, old river soils, and their soil texture was mostly identified as gravelly sand, sometime the sub-soil layers were loamy.

Since few years, local government efforts have been directed towards identifying soil productivity limitations, maximizing the water use efficiency and executing the suitable agro-management practices. Condom *et al.* (1999) reported that the geochemical nature of such soils occurred in like arid and semi-arid climatic zone, especially alkalinization and sodification that are broadly, plays an important role for the direction towards land degradation aspects. These conditions were confirmed by the findings of Dewivedi, *et al.* (1999) and Abd El Kawey (2002) who pointed out that the water-logging and subsequent salinization and/or alkalinization are the major land degradation The magnitude of the such salt affected soils has been increased fast in some desert areas, i.e., Wadi El Natrun, may be due the lateral seepage from the relatively high lands towards the relatively low one. Recently, many of development projects have been performed to scale efforts to bring additional areas under the agricultural purposes.

This study was carried out to identify the main geomorphic units and their soil taxonomic ones as well as the natural constraints of the environmental factors, then the role of land evaluation system as a guide parameter for economical land use for the agricultural utilizations in some promising areas of Western Desert of Egypt

MATERIALS AND METHDS

To fulfill the objectives of the current work, the Images of Landsat Thermatic Mupper (TM 5, SPOT 90) were used for the purpose of visual analysis, as proposed by Burnigh (1960) and Goosen (1967), as well as the detailed geomorphic features for the studied area. The studied is situated between latitudes 31^{o} 15^{-} and 31^{o} 40^{-} N, and longitudes 30^{o} 00^{-} and 30^{o} 20^{-} E. Some features related to soil conditions, such as landforms, boundaries, image tone and land use were used as the criteria for interpretation of the space images as well as to identify the model of soil potentialities that have a high correlation with geomorphic characteristics. The interpretation was made on prints of Landsat Images at the scale of 1:250000. The overall view for delineating the promising areas for agriculture purposes in the Western Desert of Egypt, which is characterized by the spectral signatures of an Orthorectified Landsat Thermatic Mupper (TM 5) Mosaic, was a composite of the bands 4, 3 and 2. The composite output was of benefit especially when focusing on the infrared bands that permit the detection and discrimination of broad combinations of different vegetation cover types and identification of water bodies, active drainage, drainage conditions, cultivated areas and rock types.

Nine soil profiles were selected to represent the identified geomorphic units along the studied area. The chosen soil sites are characterized by different soil formations developed on various geomorphic positions under environmental conditions, i.e., Deltalic stages (profiles 1 and 2), Wind blown sand deposits (profiles 3 and 4), River terraces (profiles 5 and 6) and Wadi El Natrun complex (profiles 7, 8 and 9), Fig. (1).

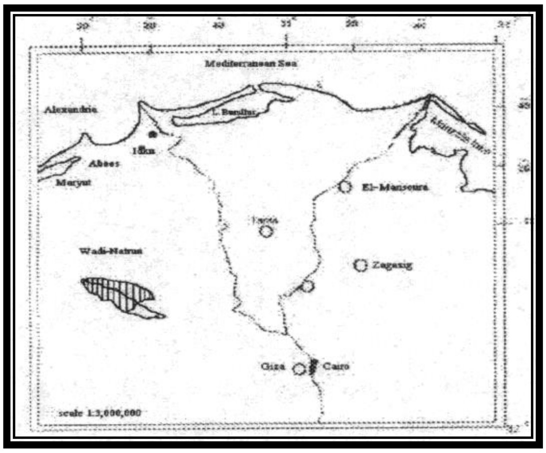
The soil profiles were dug to a depth of 150 cm, bed-rock and ground water table had permitted, and morphologically examined on the basis outlined by FAO (1990). Some physical and chemical analyses of the investigated soils were determined according to the standard methods described by Black (1965) and Page *et al.* (1982) for soil physico-chemical properties. Data obtained were used for Soil Taxonomy according the system of USDA (1999 and 2001), soil limitations as well as land suitability evaluation and its suitability for certain crops, which were obtained by using the parametric systems of Sys and Verheye (1978) and Sys *et al.* (1993).

RESULTS AND DISCUSSION

In agreement with the identified geomorphic map undertaken by using the integrated visual analysis of the Images of Landsat 5 Thermatic Mupper (TM, Spot 90), data obtained in Tables (1, 2 and 3) showed that the representative soil profiles vary in their characteristics, mainly due to they have been developed on different landscape-parent materials, i.e., Deltalic stages, Wind blown sand deposits, River terraces and Wadi El Natrun complex, as shown in the following discussion.

