 Egyptian J. Desert Res., **68**, No. 2, 243-258 (2018)

CLASSIFICATION AND LAND CAPABILITY OF SOME SOILS AT EL-MOGHRA DEPRESSION, EGYPT

Moamen M. El Kady[*1] and El-Sayed F. Essa[2]
[1]Department of Pedology, Desert Research Centre, El-Matareya, Cairo, Egypt
[2]Department of Soils and Water, National Research Centre, Dokky, Egypt
[*]E-mail: moamen.elkady@yahoo.com

The article provides valuable information about some arid soils in El-Moghra depression, western desert between 28°33'00"E to 28°38'12"E, and 30°05'30"N to 30°09'05"N; with an area of about 6541 hectares. It is one of the portions that included in the land-use planning development programs of the Egyptian government for expanding the limited arable lands. The goal of the study is to investigate the spatial distribution of soil characteristics, classification and capability assessment for land-use management. The recent technologies of remote sensing and GIS were employed in this work on basis difference of landforms. The obtained results indicate that the study area could be classified into *Entisols* and *Aridisols* orders including (1) very deep coarse-textured soils; Typic *Torripsamments* that characterized by capability class III (3195 hectares), (2) very deep coarse to moderately coarse-textured soils; *Typic Torripsamments*, which correlated to capability class III (1391 hectares), and (3) very deep medium to moderately-fine textured soils; *Typic Haplogypsids* and/or *Gypsic Haplosalids* associated with capability class II (1955 hectares). Therefore, soils of the study area can be used for conditioned agriculture with availability of irrigation water in terms of quality and quantity.

Keywords: Aridisols, Entisols, El-Moghra, land-use, remote sensing, GIS, taxonomy, desert

Acquired data of soil taxonomy and capability classes give vital information of land-use for agriculture purposes. It is one of the most prominent options for a number of substitutions. Stieglitz (1988) referred that soil scientists, planning commissions and government agencies are given the liability of gathering and assessing soil data for that objective. A goal of soil classification is to create a universal language of soils that upgrades correspondence among users of soils far and wide (Brady and Weil, 2013).

Land capability classification (LCC) is one of a number of interpretive soil groupings made chiefly for producing common field crops, orchards and pasture plants without degradation over a long duration of time, (Klingebiel and Montgomery, 1961). It extends acquaintance for appraising of soil constraints and landuse management at range of scales plus the property planning level (Murphy et al., 2004). Several soil scientists as Wells (1989) philosophized land capability term i.e. "*The ability of land to support a particular type of use without causing permanent damage"*. While, Dent et al. (1981) defined land capability as "*The potential of the land for use in specified ways, or with specified management practices"*.

In literature, soil classification and land capability show a variety of approaches. In the hyper-arid southwestern desert soils of Egypt, Gad (2015) linked among of landscape, soil taxonomy and LCC using remote sensing and GIS. Further, found that the lower capable soils were *Torripsamments* great group, which were close to the depressions margins. While, the highly capable soils (Class II) were *Typic Haplotorrerts*, *Typic Torrifluvents* and *Chromic Haplotorrerts* sub-great groups.

El Kady (2008) reported that the western part of old deltaic plain in El Alamein – Wadi El Natrun area, Egypt classified as *Typic Haplosalids* and *Typic Torripsamments* with capability classes of II and III. Ali et al. (2007) noticed that soil of old deltaic plain showed low capability classes (III, IV and N) compared with of floodplain (Classes I and II) and aeolian ones at some arid cultivated desert soils west of the Egyptian Nile Delta. Sayed (2013) concluded that land capability of the soils adjacent to El-Hammam irrigated canal at the northern-western coastal of Egypt, varied from "good capability" to "non-agriculture" classes and taxonomic units of *salids, calcids* and *psamments*.

However, very few studies discuss the priorities of land use and its management for agriculture as well as distribution of taxonomic soil units at El-Moghra depression, which is belonging to arid northwestern desert of Egypt. Where, Egyptian government granted a great potentiality for mapping and soil classification of the Egyptian desert portion (1000, 000 km^2) on a larger map scale. Hence, they are planning of land-use for expanding the limited agricultural area for facing the problem of food security for more than 100,000,000 of Egyptians.

The objectives of this research were to (i) provide data on the morphology, chemistry and physical characteristics of some soils at El-Moghra depression; (ii) assign taxonomic units and their spatial distribution to the soils and (iii) allocate land capability classes and limitations for agriculture purposes.

MATERIALS AND METHODS

1. Study Area

The considered area is a part of Qattara-Moghra Depression and lies between longitudes of 28°33'00"E and 28°38'12"E, and the latitudes of 30°05'30"N and 30°09'05"N (Map 1). It covers about 6541 hectares and locates about 10 km south the eastern edge of Qattara Depression, Western Desert, Egypt. Sit᾽s altitude is ranging from 15 m below sea level to 50 m above sea level. It has a long hot dry summer, very low precipitation and mild winter, typical of the arid region. Broadly, the average annual rainfall recorded 0.06 mm while mean maximum and minimum annual temperature recorded 29.75 and 14.34°C, respectively. Relative humidity averaged at 51.06% and wind speed at 3.52 km/h (Global Weather Website, 2018). In agreement with the limits outlined by USDA (2014), soils are attributed to Torric moisture and Hyperthermic temperature regimes. Geologically, the studied site belonged to Miocene, Pliocene and Quaternary deposits (Map 2). Miocene rocks are represented by Lower Miocene Moghra (LMM) and Middle Miocene Marmarica Formations. Formation of LMM occupies most of the area and is composed of fluviomarine sediments which grades northwards to more marine facies called Mamura Formation. The fauna of Moghra Formation reveals that these deposits accumulated in swamps and lakes in which forests were present (Said, 1962; CONOCO, 1987; Pickford et al., 2009; Hassan et al., 2012; Yousef, 2013 and Yousef et al., 2018).

