MENOUFIA JOURNAL OF SOIL SCIENCE

https://mjss.journals.ekb.eg

CHARACTERISTICS AND CLASSIFICATION OF SOME SOILS WEST OF GHARBIA GOVERNORATE, MIDDLE DELTA, EGYPT USING RS AND GIS

Asmaa M. Soliman[1]; A.B. Belal[2]; M.S. Amira[1] and Hager A. Hassan[1]

[1] Soil Sci. Dept., Fac. Agric. Menoufia univ.

[2] National Authority for Remote Sensing and Space Sciences (NARSS).

Received: Sep. 22 , 2024 Accepted: Sep. 30, 2024

ABSTRACT: The current work was performed in 2023 aiming to study the geomorphological and pedological characteristics besides classification for soils of Kafr El-Zayat province area, Gharbia governorate, middle Nile Delta, Egypt. The techniques of Remote Sensing (RS) and Geographic Information System (GIS) were used to achieve this work.

The geomorphic map and defined different geomorphic units were produced by identifying the Sentinel 2B image and the digital elevation model (DEM) for the studied area. This map indicated that the main landscape unit in this area is Alluvial Plain includes nine landforms namely: high terraces (19.93%), medium terraces (30.62%), low terraces (21.36%), depression (4.87%), decantation basin (4.41%), overflow basin (7.31%), meandering belt (4.25%) and levee (3.30%). Twenty soil profiles were chosen representing these different landforms. The land and site features are observed and registered. These profiles were dug and morphologically described, and then samples were collected representing the subsequent layers in each profile for integrated physical and chemical analyses.

The studied area has almost flat topography with deep soil profiles and freely well drained. These soils have mainly loam to sandy clay loam texture with moderate medium subangular to angular blocky structure. The analytical data revealed that the studied soils are moderately alkaline, non-saline, and haven't sodicity effect. The soils are slightly calcareous, having very slight gypsum content. Organic matter (OM) is low and decreases with depth. The cation exchange capacity (CEC) is correlated to the fine fractions and OM contents in these soils.

The modified morphological rating scales, namely, relative horizon distinctness (RHD) and relative profile development (RPD) indicated a slight distinctness between horizons which mainly attributed to the depositional pattern and /or regimes of soil materials more than development.

The studied soil profiles haven't any diagnostic horizons, therefore they are classified up to sub-great group level under Entisols order mainly as Typic Torriorthents, Vertic Torriorthents, and Typic Torripsamments.

Keywords: RS, GIS, geomorphic units, pedological characteristics, morphological rating scales, soil classification.

INTRODUCTION

The Nile Delta in Egypt is among the earliest recognized deltaic systems globally and one of the oldest regions of intensive agriculture on the planet. Also, it is one of the world's largest river deltas and it is very densely populated, with ≥1,600 inhabitants per square kilometer. The Nile Delta (with an area of about 25000 km^2) is the delta formed in Northern Egypt (Lower Egypt) where the Nile River spreads out and drains into the Mediterranean Sea. From North to south, the delta is approximately 160 km in length. From west to east, it covers some 240 km of coastline. The Nile Delta is divided into two main distributaries, the Damietta and the Rosetta, flowing into the Mediterranean at port cities with the same name (Zeydan, 2005).

The Nile Delta soils consist of Nile deposits due to the frequent flooding during geological periods. These soils were formed by the sedimentary processes between the upper Miocene and the present, and then it is built up

*Corresponding author: asmaamokhtar222@gmail.com

by the alluvium delivered by the old seven active branches of the Nile (El Banna and Frihy, 2009). Mikhailova (2001) stated that the recent classical shape of the Nile Delta was formed during the Holocene period when the Holocene Delta sediments began to accumulate with the rise in sea level at the end of the last glaciation, at a rate estimated to be around 5 mm per year.

During the Holocene, the Delta was created by seven distributaries that have subsequently silted up and been replaced by the present-day Rosetta and Damietta channels.

