Menoufia J. Soil Sci., Vol. 6 May (2021): 147 – 159 https://mjss.journals.ekb.eg/

A RECENT STUDY ON GEOMORPHOLOGY, CHARACTERISTICES AND CLASSIFICATION OF SOILS IN EL-FAYOUM GOVERNORATE, EGYPT

M.S. Amira [(1)], A.H. El-Nahry[(2)], F.E. Abu Agwa[(1)] and E. A. A. Abdelsamie [(2)]
[(1)] Soil Sci. Dept., Fac. Agric. Menoufia univ .
[(2)] National Authority for Remote Sensing and Space Sciences (NARSS)

Received: May 9, 2021 Accepted: May 25, 2021

ABSTRACT: **The current work aims to make a recent study on the geomorphology, characteristics and classification of soils in El-Fayoum governorate, Egypt. The investigated area is located to the west of the Nile at 90 km southwest of Cairo. It occupies 2138.53 km^2. The agricultural land represents 1252.4 km^2, meanwhile, the urban areas occupy 540.86 km^2. The Multi Images produced by Remote Sensing and GIS technique were used to identify the geomorphological features of the area. A reconnaissance survey followed by detailed one was done to verify the information resulted from satellite images. Five main landforms with some sub-mains were recognized in the studied area namely: Recent river terraces (high, moderate and low), Basins (overflow, and decantation), Old river terraces (high, moderate high, moderate and low), Former lake bed, Water bodies (fish ponds and Lake Qaroun). Thirty soil profiles were chosen representing these landforms and morphologically described. Soil samples were collected for physiochemical analyses.**

The studied area has almost flat topography with very deep soil materials. Some soils that having moderately high-water table levels, are moderately deep and imperfectly drained. Most of the studied soils have clay loam texture grade and some have loam to sandy loam ones. All soils have slightly alkaline reaction and most of them are slightly-saline with moderate to high sodicity effect especially the areas with high water table and/or adjacent to Lake Qaroun. These soils are moderately calcareous poor in organic matter and gypsum contents.

Most of the studied soils haven't any clear diagnostic horizons and classified according to Soil Survey Staff (2014) under Entisols. Some of them that have Natric and/or Calcic horizons are classified under Aridisols orders up to sub-great group level.

Key words: **RS, GIS, geomorphic units, landforms, soil characteristics, soil classification.**

INTRODUCTION

The challenge of agriculture in the 21st century especially in Egypt requires an integrated and systematic approach. This approach must address sustainable use and management of natural resources through the development and adoption of farming technology and management practices that will ensure food security and agricultural livelihoods. The need for food for the population increasing in Egypt is threatening natural resources as people strive to get the most out of land already in production or push into virgin territory for new agricultural land. The damage is increasingly evident: the loss of arable lands owing to erosion, salinity, desertification, urban spread, water scarcity; global warming and climate change as well as threats to biodiversity (Hegazi et al., 2005).

The agricultural area in Egypt is composed of the Nile Valley and Delta, which considered the main contributor to

food production, trading activities, and the national economy. Sustainable agricultural development requires a systematic effort towards the planning of land use activities in the appropriate way, apart from several other institutional and policy programmer initiatives. Heavy population pressure and the related increased competition from different types of land users have emphasized the need for more effective land-use planning and management. The Egyptian government adopted policies of self-sufficiency in food production, e.g., extension of cultivated land and maximization of production of the existing agricultural land. The principal purpose was and still is to overcome Egypt's overwhelmingly unfavorable population to agricultural land ratio. Such yearly progressive increase requires paying considerable attention to conserve our limited land resources to optimize our agricultural productivity per unit area and to maximize the agricultural reclaimed lands through a series of projects to develop new lands in the desert. Therefore, the Egyptian government places a high priority on exploring the natural resources in the Western Desert (Hegazi et al., 2005).

The identification of geomorphological characteristics is from the important initial stages for studying any areas (Dawoud et al., 2005). Remote sensing (RS) is now recognized as an important tool in monitoring and managing natural resources (Lillesand and Kiefer, 2007). They added that RS technique is one of the important methods used for soil survey, mapping, and environmental investigation. ESRI (2003) stated that a geographic information system (GIS) is a system for the management, analysis, and displaying of geographic information, which is represented by a series of geographic datasets that model geography using simple, generic data structures.

The aim of the present work was to make a recent study on the geomorphology, physicochemical characteristics and classification of the soils in El-Fayoum governorate. The integration of remote sensing (RS) and geographic information system (GIS) techniques was used to perform all results and produce the spatial digital maps of this work.

MATERIALS AND METHODS

Study area

El Fayoum depression is located to the west of the river Nile at 90 km southwest of Cairo city. It is located between latitudes 29° 05 to 29° 36 N, and longitudes 30° 20' to 31° 05' E (Fig, 1). It is geographically bounded by the Western Desert and the Nile Basin. It occupies 2138.53 km2 (509173.81 fed.). The agricultural land represents 1252.4 km2 (298190.48fed), meanwhile, the urban areas occupy 540.86 km2 (128776.19 fed).

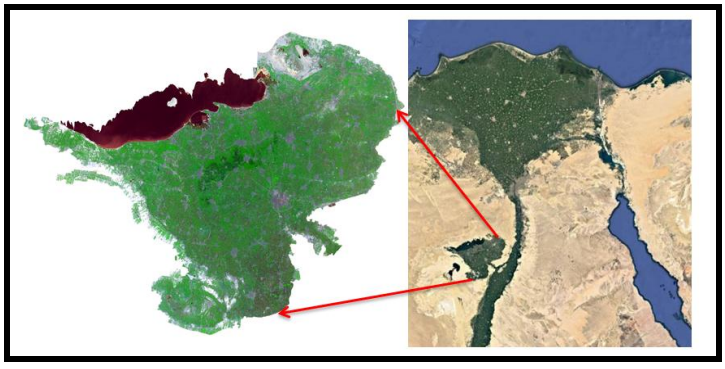

Fig (1): Study area.

Remote sensing and GIS work

The digital elevation model (DEM) of the study area was extracted from the Shuttle Radar Topography Mission (SRTM) and a topographic map with a scale of 1:25,000 covering the study area using Arc-GIS 10.7.1 software (ESRI, 2003). The Landsat 8 (path 177 / row 40) image acquired in 2018 and SRTM data were processed in ENVI 5.5 software (ITT, 2017) to identify the geomorphology and landforms of the studied area (Fig, 2) according to the approach developed by Dobos et al. (2002). The map legend was designed according to Zinck and Valenzuela (1990). ArcMap 10.7.1 software was used to display and produce geomorphic map of the study area (Fig, 2) with help of its DEM features and field observations (ESRI, 2014).

Field work

Reconnaissance soil survey was conducted throughout the investigated area in order to acquire an appreciation of its broad soil patterns and characteristic landscape. The primary mapping units resulting from analysis of the DEM and interpretation information gained during unsupervised classification of Landsat images were verified.