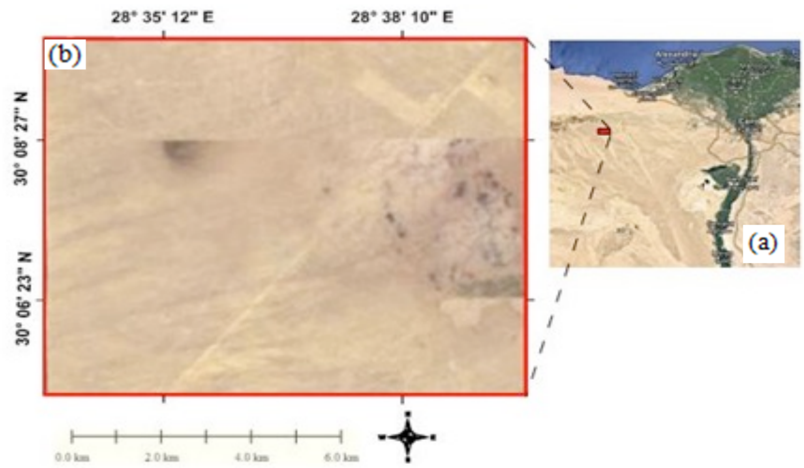
As Yousef (2013) reported, the study site is a part of Qattara-Moghra Depression is divided into three main landforms; (1) Gravel plain (GP), (2) Low land (LL) and (3) Sabkha (Sb). Gravel plain consists of brownish ferruginous sandstone and pebbles, together with worn pieces of silicified wood. Its width varies between 15 and 27 km from west to east, such plain has about 70 km length. The LL is covered by sand sheets and is composed mostly of fine sand with silt. While, Sb is predominately composed of fine sand, silt and shale are occasionally covered by a thin salt crust. It is formed as a result of upward water leakage from Moghra aquifer.

2. Soil Mapping Using Image Classification and GIS Processing

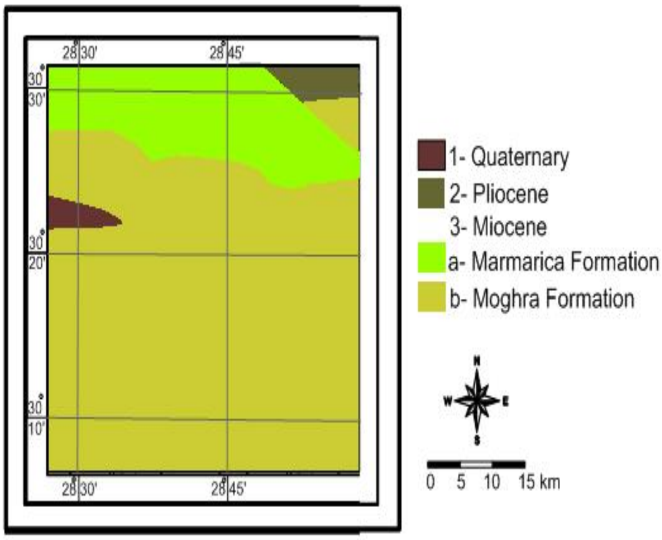
A LANDSAT 7 ETM+ scene captured in 2014 representing the study area was cropped, rectified, and geometrically corrected by Global Mapper 17 (2016). The created image was digitally interpreted using unsupervised classification. Nine spectral classes were identified characterizes the ground surface as shown in map (3). Digital Elevations Model (DEM) was produced using Shuttle Radar Topography Mission (SRTM) 90 m as shown in map (4). Information of the geological map (CONOCO, 1987) incorporated with created DEM and previous literatures of Yousef (2013) for distinguishing various dominated landforms in the area in which observation sites were spatially distributed. A digital database for the site under investigation was generated using Arc-GIS 9.2 (ESRI, 2006) software. Sites of soil observations were digitized, as a unique identifier for every location connected to correlated attribute data using the Database Management System (DBMS). Soil mapping units were produced by overlapping the most variable soil data where final soil and its assessment maps were generated.

3. Fieldwork and Laboratory Analyses

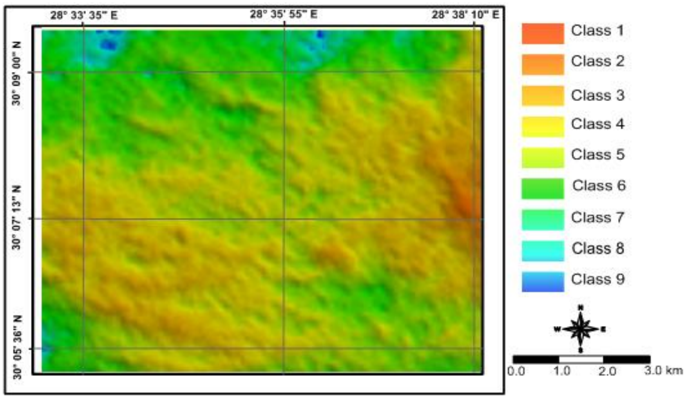
On the basis of geomorphological variation, eight pedons were digged within gravel plain, low land and sabkha (Map 5). Elaborated morphological descriptions of these pedons were recorded applying Soil Survey Manual (Soil Survey Staff, 2017). Soil laboratory analyses performed according to Page et al. (1982) including soil texture, total calcium carbonates, electrical conductivity of soil extracts (EC), and soil reaction (pH). Gypsum was estimated following the method described by Omran (2016). Organic matter content was determined according to Jackson (2005).