Integration of remote sensing (RS) and geographic information system (GIS) play a major role in both soil survey and soil mapping applications. The development of methods to map soil properties using optical RS data in combination with field measurements has been the objective of several studies during the last decade (Dehaan and Taylor, 2003).

Gharbia governorate (which is the studied area) is one of the governorates of Egypt. It is in the middle part of the Nile Delta, to the east of the Rashid Branch of the river Nile.

This research was performed in 2023 to furnish a recent study on geomorphological and pedological features including the classification of the soils in Kafr El-Zayat province, Gharbia Governorate, east of the Rashid Branch of river Nile using the integration of remote sensing (RS) and geographic information system (GIS) techniques.

MATERIALS AND METHODS

Location of the study area

The study area is Kafr El-Zayat province, Gharbia Governorate, east of the Rashid Branch, in the middle of the Nile Delta, Egypt. It lies between longitudes 30° 40` and 30° 50` E and latitudes 30° 44` and 30° 52` N, with an area of 49662.61 feddans or 208.58 Km^2 (Fig, 1).

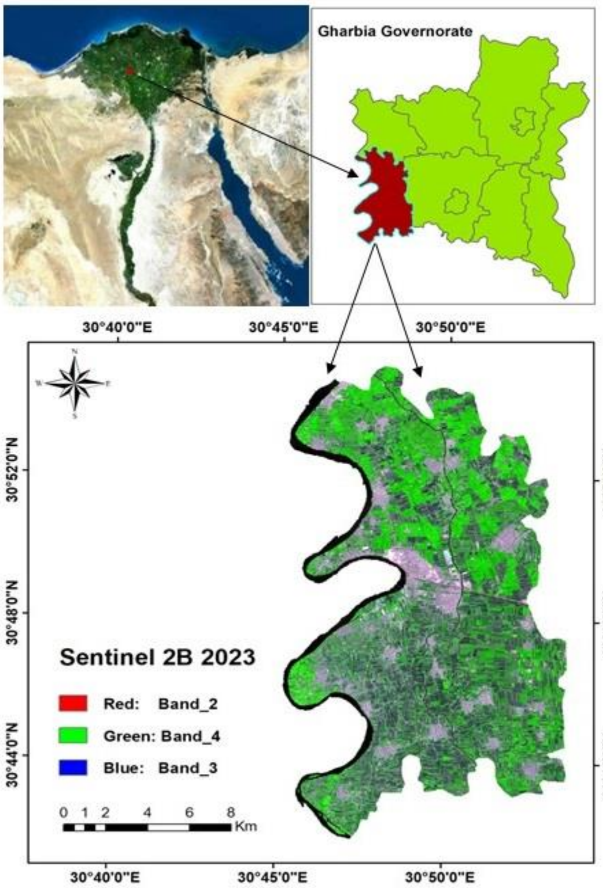

Fig (1): Kafr El-Zayat province (the study area) and its location at the Nile Delta.

Producing geomorphic maps for the study area:

Both Sentinel 2B in 2023 and the DEM are used to define different geomorphic units of the study 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 10.4 was used to display and produce landform maps with the help of field observations.

Field work:

Twenty soil profiles were chosen representing the different geomorphic units of the studied area (Fig, 2). Longitudes, latitudes and elevation were defined in the field using GPS apparatus. The land and site features are observed, described and registered according to FAO (2006). Soil profiles were dug deep down to about 150 cm and morphologically described according to FAO (2006). Soil color was determined in dry and moist samples using the Munsell Color (1992).

Soil samples were collected from each horizon of the soil profiles and air-dried. Particles less than 2 mm were used for physio-chemical analyses.

Laboratory analysis:

Particle size distribution, electrical conductivity (EC), pH, organic matter (OM), calcium carbonate ($CaCO_3$), gypsum, cation exchange capacity (CEC) and exchangeable Na^+ percentage (ESP), were determined according to Burt and Soil Survey Staff (2014). The weighted profile mean (w.p.m.) of each soil property was calculated for the studied profiles.