Thirty soil profiles were chosen from two sample areas representing the geomorphic and landform units of the studied area (Fig, 2). The soil profile's locations and elevations were defined in the field by using GPS system. The morphological description of these soil profiles was recorded on the basis outlined by FAO (2006). Soil samples were collected based on the vertical variations of each soil profile for the laboratory analyses of soil physical and chemical properties.

Laboratory analyses

Particle size distribution, electrical conductivity (EC), pH, organic matter (OM), calcium carbonate ($CaCO_3$), gypsum contents, cation exchange capacity (CEC), exchangeable Na^+ percentage (ESP) were determined according to Burt and Soil Survey Staff (2014). Identify class terms of each soil property was done according to Soil Science Division Staff (2017).

Soil classification

The soils of the studied area were classified up to sub great group level based on Soil Survey Staff (2014).

RESULTUS AND DISCUSSION

Geomorphology

Produced DEM map of the study area presented in Fig (3) indicated that, the elevation for the whole of the study area is varied between -53 m below sea level (b.s.l.) and increased gradually to 65 m above sea level (a.s.l.).

The interpretation of satellite images with the aid of produced Digital Elevation Model (DEM), topographic maps and field observations indicated that, the study area has five main geomorphic units with different landforms (Fig, 2). These geomorphic units are: 1) Recent river terraces (High, Moderate and Low), 2) Basins (Overflow basins and Decantation basins), 3) Old river terraces (High, moderately high, Moderate and Low), 4) Former lake bed, and 5) Water bodies (Fish ponds and Lake Qaroun). These units with their representative soil profiles and their areas are presented in Table (1).

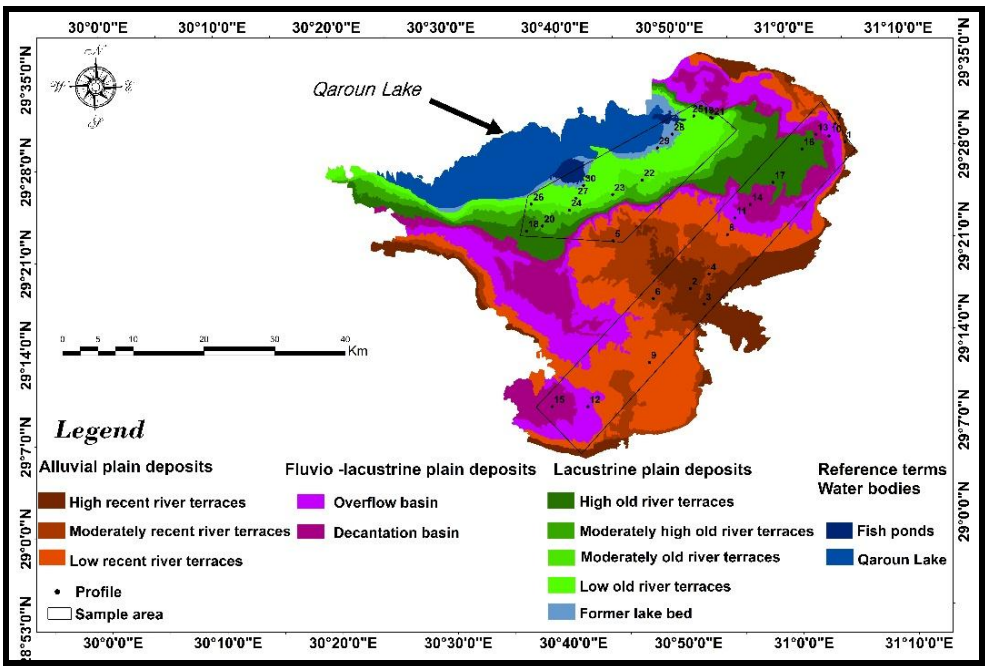

Fig (2): Geomorphic map and representative soil profiles of the study area.

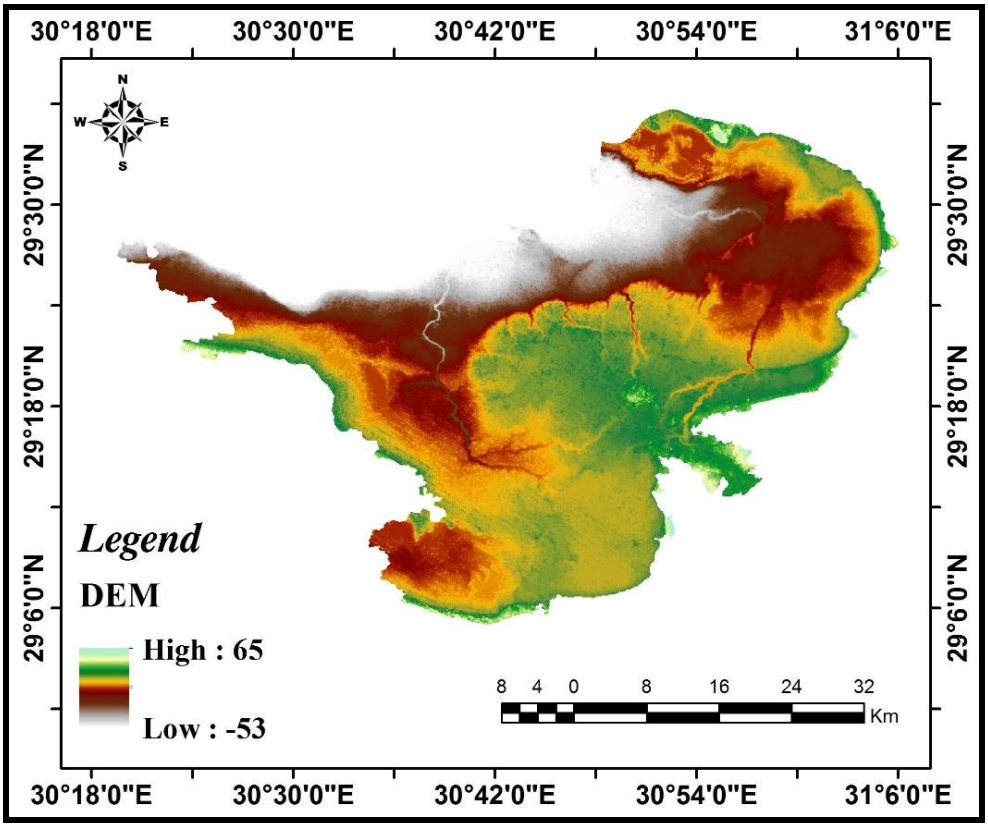

Fig (3): Digital Elevation Model (DEM) of the study area.

Table (1): Detailed geomorphic units of the study area.