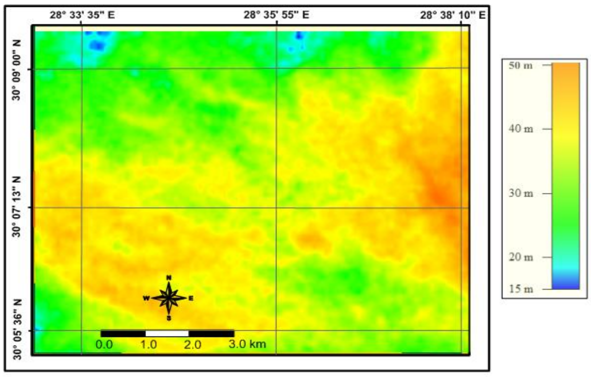
Map (1). Location (a) and Landsat 7 ETM+, 2014 image (b) of the studied area.



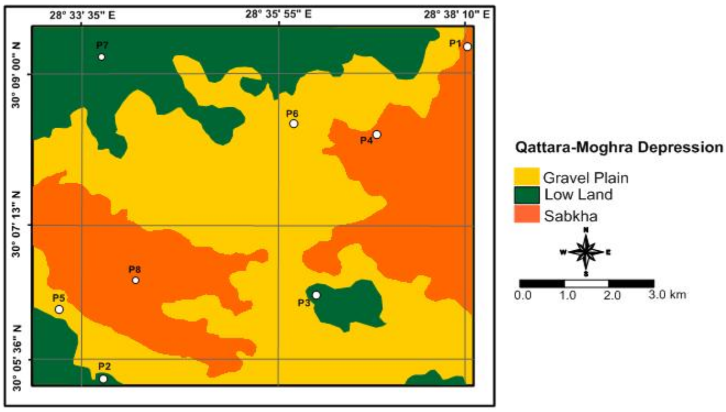
Map (2). Geologic map of the investigated site (CONOCO, 1987).



Map (3). Unsupervised classification of the study area.



Map (4). Digital Elevation Model (DEM) of the study area.



Map (5). Geomorphological mapping units along with the selected pedons in the study area.

Soils were classified according to the USDA (2014) and evaluated using the rating of soil properties adapted after USDA System of land capability classification (Klingebiel and Montgomery, 1961). Appraised soils characteristics in the present study include soil depth, soil texture, slope, erosion, permeability, and surface runoff. The research area categorized into classes based on the general guide for selecting land capability classes as shown in table (1).

Table (1). General guideline for selecting land capability classes.

Soil Factor	Description	Best Land Class
Texture (1)	Coarse textured	III
	Moderately coarse, medium	I
	Moderately fine and fine	I
Depth (2)	Deep or moderately deep	I
	Shallow	III
	Very shallow	VII
Slope (3)	Nearly level (0 to 1%)	I
	Gently sloping (1 to 3%)	II
	Moderately sloping (3 to 5%)	III
	Strongly sloping (5 to 8%)	IV
	Steep and very steep (8 to 15%+)	VI
Erosion (4)	None to slight erosion	I
	Moderate	II
	Severe or very severe	VI
Permeability (5)	Rapid	III
	Moderate and slow	I
	Very slow	II
Runoff (6)	Rapid	III
	Moderate and slow	I
	Very slow	II

RESULTS AND DISCUSSION

1. Soil Morphology

The soils were deep to very deep with depth 150-200 cm and exhibited variation in soil texture (Table 2). The thickness of the surface horizon ranged from 10-50 cm and varied with elevations and landscape. Coarse fragments were only noticed at most of the upper horizons of the studied pedons and ranged from 5.5 to 10%. Massive and platy structure was common in the soils of gravel plain; SU1 while soils of low land; SU2 characterized with massive structure at the surface horizons while the deepest ones were either angular or sub-angular blocky. Soils of Sabkha; SU3 showed dominant of angular blocky and platy structure, except some parts presented alternating layers of subangular blocky, platy, angular blocky and massive structure, respectively, which reflected their inception from heterogeneous parent materials. In general, soil consistence widely varied from soft and hard in most of the layers to sometimes very hard peds, which was noticed at the deepest horizons, while in terms of stickiness and plasticity, soils displayed

Table (2). Main morphological characteristics of the investigated soils.