Rating scale:

The important morphological features such as soil color, texture, structure, consistency, the boundary between horizons, and some chemical properties such as dissolved salts (EC), pH, calcium carbonate and gypsum were used for evaluating the pedological development according to Bilzi and Ciolkosz (1977) modified by Zayed, *et al.* (2022).

Soil classification:

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

RESULTS AND DISCUSSION

Geomorphology:

Based on the integration of RS and GIS works as well as the satellite image interpretation, the investigated area could be considered mainly as an alluvial plain geomorphic unit with eight detailed landforms (subunits) as presented in Fig (2). These landforms are High Terraces (Profiles 1,2 and 3), Medium Terraces (Profiles 5,6,7 and 8), Low Terraces (Profiles 8,9 and 10), Depression (Profiles 11 and 12), Decantation Basin (Profile 13), Overflow Basin (Profiles 14 and 15), Meandering belt (Profiles 16, 17, 18), Levee (Profiles and, 20) and Water bodies. The detailed geomorphic subunits map of the study area and their areas are presented in Fig (2) and Table (1).

Soil Morphology:

The morphological features of the studied soils presented in Table (2) revealed that the elevation of the studied soils is between 17 m to 27 m. above sea level. The soils of the studied area have almost flat topography. All studied soils are deep and well-drained. The main hue notation of the studied soil color is around brown degrees (10YR). These soils have mainly Loam or sandy clay loam to clay loam texture throughout their depths. In addition, they have mostly moderate medium angular to subangular blocky structures. They are slightly to moderately calcareous having mostly hard to extremely hard (dry) and firm to extremely firm (moist) consistency. Most of the studied soils are cultivated with field or horticultural crops.

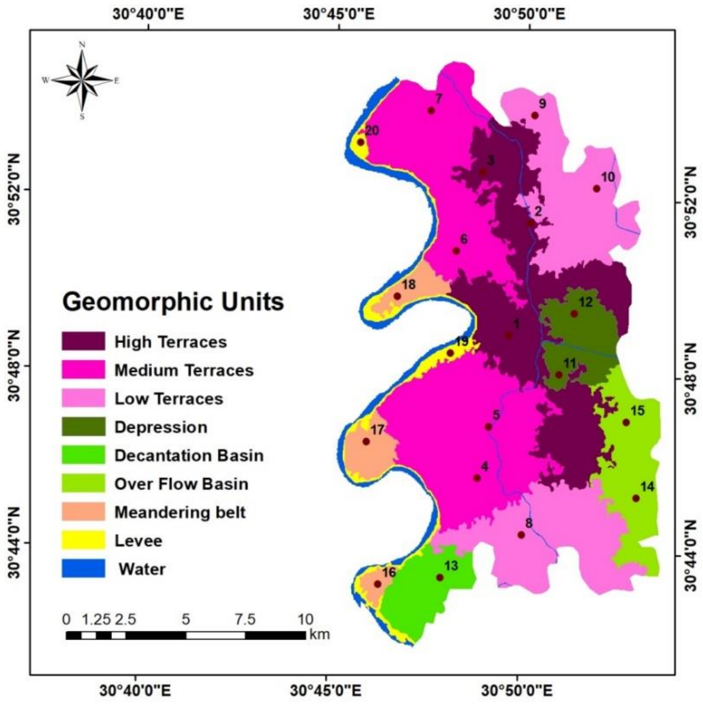

Fig (2): Detailed geomorphic map of the study area and location of the chosen profiles.

Table 1: The landforms of the study area, their areas, and chosen profiles.