Geomorphic units	Landform	Profiles No.	Area			
			Km^2	Fed	%	Total
Recent river terraces	High	1,2,3	215.77	51373.94	10.09	39.52
	Moderate	4,5,6	205.83	49007.17	9.62	
	Low	7,8,9	423.45	100820.69	19.8	
Basins	Overflow	10,11,12	301	71667.01	14.08	25.31
	Decantation	13,14,15	240.28	57209.16	11.24	
Old river terraces	High	16,17,18	187.33	44601.95	8.76	22.33
	Moderately high	19,20,21	87.48	20828.53	4.09	
	Moderate	22,23,24	67.56	16085.93	3.16	
	Low	25,26,27	135.27	32207.48	6.33	
Former lake bed	Former lake bed	28,29,30	32.21	7669.32	1.51	1.51
Water bodies	Fish ponds		16.2	3857.61	0.76	11.33
	Qaroun Lake		226.15	53844.38	10.57	
Total			2138.53	509173.81	100	100

Soil morphology

The morphological features of the studied soil profiles presented in Table (2) revealed that, the elevation of the studied soils is between - 44 m below sea level to 29 m above sea level. Most of the studied soils have almost flat topography with very deep soil materials. Some soils that having moderately high-water table levels, are moderately deep and imperfectly drained. The main hue notation of the studied soil color is around brown notation (10YR). The soils have mostly moderate medium sub-angular to granular

structure with hard dry and firm moist consistency. The studied soils are moderately calcareous.

Physiochemical properties

The physiochemical properties of the studied soil profiles and their weighted profile means (wpm) are registered in Table (3). Data in Table (3) show that, most of the studied soils have clay loam texture grade and some have loam to sandy loam ones. Most of these soils are non- to slightly-saline having a slightly alkaline reaction and slightly sodic effect. Some soils of old river terraces and all soils of Overflow basin, as well as Former lake bed, are moderately saline having sodicity effect. On the other hand, most of the studied soils are moderately calcareous having < 10% $CaCO_3$ content. Only, the soils of Overflow basin are highly calcareous having > 10% $CaCO_3$ content. All studied soils have low OM and gypsum contents.

Table (2): Morphological features of the studied soil profiles.

Geomorphic and landform units		Profile No.	Elevation m	Depth cm	Color		Structure[1]	Consistence[2]		Boundary[3]
					Dry	Moist		Dry	Moist	
Recent river terraces	High	1	26	0-30	10YR 6/3	10YR 6/2	2 m sbk	hard	firm	gradual s
				30-70	10YR 5/3	10YR 5/2	2 to s m sbk	v hard	v firm	abrupt
				70-150	10YR 4/2	10YR 4/3	2 m an to sbk	hard	firm	-
		2	29	0-25	10YR4/3	10YR 3/3	2 m sbk	hard	firm	gradual s
				25-90	10YR 4/1	10YR3/1	2 m sbk	v hard	v firm	gradual s
				90-150	10YR 4/2	10YR 4/3	2 m sbk	hard	firm	-
		3	28	0-30	10YR 4/4	10YR3/4	2 m sbk	hard	firm	gradual s
				30-60	10YR3/2	10YR 2/2	2 m sbk	v hard	v firm	abrupt
				60-150	10YR 4/2	10YR 3/2	2 m sbk	hard	firm	-
	Moderately	4	19	0-30	10YR 6/4	10YR 5/4	2 m sbk	hard	firm	clear
				30-55	10YR 4/3	10YR 4/2	2 m sbk	hard	firm	gradual s
				55-110	10YR 4/2	10YR 4/1	2 m sbk	hard	firm	clear
				110-150	10YR 5/4	10YR 5/3	2 m sbk	hard	v firm	
		5	18	0-35	10YR 6/3	10YR 6/2	2 m sbk	hard	firm	abrupt
				35-100	10YR 6/4	10YR 6/3	2m sbk	soft	friable	-
		6	18	0-25	10YR 4/1	10YR3/1	2 m sbk	hard	firm	abrupt
				25-50	10YR 4/3	10YR 4/2	2 m sbk	hard	firm	abrupt
				50-100	10YR 6/6	10YR5/6	2 m sbk	hard	firm	gradual s
				100-150	10YR 3/1	10YR2/1	2 m sbk	hard	firm	-
	Low	7	15	0-30	10YR 5/2	10YR 5/1	2 m sbk	hard	firm	gradual s
				30-60	10YR 3/2	10YR 3/1	2 m sbk	hard	firm	gradual s
				60-100	10YR 4/1	10YR 3/1	2 m sbk	hard	v firm	clear
				100-150	10YR 4/3	10YR 4/2	2 m sbk	hard	v firm	-
		8	12	0-25	10YR 4/2	10YR3/2	2 m sbk	v hard	v firm	gradual s
				25-50	10YR 4/4	10YR3/4	2 m sbk	hard	firm	clear
				50-120	10YR 7/6	10YR6/6	2 m sbk	hard	firm	gradual s
				120-150	10YR4/6	10YR3/6	s m an	hard	firm	-
		9	15	0-30	10YR 7/6	10YR 6/6	2 m sbk	hard	firm	gradual s
				30-50	10YR 6/6	10YR 6/4	2 m sbk	hard	firm	clear
				50-110	10YR 6/4	10YR 6/3	2 m sbk	hard	firm	gradual s
				110-150	10YR 5/4	10YR 5/3	1 f gr	soft	v friable	-
Basins	Overflow	10	2	0-15	10YR 7/4	10YR 7/3	2 m sbk	v hard	v firm	clear
				15-40	10YR 7/6	10YR 7/4	1 f gr	soft	v friable	clear
				40-70	10YR6/8	10YR 6/6	1 f gr	s hard	firm	clear
				70-110	10YR 7/8	10YR 6/8	1 f gr	s hard	firm	-
		11	7	0-20	10YR 6/6	10YR 6/5	1 f sbk	s hard	firm	clear
				20-50	10YR 7/4	10YR 6/4	1 m sbk	hard	friable	clear
				50-120	10YR 8/6	10YR 8/4	2 m sbk	hard	firm	-
		12	6	0-25	10YR 6/8	10YR 5/8	2 ms	soft	friable	clear
				25-50	10YR 7/4	10YR 6/4	1 m sbk	hard	friable	clear
				50-140	10YR 7/6	10YR 6/6	2 ms	soft	friable	-
	Decantation	13	2	0-25	10YR 5/3	10YR 5/2	2 m sbk	hard	firm	gradual s
				25-65	10YR 5/4	10YR 5/3	2 to s m sbk	v hard	v firm	gradual s
				65-110	10YR 5/6	10YR 5/7	1 f gr	soft	friable	clear
				110-150	10YR 3/2	10YR 3/1	2 m sbk	hard	firm	-
		14	(-1)	0-30	10YR 6/2	10YR 6/1	2 ms	soft	friable	clear
				30-60	10YR 4/2	10YR 4/1	2 m sbk	hard	firm	clear
				60-110	10YR 5/3	10YR 5/2	2 m sbk	hard	v firm	gradual s
				110-150	10YR 5/4	10YR 5/3	2 m sbk	hard	v firm	-
		15	1	0-20	10YR 7/6	10YR6/6	2 ms	soft	friable	clear
				20-50	10YR 4/4	10YR 3/4	2 m sbk	hard	firm	clear
				50-120	10YR 4/1	10YR 3/1	2 m sbk	hard	firm	diffuse
				120-150	10YR 4/1	10YR 3/1	2 m sbk	hard	v firm	-

Abbreviations: Texture*: Structure[1]: 1=weak, 2 =moderate, f = fine, s, strong, m = medium, gr = granular, an = angular ,sbk = subangular blocky, sg= single grains; Consistence[2]: v = very, Boundary[3]: s = smooth : ms=massive

Table (2): Cont.