Horizon	Depth (cm)	Colour	Texture (USDA)	Coarse fragments	Structure	Consistence Dry	Consistence Wet	Gypsum formations (cryst. and/or powd.)[a]	Redoxi-morphic features (Fe and/or Mn)[b]	Roots	Reaction with HCl	Boundary
Pedon 1 (Sabkha), Gently sloping												
C	0-45	10YR 6/6	sg, sl	cfg	abk	h	ss, ps	cm-f	cmd	-	e	as
2Cy	45-100	2.5Y 7/2	cl	-	pl	h	s, p	cm-f	cmd	-	e	ds
2C1	100-140	2.5Y 7/2	cl	-	pl	h	s, p	cm-f	cmd	-	e	cs
2C2	140-200	2.5Y 7/4	cl	-	pl	h	s, p	cm-f	mmd	-	e	-
Pedon 2 (Low Land), Nearly level												
C1	0-20	10YR 6/6	sg, cs	cfg	m	s	so, po	-	-	-	e	cs
C2	20-40	10YR 6/8	cs	-	m	s	so, po	-	-	-	e	cs
C3	40-80	10YR 5/8	cs	-	m	s	so, po	-	-	-	e	as
2C4	80-150	2.5Y 5/6	scl	-	sbk	h	s, p	cm-f	-	-	e	-
Pedon 3 (Low Land), Nearly level												
C1	0-30	10YR 7/6	sg, cs	cfg	m	s	so, po	-	-	-	e	cs
C2	30-80	10YR 6/8	cs	-	m	s	so, po	-	mmd	-	e	cs
C3	80-120	10YR 6/6	cs	-	m	s	so, po	-	mmd	-	e	as
2C4	120-160	10YR 6/4	cl	-	abk	vh	s, p	cm-f	-	-	e	-
Pedon 4 (Sabkha), Nearly level												
Cz	0-45	2.5Y 7/2	l	-	sbk	h	s, p	cm-f	-	-	e	as
Cy	45-150	2.5Y 7/2	cl	-	pl	vh	s, p	cm-f	-	-	e	aw
C1	150-180	10YR 6/8	cl	-	abk	vh	s, p	cm-f	-	-	e	aw
2C2	180-200	2.5Y 6/6	fs	-	m	s	so, po	-	-	mf	e	-
Pedon 5 (Gravel Plain), Gently sloping												
C1	0-50	10YR 6/8	sg, cs	ffg	m	s	so, po	-	-	-	e	cs
C2	50-100	10YR 6/8	cs	-	m	s	so, po	fm-f	mmd	-	e	as
2C3	100-140	10YR 6/4	sl	-	pl	vh	ss, ps	cm-f	mmd	-	e	as
3C4	140-200	10YR 6/8	cs	-	m	h	so, po	fm-f	-	-	e	-
Pedon 6 (Gravel Plain), Gently sloping												
C1	0-10	10YR 7/6	sg, cs	cfg	m	s	so, po	-	-	-	e	cs
C2	10-35	10YR 7/6	cs	-	m	s	so, po	-	-	-	e	cs
C3	35-100	10YR 7/6	cs	-	m	sh	so, po	fm-f	-	-	e	aw
2C4	100-150	10YR 7/4	sl	-	pl	vh	ss, ps	cm-f	mmd	-	e	-
C1	0-10	10YR 7/6	sg, cs	cfg	m	s	so, po	-	-	-	e	cs
Pedon 7 (Low Land), Nearly level												
C1	0-20	10YR 7/6	sg, cs	cfg	m	s	so, po	-	-	-	e	cs
C2	20-60	10YR 6/8	cs	-	m	s	so, po	-	-	-	e	cs
C3	60-100	10YR 5/8	cs	-	m	s	so, po	-	-	-	e	as
2C4	100-150	10YR 6/4	scl	-	sbk	vh	s, p	cm-f	-	-	e	-
C1	0-20	10YR 7/6	sg, cs	cfg	m	s	so, po	-	-	-	e	cs
Pedon 8 (Sabkha), Gently sloping												
Cz	0-50	10YR 6/6	sl	-	abk	h	s, p	cm-f	cmd	-	e	as
2Cy	50-120	2.5Y 7/2	cl	-	pl	h	s, p	cm-f	-	-	e	cs
2C1	120-170	10YR 6/8	cl	-	pl	h	s, p	cm-f	cmd	-	e	as
2C2	170-200	2.5Y 6/6	cl	-	abk	h	s, p	cm-f	-	mf	e	-
Cz	0-50	10YR 6/6	sl	-	abk	h	s, p	cm-f	cmd	-	e	as

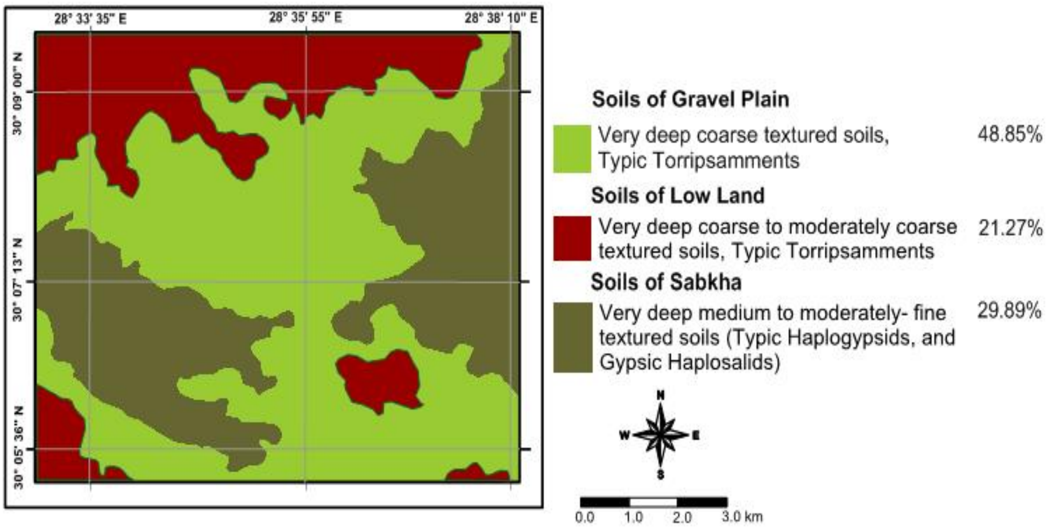
Texture (USDA): sg, sl-slightly gravel sandy loam; cl-clay loam; sg, cs-coarse sand; cs-coarse sand; scl-sandy clay loam; l-loam; fs-fine sand; sl-sandy loam
Coarse Fragments: cfg-common fine gravel; ffg-few fine gravel
Structure: m-massive; sbk-subangular blocky; abk-angular blocky; pl-platy
Consistency: (Dry): s-soft; sh-slightly hard; h-hard; vh-very hard; (Wet): so-non sticky; ss-slightly sticky; po-non plastic; ps-slightly plastic; p-plastic
[a]: cm-f: common medium and fine; fm-f: few medium and fine Roots: mf-many fine
[b]: cmd-common medium distinct; mmd- many medium distinct
Reaction: e-slightly effervescent
Boundary: as-abrupt smooth; cs-clear smooth; aw-abrupt wavy; ds-diffuse smooth

Table (3). Some soil physical and chemical characteristics along with taxonomic unites of the studied pedons.