1.Soil morphology and physico-chemical properties of the studied soils:

Field description of the representative soil profiles lead to a good knowledge about the influence of the prevailing environmental conditions, and reflect the signs of soil differentiation for soil texture that varies widely from sand to sandy loam with variable gravel contents as well as the pedo-secondary formations that originated from sediment origins, the intensive of geo-chemical weathering under aquic conditions and the environments of depositional regime, Tables (1, 2 and 3). The pedo-secondary formations throughout the studied soil profiles could be categorized into salt accumulations (profiles 2 and 4), $CaCO_3$ (profiles 5 and 6), gypsum (profile 8) and could be mixed in the form of calci-gypsic concretions (profile 7and 9).



Location of the studied area.

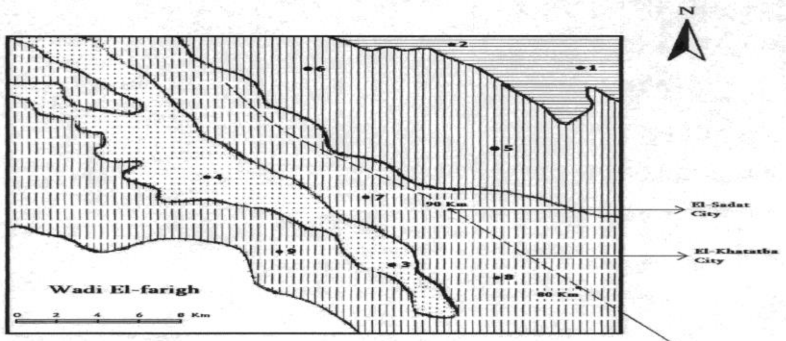


Fig. (1): Geomorphic units and the studied soil profile sites.

Soils of the Deltalic Stages.

Soils of the River Terraces.

Soils of the Wind Blown Sand.

Soils of Wadi El Natrun Complex.

Profile Sites.

Table (1): The main field morphological features of the studied soil sites.

Geomorphic unit	Topography	Profile No.	Horizon	Depth (cm)	Soil colour: Hue	Soil colour: Chroma/ value	Textural class	Soil structure	Soil consistence	Common features	Effervesce	Lower boundary
Deltalic stages	Almost flat	1	A	0-20	10YR	7/6	ls	ma	sh	fw ca, sh	w	--
			Ckyz	20-70	10YR	6/6				fw ca, gy		cw
			Cyz	70-110	10YR	7/6	s		so	fw gy		dw
			Cyz_2	110-150	10YR	5/6						
		2	A	0-25	7.5YR	6/6	ls	ma	sh	fw ca, sh	w	--
			Ckyz	25-70	10YR	5/8	s		so	fw ca, gy		cs
			Cyz_2	70-150	10YR	5/1					m	
Wind-blown sand	Gently undulating	3	A	0-20	10YR	6/7	s	sg	lo	fw ca, sh & gy	w	--
			C	20-50	10YR	6/6		ma	h			dw
		4	A	0-15	10YR	7/6	s	sg	lo	fw ca, sh	w	
			Cky	15-45	10YR	6/4	ls	ma	h	fw ca, my gy,sh		gw
			Cky_2	45-70	10YR	6/2						cs
River terraces	Undulating	5	A	0-25	7.5YR	5/6	ls	ma	sh	m ca,sh	m	--
			Ck	25-70	7.5YR	6/6	sl		h	my ca	st	gw
			Ckz	70-110	7.5YR	6/6	ls					cs
			Ckz	110-150	7.5YR	6/8			vh	co ca	m	
		6	A	0-25	7.5YR	5/6	ls	ma	h	fw ca, gy	m	--
			Cy	25-70	10YR	7/4				my ca	st	cs
			Ck	70-150	7.5YR	5/8	sl					
Wadi El Natrun complex	Gently undula.	7	A	0-25	10YR	5/6	sl	ma	sh	co ca & fw gy	st	--
			Ck	25-60	10YR	6/6			h			cs
			Ck_2	60-100	10YR	8/4			sh	co ca & my gy		dw
			Ck_3	100-150	10YR	5/6			vh			
	Almost flat	8	A	0-20	10YR	5/6	sl	ma	sh	fw ca, sh	m	--
			Ckz	20-60	10YR	7/6				fw ca & my gy		cw
			Ckz_1	60-110	10YR	8/4						gw
			Ckz_2	100-150	10YR	7/6	ls			fw ca, sh	w	dw
	Gently undula.	9	A	0-15	10YR	6/6	sl	ma	so	co ca, sh	m	--
			Ck	15-40	10YR	7/6			sh	co ca, gy	st	cw
			Ck_2	40-80	10YR	6/6			h	co ca & my gy	m	gs
			Ck_3	80-150	10YR	5/6	ls				st	cs