Geomorphic and landform units		Profile No.	Elevation m	Depth cm	Color		Structure[1]	Consistence[2]		Boundary[3]
					Dry	Moist		Dry	Moist	
Old river terraces	High	16	(-10)	0-20	10YR 5/3	10YR 5/4	2 m sbk	hard	firm	gradual s
				20-60	10YR 4/3	10YR 4/2	2 m sbk	hard	firm	gradual s
				60-115	10YR 3/2	10YR 3/1	2 m sbk	hard	v firm	clear
				115-150	10YR 4/4	10YR 4/3	2 m sbk	hard	v firm	-
		17	(-4)	0-15	10YR 6/4	10YR 6/3	2 m sbk	hard	firm	clear
				15-80	10YR 5/3	10YR 5/2	2 to s m sbk	v hard	v firm	diffuse
				80-150	10YR 5/3	10YR 5/2	2 m sbk	v hard	v firm	-
		18	(-5)	0-20	10YR 4/2	10YR 3/2	2 m sbk	v hard	v firm	clear
				20-90	10YR 3/1	10YR 2/1	2 m sbk	hard	firm	clear
				90-150	10YR 6/6	10YR 5/6	2 m sbk	hard	firm	
	Moderately high	19	(-16)	0-20	10YR 7/6	10YR 6/6	2 m sbk	hard	firm	clear
				20-55	10YR 6/6	10YR 5/6	1 m sbk	hard	firm	clear
				55-100	10YR 8/6	10YR 7/6	2 m sbk	hard	v firm	
		20	(-28)	0-25	10YR 5/3	10YR 5/2	2 m sbk	hard	firm	clear
				25-60	10YR 4/2	10YR 4/1	1 m sbk	hard	firm	gradual s
				60-100	10YR 4/3	10YR 4/2	2 m sbk	hard	v firm	clear
				100-150	10YR 3/2	10YR 3/1	2 m sbk	hard	v firm	-
		21	(-14)	0-20	10YR 5/2	10YR 4/2	2 m sbk	hard	firm	clear
				20-50	10YR 3/2	10YR 3/1	1 m sbk	hard	firm	gradual s
				50-110	10YR 4/2	10YR 4/1	2 m sbk	hard	firm	clear
				110-150	10YR 5/3	10YR 5/2	2 m sbk	hard	v firm	-
	Moderately	22	(-25)	0-25	10YR 4/2	10YR 4/1	2 m sbk	hard	firm	gradual s
				25-70	10YR 3/3	10YR 3/2	2 m sbk	hard	firm	clear
				70-130	10YR 3/1	10YR 2/1	2 m sbk	v hard	v firm	-
		23	(-26)	0-30	10YR 6/4	10YR 6/3	2 m sbk	hard	firm	gradual s
				30-50	10YR 5/4	10YR 5/3	2 m sbk	hard	firm	gradual s
				50-100	10YR 5/3	10YR 5/2	2 m sbk	hard	v firm	gradual s
				100-150	10YR 5/6	10YR 5/4	2 m sbk	hard	v firm	-
		24	(-25)	0-30	10YR 4/3	10YR 3/3	2 m sbk	hard	firm	clear
				30-60	10YR 5/4	10YR 4/4	2 m sbk	hard	firm	gradual s
				60-120	10YR 6/6	10YR 5/6	2 m sbk	hard	firm	gradual s
				120-150	10YR 5/6	10YR 5/4	2 m sbk	hard	v firm	-
	Low	25	(-40)	0-10	10YR 6/2	10YR 5/2	2 m sbk	v hard	v firm	gradual s
				10--40	10YR 4/2	10YR 3/2	2 to s m sbk	v hard	v firm	gradual s
				40-110	10YR 4/1	10YR 4/2	2 m sbk	v hard	v firm	clear
				110-150	10YR 4/3	10YR 3/3	2 m an to sbk	hard	firm	-
		26	(-35)	0-25	10YR 5/4	10YR 5/3	2 m sbk	v hard	v firm	clear
				25-70	10YR 5/2	10YR 5/1	2 m an to sbk	hard	firm	-
		27	(-37)	0-20	10YR 5/3	10YR 4/3	2 m sbk	v hard	v firm	clear
				20--40	10YR 5/4	10YR 4/4	2 m an to sbk	hard	firm	gradual s
				40-115	10YR 4/2	10YR 3/2	1 m sbk	hard	firm	gradual s
				115-150	10YR 4/1	10YR 3/1	2 m an	hard	v firm	-
Former lake bed	Former lake bed	28	(-41)	0-10	10YR 7/8	10YR 7/6	s m sbk	hard	firm	gradual s
				10--40	10YR 6/6	10YR 6/8	sg	loose	loose	clear
				40-100	10YR 4/2	10YR 3/2	2 m an	hard	firm	clear
				100-150	10YR 3/2	10YR 3/1	1 m an	hard	firm	-
		29	(-44)	0-15	10YR 7/6	10YR 6/6	2 m sbk	hard	firm	gradual s
				15--50	10YR 8/4	10YR 7/4	sg	s hard	friable	clear
				50-110	10YR 4/1	10YR 3/1	2 m an to sbk	hard	firm	clear
				110-150	10YR 5/4	10YR 4/4	2 m an to sbk	hard	firm	-
		30	(-42)	0-30	10YR 4/6	10YR3/6	s m sbk	hard	firm	clear
				30--80	10YR 8/6	10YR 7/6	2 m an	hard	firm	gradual s
				80-100	10YR 6/6	10YR 5/6	2 m sbk	hard	firm	clear
				100-150	10YR 4/2	10YR 3/2	1 an to sbk	hard	firm	-

Table (3): Some physical and chemical properties of studied soil profiles.