Horizon	Depth (cm)	pH	EC (dS m^{-1})	OM (%)	$CaCO_3$ (%)	Gypsum (%)	Gravel (%)	Particle Size Distribution 1-2	1-0.5	0.5-0.25	0.25-0.125 (mm)	0.125-0.063	<0.063	Sand (%)	Silt (%)	Clay (%)
Pedon 1 (Sabkha), *Typic Haplogypsids*																
C	0-45	7.34	7.17	1.53	1.20	4.06	9.00	-	-	-	-	-	-	66.80	20.00	13.20
2Cy	45-100	6.09	20.69	1.77	1.20	8.52	-	-	-	-	-	-	-	28.80	34.00	37.20
2C1	100-140	5.88	18.06	0.85	2.00	7.78	-	-	-	-	-	-	-	30.80	36.00	33.20
2C2	140-200	6.11	14.44	0.31	2.40	7.41	-	-	-	-	-	-	-	42.80	26.00	31.20
Pedon 2 (Low Land), *Typic Torripsamments*																
C1	0-20	8.57	0.91	0.04	2.40	NA[a]	8.50	9.97	49.27	4.31	17.14	10.26	9.05	-	-	-
C2	20-40	8.75	0.96	0.17	0.80	NA	-	19.16	55.39	2.92	6.87	10.37	5.29	-	-	-
C3	40-80	8.46	1.28	1.02	1.20	NA	-	25.81	59.97	1.95	3.73	4.06	4.48	-	-	-
2C4	80-150	7.45	10.37	0.44	1.50	6.29	-	-	-	-	-	-	-	54.80	20.00	25.20
Pedon 3 (Low Land), *Typic Torripsamments*																
C1	0-30	8.89	0.61	0.24	1.60	NA	9.50	13.77	63.19	3.16	10.99	6.73	2.16	-	-	-
C2	30-80	7.85	2.51	0.17	1.20	NA	-	16.00	65.43	3.99	8.50	4.74	1.34	-	-	-
C3	80-120	7.95	4.46	1.02	1.70	NA	-	12.51	60.70	6.70	13.06	5.56	1.47	-	-	-
2C4	120-160	7.43	12.53	0.48	1.60	8.90	-	-	-	-	-	-	-	42.80	18.00	39.20
Pedon 4 (Sabkha), *Gypsic Haplosalids*																
Cz	0-45	6.87	90.90	0.75	2.60	6.29	-	-	-	-	-	-	-	42.80	32.00	25.20
Cy	45-150	6.71	24.84	0.92	1.20	7.09	-	-	-	-	-	-	-	25.50	45.00	29.50
C1	150-180	7.07	23.41	0.17	1.20	7.04	-	-	-	-	-	-	-	26.80	44.00	29.20
2C2	180-200	7.57	6.45	0.51	1.60	NA	-	10.53	12.82	5.01	43.85	24.15	3.64	-	-	-
Pedon 5 (Gravel Plain), *Typic Torripsamments*																
C1	0-50	8.72	0.69	0.17	2.00	NA	5.50	21.53	65.45	0.20	8.57	3.12	1.13	-	-	-
C2	50-100	7.93	1.83	0.44	1.60	1.65	-	14.49	78.24	0.15	4.62	1.78	0.72	-	-	-
2C3	100-140	7.53	16.28	0.24	0.80	4.81	-	-	-	-	-	-	-	60.80	22.00	17.20
3C4	140-200	7.09	9.20	0.14	1.20	1.76	-	26.52	56.45	3.96	7.46	3.17	2.44	-	-	-
Pedon 6 (Gravel Plain), *Typic Torripsamments*																
C1	0-10	8.06	2.77	0.19	1.60	NA	10.00	11.22	53.96	4.09	19.72	9.80	1.21	-	-	-
C2	10-35	7.86	2.79	0.17	1.60	NA	-	17.49	62.22	2.68	8.95	6.90	1.76	-	-	-
C3	35-100	7.95	3.78	0.17	2.00	1.70	-	21.48	59.83	3.87	8.86	4.41	1.55	-	-	-
2C4	100-150	7.62	6.43	0.07	1.60	4.43	-	-	-	-	-	-	-	76.80	8.00	15.20
Pedon 7 (Low Land), *Typic Torripsamments*																
C1	0-20	8.82	0.80	0.14	2.00	NA	8.00	11.87	56.23	3.73	14.06	8.49	5.62	-	-	-
C2	20-60	8.30	1.80	0.18	1.00	NA	-	17.58	60.41	3.45	7.68	7.55	3.33	-	-	-
C3	60-100	8.20	2.87	1.04	1.45	NA	-	19.16	60.33	4.32	8.39	4.81	2.99	-	-	-
2C4	100-150	7.44	11.45	0.46	1.55	7.60	-	-	-	-	-	-	-	48.80	19.00	32.00
Pedon 8 (Sabkha), *Gypsic Haplosalids*																
Cz	0-50	7.11	49.03	1.14	1.90	5.17	-	-	-	-	-	-	-	54.80	26.00	19.20
2Cy	50-120	6.40	22.76	1.34	1.20	7.80	-	-	-	-	-	-	-	27.15	39.50	33.35
2C1	120-170	6.47	20.73	0.51	1.60	7.41	-	-	-	-	-	-	-	28.80	40.00	31.20
2C2	170-200	6.84	10.44	0.41	4.00	7.25	-	-	-	-	-	-	-	40.80	31.00	28.20

[a] Not available

sticky to non sticky and plastic to non plastic, respectively. Soil colour closely reflected the nature of the parent materials, which was not homogeneous throughout the investigated pedons. Soils exhibited 10YR to 2.5Y hue, 2 to 8 chroma, while value of the colour matrix did not exceed 7. Pedological features; i.e. gypsum crystals and/or powders were noticed in common quantities with moderate or fine sizes. Also, redoximorphic features like iron and/or manganese were found in common or many medium distinct. Roots were rare and only presented at the deepest horizon of the soils belonging to Sabkha (Pedon 4 and 8) in many fine dead forms. The soils displayed slightly effervescent reaction with diluted HCl without any exception. Boundaries between soil horizons ranged between diffuse to abrupt, referring to apparent differences in the mode of deposition between the genetic horizons of the soils. On basis of that, the studied soils could be categorized into three soil unites namely; (1) very deep coarse-textured soils (SU1), (2) very deep coarse to moderately coarse-textured soils (SU2) and (3) very deep medium to moderately-fine textured soils (SU3). First unite was dominant as it covers about 50%, while the second and third units comprised less than 30% both separately (Map 6).