Soil texture:	**s=sand ls=loamy sand sl=sandy loam**
Soil structure:	**mas=massive sg=single grain**
Soil consistence:	**lo=loose so=soft fr-friable sh=slight hard ha=hard vh=very hard**
Common features	**Distribution: fw=few m=moderate co=common my=many** **Features: ca= soft $CaCO_3$ concretions sh=shells gy=gypsum crystals**
Effervesce	**w=weak m=moderate st=strong**
Boundary:	**gs or gw=gradual smooth or wavy dw= diffuse wavy cs or cw=clear smooth or wavy**

These pedogenic features, in general, reflects to a great extent their formation mode under the in situ prevailing conditions as well as coincides well with cemented or compacted subsoil layers. Moreover, soil characteristics that support relief variables under investigation are as a function of alternative depositional regime or deterioration phenomena during

the salinization and gleization processes due to the location of the water table is found to be relative to the soil surface (profiles 3 and 4).
A brief description of soils developed on each of the studied geomorphic units is given herein:

Table (2): Some physical and chemical properties of the studied soil profiles.

Prof. No.	Depth (cm)	Particle size distribution%			Gravel %	Texture class	Organic matter %	$CaCO_3$ %	Gypsum %
		Sand	Silt	Clay					
Soils of deltalic stages									
1	0-22	82.8	9.5	7.7	17.70	Gls	0.06	3.65	3.15
	22-70	87.7	7.0	5.3	11.11	ls	0.13	1.59	3.35
	70-110	90.5	3.8	5.7	5.30	s	0.06	0.91	3.25
	110-150	89.8	4.0	6.2	10.71	s	0.17	0.68	3.50
2	0-25	81.2	10.6	8.2	18.00	Gls	0.26	3.94	1.91
	25-70	83.9	6.8	9.3	6.80	s	0.26	2.74	1.71
	70-100	87.1	5.7	7.2	17.50	s	0.20	0.45	2.15
	100-150	85.3	6.4	8.3	22.30	Gs	0.19	0.34	3.10
Soils wind blown sand									
3	0-20	96.3	2.2	1.5	--	s	0.17	3.50	9.35
	20-50	96.1	2.7	1.2	--	s	0.06	4.00	11.95
4	0-15	95.6	2.5	1.9	--	s	0.11	2.40	4.50
	15-45	82.1	9.7	8.2	--	ls	0.09	2.90	24.30
	45-70	84.4	8.0	7.6	--	ls	0.03	2.70	18.51
Soils of river terraces									
5	0-25	82.0	9.6	8.4	32.35	Gls	0.10	8.50	3.13
	25-70	74.5	13.3	12.2	55.50	Gsl	0.13	12.30	2.27
	70-110	85.4	9.5	5.1	32.50	Gls	0.19	16.50	4.10
	110-150	83.8	9.2	7.0	17.60	Gls	0.15	11.20	2.50
6	0-25	81.3	12.0	6.7	40.00	Gls	0.19	5.50	1.30
	25-70	84.8	6.2	9.0	43.20	Gls	0.18	17.90	3.50
	70-150	74.1	18.6	7.3	48.50	Gsl	0.39	10.10	2.10
Soils of Wadi El Natrun									
7	0-25	81.0	19.8	9.2	46.80	Gsl	0.13	12.50	1.53
	25-60	67.4	19.0	13.6	33.20	Gsl	0.19	29.10	4.40
	60-100	77.1	10.5	12.4	42.30	Gsl	0.32	10.50	15.70
	100-150	69.1	18.8	12.1	45.10	Gsl	0.27	16.30	9.20
8	0-20	75.4	12.7	12.3	28.00	Gsl	0.13	4.08	2.15
	20-60	75.2	10.0	14.8	29.40	Gsl	0.13	7.31	13.30
	60-100	75.4	14.9	10.7	30.00	Gsl	0.16	6.59	5.10
	100-150	82.1	6.4	11.5	25.50	Gls	0.13	2.17	1.71
9	0-15	74.0	13.4	12.6	29.60	Gsl	0.13	6.19	1.58
	15-40	76.5	7.5	16.0	33.60	Gsl	0.09	10.50	6.30
	45-80	81.0	15.8	13.2	29.20	Gsl	0.04	6.58	14.10
	80-150	84.6	5.3	10.1	24.00	Gls	0.10	31.47	5.30

s=sand, ls=loamy sand, sl=sandy loam and G=gravelly.