Landform		P[1] No	Depth cm	Particle size distribution %			Texture class[3]	$CaCO_3$ %	EC[4]	pH[5]	CEC[6]	Gyp[7] %	O. M %	ESP %
				Sand	Silt	Clay								
Recent river terraces	High	1	0-30	34.6	30.3	35.1	Clay loam	7.2	2.9	7.79	23.6	0.24	0.24	10.7
			30-70	19.9	37.5	42.6	Clay	6.3	2.4	7.84	27.5	0.08	0.2	7.9
			70-150	22.5	39.2	38.3	Clay loam	6.7	2.6	7.70	25.3	0.14	0.23	8.9
			WPM[2]	24.2	37.0	38.8	Clay loam	6.7	2.6	7.75	25.5	0.14	0.22	9.0
		2	0-25	32.6	31.4	36.0	Clay loam	6.9	3.1	7.85	24.1	0.26	0.24	10.0
			25-90	24.0	36.6	39.4	Clay loam	5.5	2.7	7.83	25.9	0.07	0.31	9.2
			90-150	23.6	39.1	37.3	Clay loam	6.0	2.8	7.70	24.7	0.12	0.24	9.1
			WPM	25.3	36.7	38.0	Clay loam	5.9	2.8	7.78	25.1	0.21	0.27	9.3
		3	0-30	35.0	29.0	36.0	Clay loam	8.8	2.8	7.88	24.1	0.25	0.26	11.0
			30-60	21.2	36.7	42.1	Clay	5.8	2.6	7.83	27.3	0.06	0.33	8.3
			60-150	22.7	38.2	39.1	Clay loam	5.2	2.7	7.77	25.7	0.15	0.25	7.5
			WPM	24.9	36.1	39.0	Clay loam	6.0	2.7	7.80	25.7	0.2	0.3	8.4
	Moderately	4	0-30	32.4	34.5	33.1	Clay loam	4.2	2.5	7.81	22.5	0.17	0.28	10.8
			30-55	25.0	38.6	36.4	Clay loam	7.5	2.9	7.86	24.3	0.15	0.26	10.1
			55-110	27.7	37.8	34.5	Clay loam	5.7	3.0	7.82	23.3	0.17	0.29	9.1
			110-150	30.3	35.3	34.4	Clay loam	8.9	2.7	7.76	23.2	0.14	0.25	9.9
			WPM	28.9	36.6	34.5	Clay loam	6.6	2.8	7.81	23.3	0.16	0.27	8.9
		5	0-35	40.5	31.0	28.5	Clay loam	8.6	7.3	7.70	20.1	0.21	0.27	21.0
			35-100	69.2	21.3	9.5	Sandy loam	13	2.9	7.85	10.0	0.24	0.14	10.1
			WPM	59.2	24.7	16.1	Sandy loam	11.5	4.4	7.80	13.5	0.23	0.18	13.9
		6	0-25	34.7	31.3	34.0	Clay loam	7.6	2.2	7.81	23.0	0.19	0.26	9.6
			25-50	24.7	37.2	38.1	Clay loam	8.3	2.9	7.85	25.2	0.2	0.28	10.0
			50-100	24.9	38.5	36.6	Clay loam	5.8	2.8	7.84	24.4	0.23	0.26	8.3
			10-150	25.8	37.7	36.5	Clay loam	13.0	3.1	7.87	24.3	0.22	0.13	9.5
			WPM	26.8	36.8	36.4	Clay loam	8.9	2.8	7.84	24.3	0.22	0.22	9.2
	Low	7	0-30	24.0	39.0	37.0	Clay loam	5.6	2.6	7.83	24.6	0.13	0.23	9.9
			30-60	27.1	37.6	35.3	Clay loam	4.0	3.6	7.79	23.7	0.11	0.25	11.9
			60-100	23.9	38.5	37.6	Clay loam	3.8	3.0	7.78	24.9	0.13	0.27	9.4
			100-150	32.1	35.3	32.6	Clay loam	5.0	2.8	7.75	22.2	0.15	0.24	11.4
			WPM	27.3	37.3	35.4	Clay loam	4.6	3.0	7.78	23.7	0.13	0.25	10.7
		8	0-25	54.4	24.1	21.5	S clay loam	12.5	2.7	7.78	16.4	0.23	0.14	11.0
			25-50	46.7	26.8	26.5	S clay loam	11.2	2.9	7.85	19.0	0.24	0.16	10.0
			50-120	47.4	22.5	30.1	S clay loam	9.7	3.6	7.78	20.9	0.2	0.14	12.4
			120-150	51.1	21.6	27.3	S clay loam	13.8	4.0	7.70	19.4	0.22	0.15	11.4
			WPM	49.2	23.3	27.5	S clay loam	11.2	3.4	7.77	19.5	0.22	0.15	11.6
		9	0-30	54.2	23.3	22.5	S clay loam	13.3	2.9	7.85	16.9	0.24	0.16	9.2
			30-50	46.7	28.8	24.5	Loam	14.5	3.0	7.82	18.0	0.26	0.15	7.8
			50-110	52.4	27.3	20.3	S clay loam	11.4	3.5	7.80	15.7	0.22	0.13	12.0
			110-150	61.3	23.8	14.9	Sandy loam	13.6	3.9	7.70	12.9	0.24	0.14	11.8
			WPM	54.4	25.8	19.8	S clay loam	12.8	3.4	7.79	15.5	0.23	0.14	10.8
Basins	Overflow	10	0-15	74.9	15.5	9.6	Sandy loam	21.3	8.6	7.73	10.1	0.26	0.11	22.3
			15-40	69.7	20.8	9.5	Sandy loam	15.3	7.0	7.77	10.0	0.17	0.15	23.2
			40-70	67.1	22.6	10.3	Sandy loam	17.5	6.9	7.76	10.4	0.19	0.16	22.3
			70-110	69.5	21.2	9.3	Sandy loam	16.8	8.5	7.79	9.9	0.16	0.14	22.7
			WPM	69.6	20.7	9.7	Sandy loam	17.3	7.7	7.77	10.1	0.18	0.14	22.6
		11	0-20	63.7	23.0	13.3	Sandy loam	14.3	16.4	7.79	12.0	0.19	0.17	29.0
			20-50	70.3	13.5	16.2	Sandy loam	16.6	7.1	7.77	13.6	0.26	0.11	18.2
			50-120	81.4	13.1	5.5	Loamy sand	11.7	6.3	7.76	7.9	0.24	0.13	17.6
			WPM	75.7	14.8	9.5	Sandy loam	13.4	8.2	7.76	10.0	0.24	0.13	19.7
		12	0-25	68.0	22.0	10.0	Sandy loam	14.9	10.2	7.78	10.3	0.22	0.16	22.6
			25-50	72.3	12.5	15.2	Sandy loam	16.7	7.4	7.76	13.0	0.28	0.08	19.1
			50-140	67.5	22.2	10.3	Sandy loam	13.5	7.2	7.75	10.4	0.26	0.11	21.4
			WPM	68.5	20.4	11.1	Sandy loam	14.3	7.8	7.75	10.9	0.26	0.11	21.2

[1]P No = Profile No, [2]WPM = weighted profile mean, [3]S clay loam = Sandy clay loam, [4]EC = dSm^{-1}, [5]pH in 1:2.5, [6]CEC = Cmole/Kg, [7]Gyp = Gypsum

Table (3): Cont.