Map (6). Associated soil classification map of the study area.

2. Soil Physical and Chemical Properties

Chemical and physical characteristics of the investigated soils are variable and influenced by landscape position (Table 3). Soil reaction (pH) ranged from 5.9 (Pedon 1; Sabkha) to 8.9 (Pedon 3; Low land) with no consistent depth trends in general. Lower values of pH were due to gypsum formations and redoximorphic features of Fe and Mn which are clearly noticed at the described pedons. The electrical conductivity (EC) of soils widely varied between 0.61 to 90.90 dS m^{-1}, where the lower contents of EC were showed at surface and subsurface soils of the study area, reflecting non-saline to very slightly saline classes. The higher values of EC were noticed at soils of Sabkha and at the deepest horizons of the studied pedons representing to the other geomorphological units, where it classified as strongly saline. Organic matter content (OM) of the soils tends to be low; ranging 0.04 to 1.77% and this is owing to location of the investigated soils under the hyperthermic climate conditions. Calcium carbonate ($CaCO_3$) contents in the soils not exceed 4%, explained why it exhibited slight effervescent with HCl at the field. Gypsum was distinctly found at all layers belonging to soils of Sabkha. Also, was noticed at the deepest horizons of the other studied soils while their surface and subsurface ones were free of gypsum formations. The determined values of gypsum ranged between traces to 8.90%. Total sand content varied between 25.50 percent at Cy horizon of Pedon 4 (Sabkha) and 100% at surface and subsurface horizons of Pedons 2, 3, 5, 6, 7 and the deepest layer of Pedon 4. Likewise, a significant variation in silt contents is noticed, where it varied between 8.00 percent in 2C4 horizon of Pedon 6 (Gravel Plain) and 45.00% in Cy horizon of Pedon 4 (Sabkha). The clay percentages ranged between 13.20% in C horizon of Pedon 1 (Sabkha) and 39.20% in 2C4 horizon of Pedon 3 (Low Land).

3. Soil Classification

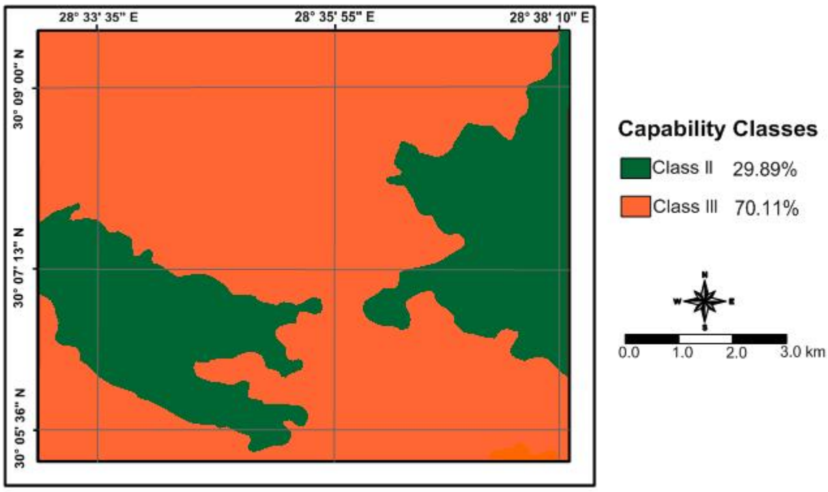
According to the morphological and laboratory data, soils were classified as *Aridisols* and *Entisols*. Soils of Sabkha were categorized into *Typic Haplogypsids* (Pedon 1) and *Gypsic Haplosalids* (Pedons 4, and 8) because of their depth to bedrock (>150 cm) with presence of a gypsic horizon alone or along with a salic horizon. Both of low land and gravel plain soils (Pedons 2, 3, 5, and 7) had characteristics of *Typic Torripsamments*; such as it has a total of more than 90 % resistant minerals within the particle-size control section and 150-200 cm depth, (Table 3). It is worth mentioning that *Typic Torripsamments* covered 51.16% of the investigated soils of the total area. Classification data showed that soils of Sabkha are developed where both of Gypsification and Salinization as pedogenesis processes were common, while the other soils are young and lack to the features of evolution, (Map 6).

4. Land Capacity Classification

Soil features of a particular area are all considered when define the land capability class. There are eight recognized classes of land are divided into cultivated and non-cultivated using nine soil inputs; i.e. surface texture, soil depth, slope, erosion permeability, and surface runofff. Land classes from V to VIII are not capable of supporting cultivation of crops. Data in table (4) summarized calculated land capability indices at different units of the investigated area. The studied soils could be classified according to their capability into classes III and II. Class III occupied the major portion where it covered 70.11% of the total area; associated with the soils of *Typic Torripsamments*, which represented both of low land and gravel plain. Soils of class III is good for crop cultivation, but has severe limitations that reduce the choice of plants and/or require special conservation practices that are more difficult to apply. These soils require to vegetative practices; such as row crops not less than 2 to 4 years to return two-thirds of crop residue to the soil and at least 30% residue should remain on the soil surface after planting. Class II comprised less than 30% representing soils of Sabkha; associated with *Typic Haplogypsids* and *Gypsic Haplosalids* (Map 7).