Table (3): Chemical analysis of soil paste extract for the studied soils.

Profile No.	Depth (cm)	Soil pH*	ECe (dS/m)	Soluble ions (me/l)						
				Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{2-}
Soils of deltalic stage										
1	0-22	7.9	1.66	5.44	3.00	7.75	0.41	2.38	9.00	5.22
	22-70	7.9	5.30	16.40	12.30	23.45	0.85	2.50	32.50	18.00
	70-110	7.5	6.50	18.50	13.70	31.99	0.81	2.10	42.60	20.30
	110-150	7.4	7.00	20.20	15.80	33.29	0.71	2.50	52.30	15.20
2	0-25	7.6	2.80	7.60	4.80	15.40	0.46	2.20	17.50	8.30
	25-70	7.7	3.50	9.80	7.20	17.47	0.53	2.00	22.30	14.36
	70-100	7.6	5.30	17.80	12.30	22.30	0.60	2.50	38.60	21.90
	100-150	7.9	4.10	11.50	9.60	18.40	0.50	2.50	25.60	12.90
Soils of wind blown sand										
3	0-20	7.8	90.80	875.0	441.90	780.0	3.10	3.50	922.0	1176.5
	20-50	7.7	110.60	1245.0	471.50	1180.0	3.50	3.20	138.0.0	396.3
4	0-15	7.7	75.40	415.0	266.20	816.0	2.80	3.70	910.0	586.3
	15-45	7.6	84.30	710.0	457.70	680.0	2.30	3.40	920.0	1226.6
	45-70	7.8	95.90	920.0	586.30	791.0	2.70	3.30	1120.0	1176.7
Soils of river terraces										
5	0-25	7.9	5.02	17.50	8.00	23.90	0.82	1.63	30.75	17.82
	25-70	7.9	6.20	12.50	6.58	42.75	0.17	1.20	51.75	9.05
	70-110	7.5	3.43	8.90	7.60	17.45	0.35	1.50	18.60	14.20
	110-150	7.7	4.23	2.23	1.33	38.50	0.20	1.33	27.88	13.05
6	0-25	7.5	5.00	6.00	2.68	41.00	0.32	1.30	45.00	3.70
	25-70	7.5	5.20	17.20	10.50	23.60	0.70	2.80	40.20	9.00
	70-150	7.2	2.84	5.50	2.63	20.00	0.24	1.30	22.00	5.07
Soils of wadi El Natrun complex										
7	0-25	7.6	2.50	6.70	4.50	13.10	0.42	1.70	15.60	7.70
	25-60	7.5	3.80	10.50	7.60	19.73	0.53	2.20	25.10	10.70
	60-100	7.3	4.70	15.40	10.30	20.58	0.72	2.80	27.30	16.90
	100-150	7.4	7.80	3.67	1.75	13.33	0.16	0.87	14.67	3.30
8	0-20	7.9	3.93	8.40	3.50	41.00	0.34	2.20	42.00	9.04
	20-60	7.5	3.00	55.80	31.50	212.0	0.68	2.20	277.0	20.78
	60-100	7.3	6.60	11.96	4.38	40.14	0.09	0.66	51.86	4.00
	100-150	7.4	4.05	9.30	3.17	31.00	0.10	0.64	39.86	3.00
9	0-15	7.6	2.44	7.80	2.60	12.90	0.88	2.40	16.80	5.00
	15-40	7.6	3.87	5.70	3.00	19.40	0.56	2.00	25.70	11.00
	45-80	7.9	2.60	4.90	2.00	19.31	0.28	2.80	16.70	6.50
	80-150	8.0	2.65	6.70	2.30	17.00	0.31	2.00	17.60	6.70

*** Soil pH in 1:2.5 soil water suspension**

a. Soil of deltalic stages:

These soils are represented by the studied two soil profiles Nos. 1 and 2. Data illustrated in Tables (1, 2 and 3) show that the topographic features of soil surface are almost flat. Also, the representative soils are characterized by skeletal nature as soil texture is predominated with gravelly loamy sand and sand, where the gravel content reached a maximum value of 22.3 %. Total calcium carbonate and gypsum contents are relatively low (> 4.0 %) in these soils, and $CaCo_3$ content tends to decrease with increasing soil depth, while the reverse was true for gypsum content.