Landform		P No.	Depth cm	Particle size distribution %			Texture Class	$CaCO_3$ %	EC	pH	CEC	Gyp %	O M %	ESP %
				Sand	Silt	Clay								
Basins	Decantation	13	0-25	41.5	31.0	27.5	Clay loam	9.3	3.50	7.77	19.5	0.26	0.17	13.1
			25-65	22.4	36.9	40.7	Clay	3.5	2.71	7.81	26.5	0.07	0.11	10.2
			65-110	86.8	10.2	3.0	Sand	7.8	2.30	7.77	6.6	0.14	0.27	9.7
			110-150	26.5	37.8	35.7	Clay loam	4.7	2.00	7.81	23.9	0.14	0.29	10.7
			WPM	46.0	28.1	25.9	Loam	6.07	2.52	7.80	10.7	0.14	0.22	10.7
		14	0-30	64.4	27.5	8.1	Sandy loam	11.2	3.44	7.78	9.3	0.22	0.18	8.3
			30-60	27.5	36.3	36.2	Clay loam	4.7	3.53	7.73	24.2	0.15	0.23	10.0
			60-110	23.9	37.7	38.4	Clay loam	5.5	4.14	7.82	25.3	0.14	0.25	11.0
			110-150	24.2	38.5	37.3	Clay loam	6.5	3.63	7.81	24.7	0.13	0.29	11.1
			WPM	32.8	35.6	31.6	Clay loam	6.74	3.74	7.79	21.7	0.16	0.24	10.30
		15	0-20	62.7	27.2	10.1	Sandy loam	12.3	3.21	7.72	10.3	0.23	0.17	9.0
			20-50	25.7	37.5	36.8	Clay loam	5.3	3.00	7.71	24.5	0.15	0.24	9.4
			50-120	24.8	36.7	38.5	Clay loam	6.5	4.20	7.81	25.4	0.13	0.26	10.7
			120-150	22.2	40.5	37.3	Clay loam	5.5	3.50	7.79	24.7	0.15	0.31	10.6
			WPM	29.5	36.4	34.1	Clay loam	6.83	3.68	7.77	23.6	0.15	0.25	10.17
Old river terraces	High	16	0-20	24.9	37.5	37.6	Clay loam	4.5	4.31	7.77	24.9	0.18	0.23	13.6
			20-60	29.2	36.2	34.6	Clay loam	4.2	8.50	7.78	23.3	0.13	0.28	24.7
			60-115	28.9	36.8	34.3	Clay loam	5.3	7.50	7.79	23.1	0.15	0.25	22.2
			115-150	29.7	35.3	35.0	Clay loam	5	9.50	7.89	23.5	0.19	0.29	22.9
			WPM	28.6	36.4	35.0	Clay loam	4.83	7.80	7.80	23.5	0.16	0.26	21.90
		17	0-15	21.3	39.4	39.3	Clay loam	12.3	5.91	7.88	25.8	0.14	0.27	13.6
			15-80	21.7	37.7	40.6	Clay	5.3	5.32	7.86	26.5	0.08	0.31	12.6
			80-150	22.5	38.0	39.5	Clay loam	6	3.80	7.81	25.9	0.12	0.28	11.0
			WPM	22.0	38.0	40.0	Clay	6.33	4.66	7.84	26.2	0.1	0.29	11.9
		18	0-20	23.4	36.4	40.2	Clay	14.1	5.13	7.80	26.3	0.16	0.29	12.7
			20-90	23.4	37.1	39.5	Clay loam	3.5	4.21	7.70	25.9	0.09	0.33	9.9
			90-150	23.3	38.3	38.4	Clay loam	4.2	3.90	7.70	25.3	0.14	0.26	11.8
			WPM	23.4	37.5	39.1	Clay loam	5.19	4.20	7.71	25.7	0.12	0.30	11.0
	Moderately high	19	0-20	82.2	13.0	4.8	Loamy sand	14	8.72	7.77	7.5	0.29	0.11	25.1
			20-55	81.3	13.2	5.5	Loamy sand	7.3	12.51	7.79	7.9	0.23	0.13	28.5
			55-100	30.5	35.2	34.3	Clay loam	15.2	8.30	7.79	23.1	0.13	0.21	24.1
			WPM	58.6	23.1	18.3	Sandy loam	12.2	9.85	7.78	14.7	0.2	0.16	25.8
		20	0-25	25.6	38.0	36.4	Clay loam	5.5	2.93	7.78	24.3	0.13	0.25	6.5
			25-60	23.2	39.3	37.5	Clay loam	4.9	2.21	7.75	24.8	0.14	0.27	8.1
			60-100	30.4	35	34.6	Clay loam	5.2	3.30	7.79	23.3	0.17	0.24	16.6
			100-150	27.4	37.6	35.0	Clay loam	5.6	4.00	7.77	23.5	0.16	0.21	12.5
			WPM	26.9	37.4	35.7	Clay loam	5.31	3.21	7.77	23.9	0.15	0.24	11.5
		21	0-20	30.9	39.2	29.9	Clay loam	6.2	3.73	7.81	20.8	0.14	0.22	11.6
			20-50	30.2	36.6	33.2	Clay loam	7.5	3.42	7.78	22.6	0.13	0.24	8.3
			50-110	27.0	38.3	34.7	Clay loam	5.5	2.70	7.75	23.4	0.16	0.21	10.8
			110-150	29.2	36.3	34.5	Clay loam	4.5	3.10	7.74	23.3	0.14	0.23	10.4
			WPM	28.7	37.6	33.7	Clay loam	5.73	3.08	7.76	22.8	0.15	0.22	10.3

Table (3): Cont.