Table (4). Land Capability indices and classes of the study soils.

Pedon No.	Slope (%)	Erosion	Soil texture	Soil structure	Permeability	Surface runoff	Capability class
1	1-3	Slight	Medium to moderately fine textured soils	abk, pl, pl, pl	Slowly permeable	Moderate	II
2	<1	Slight	Coarse to moderately coarse textured soils	m, m, m, sbk	Rapidly permeable	Very slow	III
3	<1	Slight	Coarse to moderately coarse textured soils	m, m, m, abk	Rapidly permeable	Very slow	III
4	<1	Slight	Medium to moderately fine textured soils	sbk, pl, abk, m	Slowly permeable	Slow	II
5	1-3	Slight	Coarse textured soils	m, m, pl, m	Rapidly permeable	Very slow	III
6	1-3	Slight	Coarse textured soils	m, m, m, pl	Rapidly permeable	Very slow	III
7	<1	Slight	Coarse to moderately coarse textured soils	m, m, m, sbk	Rapidly permeable	Very slow	III
8	1-3	Slight	Medium to moderately fine textured soils	abk, pl, pl, pl	Slowly permeable	Moderate	II



Map (7). Land capability classification map of the study area.

Soils of class II are suited for cultivation over a long period of time and have slight to moderate hazards and limitations where it was detected that salt accumulations are the dominant one. These kinds of limitations can reduce the choice of plants or require moderate conservation practices that are easy to apply. These soils need to vegetative conservation practices like a row crop with close seeded soil conserving crop every other year. However, it was noticed from previous literature that salinity of water resources exhibited 3000 to 6000 mg/kg (Yousef et al., 2018). These water conditions can facilate process of salt accumulations leaching within *Typic Haplogypsids* and *Gypsic Haplosalids*; class II as a key step to land use management for this type of soil.

The obtained feedbacks of assessment capability for the study area are matched with investigations of Belal et al. (2018) at El-Moghra area. Where, they found that most of the studied soils of El-Moghra are land with moderate use capability (C3) and good use capacity (C2). They observed that C2 occupied the lowest geographical area compared to C3 within their investigation.

CONCLUSION

The investigated area was categorized into three soil mapping unites; (1) very deep coarse-textured soils, SU1 (2) very deep coarse to moderately coarse-textured soils, SU2 and (3) very deep medium to moderately-fine textured soils, SU3. The obtained mapping unites were classified and evaluated for capability into; (i) *Typic Torripsamments*, which was associated to capability class III; SU1 and SU2 (ii) *Typic Haplogypsids* and *Gypsic Haplosalids*, which were linked to class II; SU3. Therefore, soils of the study area can be used for conditioned agriculture with availability of irrigation water in terms of quality and quantity. Findings suggest that this approach could also be useful for decision-makers in Egypt. Where, it considered a starting-point in development of land-use plans that promote wise use for agriculture and conservation of the land resource by thousands of farmers and other land holders within those kinds of desert areas. On the basis of the promising feedbacks presented in this research, work on the remaining issues is continuing and should be presented in future work.

REFERENCES

Ali, R.R., G.W. Ageeb and M.A. Wahab (2007). Assessment of soil capability for agricultural use in some areas west of the Nile Delta, Egypt: an application study using spatial analyses. J. Appl. Sci. Res., 3: 1622–1629.

Belal, A.B., E.S. Mohamed, A. Saleh, M.E. Jalhoum, E.A. Hendawy, M. Abdou and M.E. Sayed (2018). Optimum cropping pattern assessment of El-Moghra area, Egypt using remote sensing and GIS techniques. Presentation at the 13th International Conference of Egy. Soil Sci. Soc. (ESSS) "Management of Water and Soil Resources under Global Climate Changes", Cairo.

Brady, N.C. and R. Weil (2013). In: “Nature and Properties of Soils”. 14th Edition. Published by Dorling Kindersley (India) Pvt. Ltd., licensees of Pearson Education in South Asia, 1046 p.

CONOCO (1987). Geological map of Egypt, scale 1:500,000.

Dent, D., A. Young et al. (1981). In: “Soil Survey and Land Evaluation”. George Allen and Unwin Publishers, London, 278 p.

El Kady, M.M. (2008). Soils distribution and development of El Alamein – Wadi El Natrun Area, Egypt. M.Sc. Thesis, Fac. Agric., Al-Azhar University, Cairo, Egypt.

ESRI (2006). In: “Arc-GIS User Manual”. Version 9.2. Redlands. California.

Gad, A.A. (2015). Land capability classification of some western desert Oases, Egypt, using remote sensing and GIS. Egypt. J. Remote Sens. Sp. Sci., 18: S9-S18.

Global Mapper 17 (2016). Geographic Information System (GIS) software package. Blue Marble Geographics, USA.

Global Weather Website (2018). Global Weather Data for SWAT. The National Centers for Environmental Prediction (NCEP). Climate Forecast System Reanalysis (CFSR). Available online: https://globalweather.tamu.edu/#pubs

Hassan, S.M., R.J. Steel, A. El Barkooky, M. Hamdan, C. Olariu and M.A. Helper (2012). Stacked, lower Miocene tide-dominated estuary deposits in a transgressive succession, Western Desert, Egypt. Sediment. Geol., 282: 241–255.

Jackson, M.L. (2005). In: “Soil Chemical Analysis: Advanced Course”. UW-Madison Libraries Parallel Press, USA, 930 p.

Klingebiel, A.A. and P.H. Montgomery (1961). Land Capability Classification. In: “Agriculture Handbook No. 210”. USDA, Soil Conserv. Serv., Washington, DC.