According to USDA (1993), salinity levels of these soils are classified as non-saline to slightly saline, where their ECe values ranged 1.66-7.0

dS/m. In general, salts distribution entire soil profile tends to increment with increasing soil depth, may be due to the salt leaching process from the upper layer to the subsoil ones. These conditions indicate that these soils are very young or belonging the recent immature mineral soils. These conditions are confirmed the absence of any signs of pedogenic feature or diagnostic horizons.

***b.* Soils of wind blown sand:**

These soils are represented by the studied soil profiles Nos. 3 and 4. The soil relief of these soils is almost flat, Table (1), and their soil texture is sandy to loamy sand, where the sand fraction reached to 96.3 %, Table (2). The soluble salts content in these soils is very high and tends to increase with depth, that conditions confirmed by the relatively high ECe values that are ranged between 75.4 and 160.6 dS/m, Table (3). These pedo-secondary formations of salts and gypsum throughout the representative profiles could be mixed in the form of sali-gypsic concretions or over lined by accumulation zone of salts that, in general, reflects to great extent its formation mode under the in situ prevailing aquic condition of shallow saline water table as well as coincides well with cemented or compacted subsoil layers. These accumulated salts are more related to the geo-chemical weathering process as well as inheriting the salts from their marine materials. Therefore, these studied soils are classified as strongly saline soils. Moreover, these salt accumulations in some profile horizons are enough qualified the requirements of some diagnostic horizon formations such as salic and gypsic ones.

c. Soils of river terrace:

These soils are represented by the studied soil profiles Nos. 5 and 6. Soil surface relief is very gently slopping to undulating, Table (1). Soil texture is very gravelly loamy sand to gravelly sandy loam. The gravel content reached a maximum value of to 55.50 % at horizon of Ck of the studied soil profile No. 5, Table (2). The studied soil profiles are characterized by non-saline to slightly saline, where the ECe values ranged between 2.84 and 6.20 dS/m The salts distribution entire the soil profile have no specific trend. The secondary soft $CaCO_3$ concretions in some Ca-enrichment profile horizons of the studied two soil sites are enough qualified the requirements to form a calcic zone classified as a diagnostic horizon.

***d.* Soils of Wadi El Natrun complex:**

The studied soils are represented by the studied soil profiles Nos. 7, 8 and 9. Soil texture is ranged between gravelly loamy sand to gravelly sandy loam, Table (2). The gravel contents reached to a maximum value of 48.80 % at the A horizon of the studied soil profile No. 7. The studied soil profiles are classified as non-saline to slightly saline, where the ECe values ranged between 2.50 and 7.80 dS/m, Table (3). On the other hand, the pedo-secondary formations of gypsum in profile 8 as well as $CaCO_3$ and gypsum throughout the studied soil profiles of 7 and 9 could be mixed in the form of calci-gypsic concretions, in general, reflects to great extent its formation mode under the in situ prevailing conditions as well as coincides well with the relatively cemented or compacted subsoil layers. Therefore, these pedo-secondary accumulations in some profile horizons are enough qualified the requirements of some diagnostic horizon formations such as gypsic and calci-gypsic ones.

2. Soil taxonomic units:

Data in Table (4) show the prevailing taxonomic units of the studied area according to USDA (1999 and 2001).

Table (4): Soil taxonomic units of the studied soil profiles.

Order	Sub-order	Great group	Sub-group	Family	Representative soil profile
Entisols	Orthents	Torri-orthents	Typic Torri-orthents	Sandy, mixed, thermic	1 and 2
Aridisols	Salids	Aquic-salids	Gypsic- Aquic-salids	Sandy, mixed, thermic	3 and 4
	Calcids	Haplo-Calcids	Typic Haplo-calcids	Sandy, skeletal, mixed, thermic	5and 6
	Gypsids	Calci-gypsids	Typic Calci-gypsids	Loamy, skeletal, mixed, thermic	7
				Coarse loamy, mixed, thermic	9
	Gypsids	Haplo-gypsids	Typic Haplo-gypsids	Coarse loamy, mixed, thermic	8

By using the obtained data of soil morphology and physico-chemical properties, the soils under investigation could be classified up to the family level into five taxonomic units, as shown in Table (4). The studied soils are mainly encompassing the different deposits derived mainly from the Deltalic stages, Wind blown sand deposits, River terraces and Wadi El Natrun complex that occupy the studied localities. Moreover, the investigated areas laying within the climatic conditions characterized by a long hot rainless summer and short mild winter with a scarcity rainfall. Some of the studied soil profiles are enriched with expanding salts, $CaCO_3$ and gypsum enrichments that satisfy the requirements of salic, calcic, gypsic and calci-gypsic horizons as well as Aridisols (profiles 3, 4, 5, 6, 7, 8 and 9). In addition those characterized by young without signs that satisfy the requirement diagnostic horizons, so they are classified as Entisols (profiles 1 and 2).