Landform		P No	Depth cm	Particle size distribution %			Texture Class	$CaCO_3$ %	EC	pH	CEC	Gyp %	O. M %	ESP %
				Sand	Silt	Clay								
Old river terraces	Moderate	22	0-25	30.4	35.0	34.6	Clay loam	5.3	5.3	7.78	23.3	0.15	0.25	14.2
			25-70	31.2	35.3	33.5	Clay loam	5.0	3.5	7.77	22.7	0.11	0.23	12.2
			70-130	23.9	38.6	37.5	Clay loam	4.8	2.5	7.76	24.8	0.13	0.27	8.6
			WPM	27.7	36.8	35.5	Clay loam	5.0	3.4	7.77	23.8	0.13	0.25	10.9
		23	0-30	29.6	35.3	35.1	Clay loam	5.5	2.8	7.79	23.6	0.13	0.26	7.2
			30-50	27.2	36.4	36.4	Clay loam	4.6	3.6	7.84	24.3	0.15	0.24	10.6
			50-100	28.4	35.9	35.7	Clay loam	4.8	2.6	7.75	23.9	0.13	0.23	10.3
			100-150	38.2	31.3	30.5	Clay loam	6.7	2.7	7.77	21.1	0.27	0.15	10.6
			WPM	31.8	34.3	33.9	Clay loam	5.5	2.8	7.78	23.0	0.18	0.21	9.8
		24	0-30	31.0	34.7	34.3	Clay loam	4.5	3.2	7.79	23.1	0.15	0.23	8.4
			30-60	27.6	37.1	35.3	Clay loam	6.6	3.5	7.78	23.7	0.13	0.24	10.9
			60-120	27.0	36.6	36.4	Clay loam	7.5	2.5	7.72	24.3	0.12	0.22	9.7
			120-150	38.2	32.3	29.5	Clay loam	9.7	2.9	7.79	20.6	0.23	0.13	9.5
			WPM	30.1	35.5	34.4	Clay loam	7.2	2.9	7.76	23.2	0.15	0.21	9.6
	Low	25	0-10	23.2	35.0	41.8	Clay	5	3.0	7.78	27.1	0.15	0.25	8.6
			10--40	22.2	37.2	40.6	Clay	3.5	2.9	7.77	26.5	0.12	0.27	9.8
			40-110	21.9	36.8	41.3	Clay	4.2	3.6	7.79	26.9	0.11	0.29	13.3
			110-150	23.2	38.5	38.3	Clay loam	3.5	3.5	7.78	25.3	0.13	0.28	15.2
			WPM	22.4	37.2	40.4	Clay	3.9	3.4	7.78	26.4	0.12	0.28	12.8
		26	0-25	22.1	36.8	41.1	Clay	7.8	3.6	7.79	26.8	0.11	0.23	11.8
			25-70	32.5	34.0	33.5	Clay loam	6.6	5.4	7.87	22.7	0.12	0.22	15.3
			WPM	28.8	35.0	36.2	Clay loam	7.0	4.7	7.84	24.2	0.12	0.22	14.0
		27	0-20	25.3	33.1	41.6	Clay	7.9	3.2	7.76	27.0	0.15	0.26	12.4
			20--40	30.0	34.7	35.3	Clay loam	4.3	2.8	7.78	23.7	0.11	0.22	10.0
			40-115	23.4	39.9	36.7	Clay loam	6.6	3.7	7.80	24.4	0.14	0.13	12.6
			115-150	31.3	36.2	32.5	Clay loam	6.5	5.5	7.85	22.2	0.11	0.24	14.9
			WPM	26.4	37.4	36.2	Clay loam	6.4	3.9	7.80	24.1	0.13	0.18	12.7
Former lake bed	Former lake bed	28	0-10	82.2	12.5	5.3	Loamy sand	6.8	12.3	7.93	7.8	0.28	0.07	24.2
			10--40	86.4	11.0	2.6	Sand	7.3	10.6	7.85	6.3	0.27	0.07	26.1
			40-100	23.4	38.9	37.7	Clay loam	4.4	7.5	7.87	25.0	0.15	0.29	23.2
			100-150	30.2	35.5	34.3	Clay loam	4.5	8.4	7.89	23.1	0.14	0.23	18.5
			WPM	42.2	30.4	27.4	Clay loam	5.2	8.7	7.88	19.5	0.18	0.21	22.3
		29	0-15	80.2	15.5	4.3	Loamy sand	6.9	13.3	7.98	7.2	0.26	0.06	22.1
			15--50	86.4	11.0	2.6	Sand	7.7	11.3	7.88	6.3	0.25	0.04	25.2
			50-110	25.6	37.9	36.5	Clay loam	4.8	8.5	7.89	24.3	0.14	0.26	22.8
			110-150	30.2	35.7	34.1	Clay loam	6.5	8.8	7.86	23.0	0.12	0.24	16.4
			WPM	46.5	28.8	24.7	Loam	6.1	9.7	7.89	18.1	0.17	0.18	21.6
		30	0-30	82.2	11.2	6.6	Loamy sand	7.4	11.5	7.88	8.5	0.29	0.11	23.0
			30--80	85.4	11.4	3.2	Loamy sand	6.9	12.0	7.87	6.7	0.24	0.09	26.2
			80-100	25.4	38.9	35.7	Clay loam	5.1	8.5	7.87	23.9	0.17	0.28	24.4
			100-150	27.2	36.6	36.2	Clay loam	5.2	8.1	7.84	24.2	0.14	0.21	18.4
			WPM	57.4	23.4	19.2	Sandy loam	6.2	10.1	7.86	15.1	0.21	0.16	22.7

Soil classification

Based on the climatic condition, soil morphological and physiochemical characteristics, the studied soils are classified up to sub great group level according to Soil Survey Staff (2014). According to FAO (1977) and USDA-NRCS (1997), the dominant soil moisture

regime of this area is "Torric" with "Thermic" soil temperature regime. Most of these soils haven't any clear diagnostic sub-surface horizons and therefore are classified under *Entisols* order (Table, 4). About 50.77% from the studied soils have > 30 swelling clay contents and cracked when not irrigated (Tables, 3 and 4), therefore they classified as *Vertic Torriorthents*. The soils of profiles 5, 8 and 9 have light loamy texture and classified as *Typic Torriorthents* (18.61%). The soils of profiles 11, 12, 16, 19, 28, 29 and 30 have a clear sodicity effect on the hall profile layers (Tables 3 and 4) and classified as *Sodic Torriorthents* (14.27). The soils of profile 26 have a highwater table level (70 cm from the soil surface) and classified as *Aquic Torriorthents* (0.95). Only, the soils of profile 10 in the Overflow basin have both *Calcic* and *Sodic* horizons and classified under Aridisols as *Sodic Haplocalcids*. Classification of the studied soils are presented in Table (4) and Fig (4).

Table (4): Soil classification in the study area.

Order	Sub Great Group	Soils of profiles No.	Area	
			Km^2	%
Entisols	*Vertic Torriorthents*	1, 2, 3, 4, 6, 7, 13, 14, 15, 17, 18, 20, 21, 22, 23, 24, 25, 27	1085.8	50.77
	Typic Torriorthents	5, 8, 9	397.9	18.61
	Sodic Torriorthents	11, 12, 16, 19, 28, 29, 30	305.1	14.27
	Aquic Torriorthents	26	20.4	0.95
Aridisols	*Sodic Haplocalcids*	10	86.96	4.07
Water bodies			242.35	11.33
Total			2138.53	100

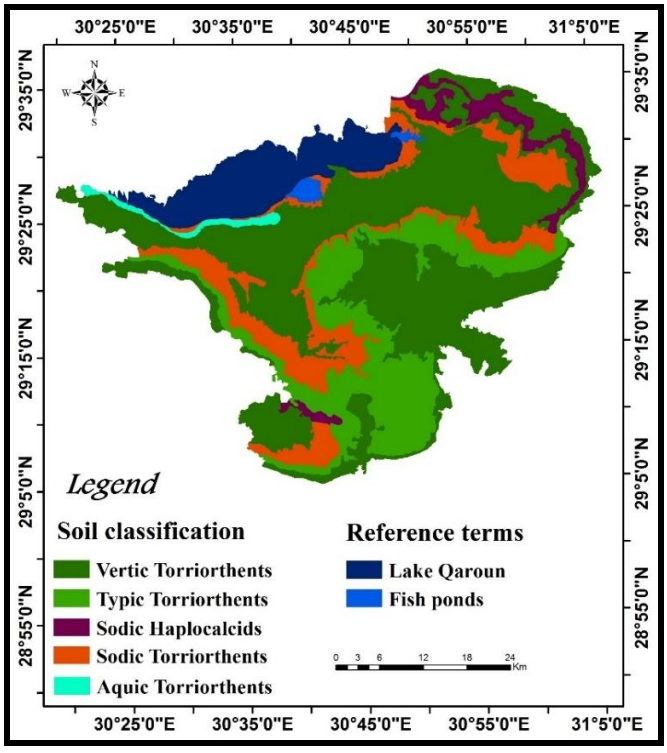

Fig (4): Soil classification map.