Murphy, B.W., C. Murphy, B.R. Wilson, K.A. Emery, J. Lawrie, G. Bowman, R. Lawrie, and W. Erskine (2004). A revised land and soil capability classification for New South Wales. The 13th International Soil Conservation Organisation Conference, Brisbane.

Omran, E.S.E. (2016). A simple model for rapid gypsum determination in arid soils. Model. Earth Syst. Environ., 2:185.

Page, A.L., R.H. Miller and D.R. Keeney (1982). In: “Methods of Soil Analysis”. Part 2. Chemical and Microbiological Properties. Agronomy, No. 9. Soil Sci. Soc. Am. Madison, WI 1159.

Pickford, M., E.R. Miller and A.N. El-Barkooky (2009). Suidae and Sanitheriidae from Wadi Moghra, Early Miocene, Egypt. Acta Palaeontol. Pol., 55: 1–11.

Said, R. (1962). In: ‘The Geology of Egypt”. Eisvier, Amsterdam-New York, 377 pp.

Sayed, A.S.A. (2013). Evaluation of the land resources for agricultural development-case study: El-Hammam canal and its extension, NW Coast of Egypt. Dissertation, zur Erlangung des Doktorgrades der Naturwissenschaften im Department Geowissenschaften der Universität Hamburg.

Soil Surcey Staff (2017). In: ‘Soil Survey Manual”. Ditzler, C., K. Scheffe and H.C. Monger (eds.). USDA Handbook 18. Government Printing Office, Washington, D.C., USA, 603 p.

Stieglitz, R.D. (1988). Land Capability Analysis. In: “General Geology”. Springer, p. 379–385.

USDA, N. (2014). In: “Keys to Soil Taxonomy”. Soil Surv. Staff. Washingt, USA.

Wells, M.R. (1989). An Assessment of soil capability for on-site effluent disposal, East Carnarvon, Western Australia. Resource Management Technical Report No.79.

Yousef, A.F. (2013). Lights on the hydrogeology of Moghra Oasis, North Western Desert, Egypt. Accepted in 29/8/2013, Annals Geol. Surv. Egypt, V. XXXII: 1-24.

Yousef, A.F., M.A. El Fakharany, U.A.A. Risha, M.M. Afifi and M.A. Al Sayyad (2018). Contributions to the geology of Moghra-Qattara area, North Western Desert, Egypt. J. Basic Environ. Sci., 5: 1-19.

تصنيف وتقييم بعض الأراضي حسب قدرتها الإنتاجية بمنخفض المغرة، مصر

مؤمن محمد القاضي[1] والسيد فتحي عيسى[2]
[١]قسم البيدولوجي، مركز بحوث الصحراء، المطرية، القاهرة، مصر
[٢]قسم الأراضي والمياه، المركز القومي للبحوث، الجيزة، مصر

يقدم هذا البحث معلومات قيمة عن بعض الأراضي الجافة بمنخفض المغرة بصحراء مصر الغربية بالمنطقة الواقعة فيما بين خطي طول ٢٨°٣٣'٠٠" إلى ٢٨°٣٨'١٢" شرقًا، ودائرتي عرض ٣٠°٠٥'٣٠" إلى ٣٠°٠٩'٠٥" شمالًا والتي تغطي مساحة حوالي ٦٥٤١ هكتار، وتعتبر واحدة من المناطق التي أولتها الحكومة المصرية اهتمامًا من حيث دراسة، واستكشاف، وتقييم موارد أرضية جديدة يمكن استغلالها زراعيًا لزيادة مساحة الرقعة الزراعية بمصر، والتي باتت لا تتناسب انتاجيتها مع التزايد المستمر، والمخيف من الموارد البشرية بها. من أجل هذا استهدف البحث دراسة توزيع وتصنيف وتقييم الموارد الأرضية للإستغلال الزراعي بالمنطقة المذكورة بمساعدة تقنيات الإستشعار عن بعد، ونظم المعلومات الجغرافية الحديثة. فكانت النتائج المتحصل عليها أن التربة المدروسة صنفت إلى رتبتي الأراضي الحديثة *Entisols*، والقديمة *Aridisols*، حيث اشتملتا على ثلاثة نوعيات من الأراضي المصاحبة وزعت كالآتي: (١) الأراضي العميقة جدًا ذات القوام الخشن، وشكلت مساحتها ٣١٩٥ هكتار، (٢) الأراضي العميقة جدًا ذات القوام ما بين الخشن والمتوسط الخشونة، وكانت مساحتها ١٣٩١ هكتار. وقد تم تصنيفهما تحت مجموعة الأراضي الرملية ذات القطاع العميق *Typic Torripsamments*، ووقعتا ضمن الدرجة الثالثة عند تقييمهما حسب القدرة الإنتاجية. (٣) الأراضي العميقة جدًا ذات القوام ما بين الدرجة المتوسطة النعومة إلى القريبة من الناعم، وغطت مساحتها ١٩٥٥ هكتار، وتم تصنيفها تحت مجموعتي كلًا من الأراضي القديمة المتطورة من حيث النشأة ذات القطاع العميق المحتوية على أفق الجبس فقط *Typic Haplogypsids*، وذات القطاع العميق المحتوية على كلًا من أفقي الجبس، والملح متزامنين معًا *Gypsic Haplosalids*، وكانت القدرة الإنتاجية لهما من الدرجة الثانية. يتضح من الدراسة أن بعض الأراضي بمنخفض المغرة يمكن إستغلالها زراعيًا بشرط توافر كلا من (١) الإدارة المزرعية الحكيمة لها للتغلب على المحددات السائدة بها المتمثلة في ضعف الحالة الخصوبية، خشونة القوام، سرعة النفاذية، الجريان السطحي وارتفاع نسبة الملوحة ببعضها، (٢) الموارد المائية من حيث الكمية، الجودة المناسبة للري والغسيل.