3. Limiting factors and soil suitability classes:

The parametric soil evaluation system, undertaken by Sys and Verheye (1978) is applied to identifying soil limitations and their intensities as well as soil suitability classes according to the current and potential suitability ratings. Data obtained in Table (5) reveal that most of the studied soils are suffering from some limiting factors, i.e., topography (t), wetness (w), soil texture (s1) and salinity/alkalinity (n), that are put into variable intensity degrees, i.e., slight (> 85), moderate (85-60), severe (60-45) and very severe (< 45).

Table (5): Soil limitations and land suitable evaluation for the studied soils

Profile No.	Topography (t)	Wetness (w)	Soil texture (s1)	Soil depth (s2)	$CaCO_3$ (s3)	Gypsum (s4)	Salinity/ alkalinity (n)	Rating (Ci)		Suitability class		Sub-class of the current suitability
								Current	Potential	Current	Potential	
Soils of deltalic stage												
1	100	100	55	100	95	100	98	51.2	52.3	S2	S2	S2S1
2	100	100	55	100	95	100	98					
Soils of wind blown sand deposits												
3	95	55	40	100	95	80	80	12.7	30.4	N1	S3	N1ws1n
4	95	55	40	100	95	80	80					
Soils of river terraces												
5	85	100	50	100	100	100	98	41.7	50.0	S3	S2	S3ts1
6	85	100	50	100	100	100	98					
Soils of Wadi El Natrun complex												
7	95	100	65	100	100	80	98	48.7	52.0	S3	S2	S3s1
8	100	100	65	100	95	80	98					
9	95	100	65	100	100	80	100					

S2: moderately, S3: marginally, and N1: currently not suitable

According to the evaluation system of Sys and Verheye (1978) and the estimated Ci ratings, the suitability indices for the studied twelve soil profiles for current classes are assessed and recorded in Table (5). The obtained results show that the estimated current ratings of the studied soil profiles ranged between 12.7 and 51.2, indicate that the soils of the studied area could be categorized into three classes, as follows.

*** Moderately suitable soils (S2):**

The rating of this class is 75-50 and represented by soil profiles Nos. 1 and 2.

*** Marginally suitable soils (S3):**

The rating of this class is 25-<50, and represented by soil profiles Nos. 5, 6, 7, 8 and 9.

*** Unsuitable soils (N1):**

The rating of this class is <25, and represented by soil profiles Nos. 3 and 4. It is quite to noticeable that the soils of N1 class can be corrected by using suitable agro-management practices.

For raising the capability 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. Such agro-management practices will be corrected the ratings of soil potential suitability class for the majority of the studied soils, and it to be ranged 30.4-52.3, and potential soil suitability becomes as follows.

*** Moderately suitable soils (S2):**

The rating of this class is 75-50, and represented by soil profiles Nos. 1, 2, 5, 6, 7, 8 and 9.

*** Marginally suitable soils (S3):**

The rating of this class is 50-25, and represented by soil profiles Nos. 3 and 4.

4. Land suitability for certain crops:

Matching charts of both supreme and subsequent prior potential suitability for specified utilizations with the representative soils developed on the different geomorphic units of the studied areas at El Natrun and adjacent areas according to Sys et al. (1993), are shown in Table (6).

Table (6): Matching the geomorphic units with suitability for certain crops.