REFERANCES

Burt, Rebecca and Soil Survey Staff (2014). Kellogg Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report No. 42, Version 5.0, Kellogg Soil Survey Laboratory, National Soil Survey Center, Natural Resources Conservation Service, USDA, Lincoln, Nebraska, USA.

Dawoud, M.A., M.M. Darwish and M.M. El-Kady (2005). GIS-based groundwater management model for Western Nile Delta. Water Resources Manag. 19: 585–604.

Dobos, E., B. Norman, W. Bruee, M. Luca, J. Chris and M. Erika (2002). The use of DEM and satellite images for regional scale soil database. Proceedings of the 17th World Congress of Soil Science, Bangkok.

ESRI "Environmental Systems Research Institute" (2003). Using ArcGIS Geostatistical Analyst. Environmental Systems Research Institute (ESRI) Press, Redlands, California.

ESRI "Environmental Systems Research Institute" (2014). Arc Map Version 10.1 User Manual. ESRI, 380 New York Street, Redlands, California, 92373-8100, USA.

FAO (1977). Soil map of the world 1 : 5 000 000, Volume VI Africa, FAO, UNSCO, Paris.

FAO (2006). Guidelines for soil profile description. Soil Res. Dev. and Co. Serv., Land and Water Dev. Div., Rome, Italy.

Hegazi, A.M., M.Y. Afifi, M.A. EL Shorbagy, A.A. Elwan and S. El-Demerdashe (2005). Egyptian national action program to combat desertification, Arab Republic of Egypt, Ministry of Agriculture and Land Reclamation, Desert Research Center (DRC), UNCCD Egypt Office, 1 Mathaf El Mataria – P.O.Box: 11753 El Mataria, Cairo, Egypt.

ITT "International Telephone and Telegraph" (2017). ENVI 5.5 software help manual, ITT corporation, 1133 Westchester Avenue, White Plains, NY 10604, USA.

Lillesand, T. M. and R. W. Kiefer (2007). Remote Sensing and Image Interpretation. 5th Ed. Paper back. John Wiley, New York.

Soil Science Division Staff (2017). Soil Survey Manual, Handbook No. 1 USDA. 1400 Independence Avenue, SW, Washington, D.C. USA

Soil Survey Staff (2014). Keys to Soil Taxonomy, 11th Ed., USDA, NRCS, Pocahontas Press, Inc., Blacksburg, Virginia, USA.

USDA-NRCS (1997). Soil climate map, Soil Science Division, World Soil Resources, United States Department of Agriculture & Natural Recourses Conservation Service, Washington D.C.

Zinck, J.A. and C.R. Valenzuela (1990). Soil Geographic Database: Structure and Application Examples. ITC journal, 3: 270.

دراسة حديثة عن جيومورفولوجيا وخصائص وتقسيم أراضي محافظة الفيوم، مصر

محمد سمير عراقي عميرة [1]، علاء الدين حسن النهري [2]، فوزي الشاذلي أبو عجوة [1]، السيد عبد الستار احمد عبد السميع [2]

[1] قسم علوم الأراضي – كلية الزراعة – جامعة المنوفية

[2] الهيئة القومية للاستشعار من البعد وعلوم الفضاء – القاهرة

الملخص العربى

أجري هذا البحث بهدف اجراء دراسة حديثة عن الخصائص الجيومرفولوجية والفيزيوكيميائية وكذلك تقسيم أراضي محافظة الفيوم، مصر، ولقد استخدم تكامل التقنيات الحديثة للاستشعار من البعد (RS) مع نظم المعلومات الجغرافية (GIS) في اجراء هذا العمل، وتقع منطقة الدراسة غرب النيل على بعد 90 كم جنوب غرب القاهرة. تبلغ مساحتها 2138.53 كم^2 , وتبلغ مساحة الاراضي الزراعية بها حوالي 1252.4 كم^2 ، بينما تشغل المناطق السكنية حوالي 540.86 كم^2. ولقد استخدمت صور متعددة الاطياف من الأقمار الصناعية بعد معالجتها وتصحيحها وفهم البيانات المكانية الخاصة بها، وتم من خلال تلك الصور التعرف على الخصائص الجيومورفولوجية والأرضية للمنطقة، أعقبها عمل حصر نصف تفصيلي لها لتأكيد معلومات الخرائط الناتجة من الأقمار الصناعية،

وقد تم التعرف على خمس وحدات جيومورفولوجية رئيسية متضمنة أشكال أرضية فرعية وهي: الشرفات النهرية الحديثة (عالية – متوسطة – منخفضة) ، الأحواض (الفيضية، التجميع) ، الشرفات النهرية القديمة (عالية – متوسطة الارتفاع – متوسطة – منخفضة) ، الجزء المجفف من بحيرة قارون ، بالإضافة للمسطحات المائية (المزارع السمكية وبحيرة قارون) – ولقد تم اختيار وحفر ووصف ثلاثون قطاعاً الأشكال الأرضية السائدة ، وجمعت عينات تمثل آفاقها لتحليل خصائصها الطبيعية و الكيماوية.

أوضحت الدراسات الحقلية أن سطح أراضي معظم الوحدات شبه مستوية إلى مائلة، ومعظم الأراضي عميقة القطاع، وحالة صرفها جيدة، إلا الأراضي القريبة من البحيرة أو ذات مستوى الماء الأرضي المرتفع.

قوام التربة في معظم الأراضي طيني طميي، وبناءها كتلي متوسط وقليل منها رملي طمييي، ويميل تأثير الأراضي إلى القلوي، ومعظمها قليل الملوحة، وتتأثر بدرجات متفاوتة من الصودية التي تزداد في الأراضي ذات مستوى الماء الأرضي المرتفع أو القريبة من البحيرة، وأغلب الأراضي يحتوي نسبة متوسطة من كربونات الكالسيوم، وقليل منها ذات نسبة عالية، ونسبة الجبس والمادة العضوية والسعة التبادلية الكاتيونية منخفضة.

ونظراً لعدم تمييز أي أفاق تشخيصية تحت سطحية في معظم الأراضي فلقد قسمت تحت رتبة الأراضي غير المتطورة **Entisols**، وقليل من أراضي الأحواض الفيضية التي تميزت بوجود أفق كالسي وأفق صوديومي فلقد قسمت تحت رتبة الأراضي الجافة **Aridisols** حتى مستوى تحت المجموعات العظمى.

الكلمات الدالة: الاستشعار من البعد، نظم المعلومات الجغرافية، الوحدات الجيومورفولوجية، الخصائص الفيزيوكيميائية للأراضي، تقسيم الأراضي.

أسماء السادة المحكمين

أ.د/ صلاح عبدالمجيد رضـــــوان كلية الزراعة – جامعة المنوفية

أ.د/ الحسينى عبدالغفار أبو حسين كلية الزراعة – جامعة المنوفية