Tested crops	Soils of the studied geomorphic units							
	Deltalic stage		Wind blown sand		River terraces		El Natrun complex	
	CS	PS	CS	PS	CS	PS	CS	PS
Field crops								
Clover	S3g	S2m	N1s	S2y	S3x	S2g	N1gy	S3gy
Barley	S3x	S3x	N1s	S3xy	S3x	S3x	S3xy	S3gy
Maize	N1gs	S3g	N1s	S3y	S3x	S2g	N1gy	S3gy
Potato	N1g	S3g	N1s	S2m	N1g	S3g	N1g	S3g
Sesame	S3g	S2g	N1s	S1*	S3g	S2g	S3xg	S2g*
Sorghum	S3g	S2m	N1s	S3y	S3xg	S2g	S3xgy	S2gy
Soya	N1y	N1y	N1ys	N1y	N1gy	N1gy	N1y	N1y
Sunflower	S3g	S3g	N1s	S3y	S3xg	S3xg	N1gy	S3gy
Wheat	S3xg	S3xg	N1s	S3xy	S3x	S3g	N1xy	S3xgy
Peanut	S3g	S2g	N1s	S1	S3g	S2g	S3xg	S2g
Vegetable crops								
Cabbage	S3m	S3m	N1s	S2y	S3xg	S2g	N1gy	S3gy
Green pepper	S3gcy	S3gcy	N1s	S3y	S3gc	S3gc	N1y	N1gy
Pea	S3g	S3g	N1sn	S3y	S3xg	S2m	N1y	S3gy
Tomato	N1gcy	N1gcy	N1s	N1y	S3xg	S3gc	N1y	N1gyc
Watermelon	S3g	S2g	N1s	S1	S3xg	S2g	S3xg	S2g
Fruit crops								
Banana	N1s	N1xcy	N1ysn	N1y	N1xg	N1xgc	N1y	N1gcy
Citrus	N1gcy	N1gcy	N1psn	S2n	S3xg	S3gcy	N1y	S3gcy
Date palm	N1xc	S3xc	N1s	S3y	S3xg	S3xgc	N1xcy	N1xcy
Guava	N1xs	S3x	N1s	S1	S3xg	S3xg	S3xg	S2m
Mango	N1gcy	N1gcy	N1ysn	N1y	S3xgc	S3xgc	N1y	N1gcy
Olive	S2gm	S1*	N1ps	S1	S2m	S1*	S3m	S2m

CS: current suitability, PS: potential suitability, t: topography, d: drainage, x: soil texture, g:gravel,

p: soil depth, c: $CaCO_3$ %, y: gypsum %, h: pH, s: salinity (ECe), n: ESP, m: minor limitations.

***Supreme potential suitability for specified utilizations, while the rest crops are subsequent prior potential suitability for specified utilizations, except those are not suitable (N1).**

Supreme potential suitability for specified utilizations:

*** Highly suitable (S1) adaptations:**

- Soils of deltalic stage for olive.
- Soils of wind blown sand for sesame, peanut, watermelon, guava and olive.

- Soils of river terraces for olive.

*** Moderately suitable (S2) adaptations:**

- Soils of Wadi El Natrun complex for sesame, sorghum, peanut, watermelon, guava and olive.

Subsequent prior potential suitability for specified utilizations:

*** Moderately suitable (S2) adaptations:**

- Soils of deltalic stage for clover, sesame, sorghum, peanut, watermelon, guava, and olive.
- Soils wind blown sand for clover, cabbage and citrus.
- Soils of river terraces for Clover, sesame, maize, sorghum, peanut, cabbage, pea and watermelon.

*** Marginally suitable (S3) adaptations:**

- Soils of deltalic stage for barely, maize, potato, sunflower, wheat, cabbage, green pepper, pea, date palm and guava.
- Soils of wind blown sand for barely, maize, sorghum, sunflower, wheat, green pepper, pea and date palm.
- Soils of river terraces for barely, potato, sunflower, wheat, green pepper, tomato, citrus, date palm and guava.
- Soils of Wadi El Natrun complex for clover, barely, maize, potato, sunflower, wheat, cabbage, pea and citrus.

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تصنيف وتقييم تربة بعض المناطق الواعدة فى مجال التنمية الزراعية فى صحراء مصر الغربية

عاطف عبد العظيم حجاج* وعاطف عبد التواب عوض الله**

*** معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – جيزة**

**** قسم الأراضى والمياه - كلية الزراعة بالفيوم – جامعة القاهرة**

تظهرالدراسة أن هناك جهودا على نطاق واسع متزايدة وسريعة تبذل بهدف إدخال وإضافة مساحات جديدة من الأراضى الصحراوية فى مشاريع التنمية الزراعية خلال العقود الحديثة، ويتحقق ذلك من خلال تحديد المعوقات الأرضية والظروف البيئية المعاكسة المحتملة، مع إجراء المعالجات المناسبة بإتباع الأسلوب العلمى لتصحيحها، وخاصة فيما يتعلق بزيادة قدرة التربة الإمدادية بالمغذيات والرطوبة الأرضية، ومن ثم تعظيم إنتاجية النباتات المنزرعة .

لذا فان هذه الدراسة تهدف إلى تحديد وتقييم المعوقات المرتبطة بتحسين صفات هذه الأراضى الصحراوية تحت الظروف البيئية السائدة لصحراء مصر الغربية . وهذا المقترح يغطى من خلال ثلاث إتجاهات ممثلة فى تصنيف وتقييم التربة ومدى صلاحيتها لبعض الحاصلات الزراعية :

Soil taxonomy, evaluation and its suitability for certain crops. وقد تلاحظ أن أراضى المنطقة تحت الدراسة تحتل الظهير الصحراوى للجزء الشالى الشرقى لمنخفض وادى الريان وما يجاوره من أراضى صحراوية من الشرق، والذى يقع بين خطى طول ١٥´ ٣١°، ٤٠´ ٣١°شمالا، عرض ٠٠´ ٣٠°، ٢٠´ ٣٠° شرقا، وبالإشارة إلى وضع تصور للتعرف على صفات أراضى المنطقة تحت الدراسة فقد وجد أن تحليل وتفسير صور الفضاء (صور الأقمار الصناعية) يلعب دورا ذو أهمية كبيرة فى تحديد الوحدات الجيومورفولوجية السائدة وكذا المواقع الواعدة لإستغلالها فى مشاريع التنمية الزراعية .

وتشير نتائج تحليل وتفسير صور الفضاء (صور الأقمار الصناعية) - مستخدما Thermatic Mupper (TM 5, SPOT 90) - إلى أن هناك أربعة وحدات جيومورفولوجية رئيسية تحتل أراضى المنطقة تحت الدراسة، هى :

1. Deltalic stages, 2. Wind blown sand, 3. River terraces and 4. Wadi El Natrun complex.

كما تم تصنيف تربة المنطقة تحت الدراسة، وقد وجد أنها تنتمى إلى ٢ رتبة، ٥ تحت رتبة، ٦ مجموعات عظمى، ٥ تحت مجموعات عظمى، ٦ عائلة، وذلك وطبقا لنظام التقسيم الأمريكى *USDA (1999 and 2001)* ، وذلك وطبقا لنظام التقسيم الأمريكى ، وقد تبين أنها تنتمى إلى خمسة وحدات تقسيمية هى:

a. Typic Torriorthents (Deltaic stages), b. Gypsic Aquisalids (Wind blown sand), c. Typic Haplocalcids (River terraces), d. Typic Calcidgypsids and e. Typic Haplogypsids (Wadi El Natrun complex).

تبعا لنظام تقييم الأراضى المتبع بواسطة *Sys and Verheye (1978)*، فإن معظم الأراضى تحت الدراسة تعانى من كثير من المعوقات أو محددات الإنتاجية، ممثلة فى الطبوغرافية، الترطيب، قوام لتربة، الملوحة/القلوية، وبدرجات شدة متباينة . كما وجد أن أراضى المنطقة تحت الدراسة تنتمى إلى ثلاث مستويات من الصلاحية تتمثل فى الآتى:

أ. متوسطة الصلاحية : Moderately suitable (S2, Deltaic stages)

ب. هامشية أو قليلة الصلاحية

Marginally suitable soils (S3, River terraces and Wadi El Natrun complex).

ج. غير صالحة بظروفها الحالية ويمكن إصلاح المعوقات بها :

Unsuitable soils (N1, Wind blown sand).

وبرفع قدرتها الإنتاجية عن طريق إجراء عمليات تحسين التربة المناسبة يمكن إصلاح ورفع دليل الصلاحية لمعظم الأراضى تحت الدراسة، وتصبح درجات الصلاحية الكامنة هى:

أ. متوسطة الصلاحية :

Moderately suitable (S2, Deltaic stages, river terraces and Wadi El Natrun complex).

ب. هامشية الصلاحية بعد إصلاح المعوقات بها :

Marginally suitable soils (S3, Wind blown sand).

ولقد أمكن تحديد مدى ملائمة أراضى الوحدات الخيومورفولوجية تحت الدراسة للحاصلات الزراعية المختلفة من خلال ربط النتائج المتحصل عليها من دليل تقييم خواص الأراضى تحت الدراسة بالمستويات المختلفة لإحتياجات الحاصلات الزراعية المختارة بإستخدام النظام المتبع بواسطة *Sys et al. (1993)* ، حيث تم تحديد الصلاحية الحالية والكامنة للأراضى تحت الدراسة بالنسبة لإجدى وعشرين محصولا تمثل أنواع مختلفة من المحاصيل الحقلية والخضر والفاكهة فى صورة الصلاحية الأعلى:

Supreme potential suitability for specified utilizations.

أو فى صورة التالية فى الأهمية:

Subsequent prior potential suitability for specified utilizations.