Geomorphic unit	Detailed Landforms (Subunits)	Area (km^2)	Area (fed)	%	Profiles
Alluvial plain	High Terraces	41.578	9899.62	19.93	P1, P2, P3
	Medium Terraces	63.863	15205.55	30.62	P4, P5, P6, P7
	Low Terraces	44.555	10608.55	21.36	P8, P9, P10
	Depression	10.157	2418.55	4.87	P11, P12
	Decantation Basin	9.188	2187.75	4.41	P13
	Overflow Basin	15.25	3632.65	7.31	P14, P 15
	Meandering belt	8.872	2112.55	4.25	P16, P17, P18
	Levee	6.890	1640.6	3.30	P19, P20
Water body (Rashid branch)		8.218	1956.75	3.94	-
Total		208.583	49662.61	100	

Physiochemical properties:

The analytical data of studied soils presented in Table (3) show that these soils have mainly clay loam to clay texture as indicated from the whole profiles means (wpm). They are non-saline, as indicated by their EC values that they are lower than 4 dSm^{-1} (as wpm). Soil reaction is slightly alkaline, with pH values < 8.0 in most profile layers. These soils are slightly calcareous (having < 6% $CaCO_3$ contents as wpm, and non-gypsiric (having < 1% gypsum). Also, organic matter (OM) is very low (< 2%) owing to the prevailing aridity of the region. The cation exchange capacity (CEC) agrees with the fine fractions and organic matter contents. The ESP values are lower than 15%, indicating non-sodicity effect in all studied soils.

Table 2: Morphological features of the studied soil profiles.

Landform	P No.	Elevation m, asl	Depth cm	Color		Structure[1]	Consistence[2]		Boundary[3]
				Dry	Moist		Dry	Moist	
High Terraces	1	+ 17	0-30	10YR 5/2	4/2	2 m, f sbk	S hard	friable	diffuse
			30-60	10YR 5/2	4/2	2 m, f bk	x hard	v firm	diffuse
			60-90	10YR 5/2	4/2	2 m, f bk	x hard	v firm	diffuse
			90-120	10YR5/2	4/2	2 m, f bk	x hard	v firm	diffuse
			120-150	10YR 5/2	4/2	2 m, f sbk	S hard	friable	-
	2	+ 23	0-40	10YR 4/3	3/3	2 m, f bk	hard	friable	Clear
			40-60	10YR 5/3	4/3	1 f sbk	soft	v friable	clear
			60-90	10YR 4/3	3/3	3 m bk	x hard	friable	diffuse
			90-120	10YR 4/3	3/3	3 m bk	x hard	friable	diffuse
			120-150	10YR4/3	3/3	3 m, f bk	x hard	friable	-
	3	+22	0-30	10YR 4/2	3/3	2 m, f bk	x hard	Friable	diffuse
			30-60	10YR 4/2	3/3	2 m, f bk	x hard	firm	diffuse
			60-90	10YR 4/2	3/3	2 m, f bk	x hard	firm	diffuse
			90-120	10YR 4/2	3/3	2 m, f bk	x hard	firm	diffuse
			120-150	10YR 4/2	3/3	2 m, f bk	x hard	firm	-
Medium Terraces	4	+22	0-30	10YR 5/2	3/3	2 m, f sbk	x hard	friable	diffuse
			30-60	10YR 5/2	4/3	2 m, f bk	x hard	v firm	diffuse
			60-90	10YR 5/2	4/3	2 m, f bk	x hard	m firm	diffuse
			90-120	10YR 5/2	4/3	2 m, f bk	x hard	v firm	-
	5	+19	0-30	10YR 4/3	3/3	2 m, f sbk	soft	v friable	diffuse
			30-60	10YR 4/3	3/3	3 m, f bk	x hard	v friable	diffuse
			60-90	10YR 5/3	4/3	2 m, f sbk	hard	friable	diffuse
			90-120	10YR 5/3	4/3	2 m, f sbk	hard	friable	diffuse
			120-150	10YR 5/3	4/3	2 m, f sbk	s hard	friable	-
	6	+ 23	0-30	10YR 4/2	3/2	2 m, f bk	x hard	firm	diffuse
			30-60	10YR 5/2	4/2	2 m, f bk	x hard	firm	diffuse
			60-90	10YR 5/2	4/2	2 m, f bk	x hard	firm	diffuse
			90-120	10YR 5/2	4/2	2 m, f bk	x hard	firm	diffuse
			120-150	10YR 5/2	4/2	2 m, f bk	x hard	firm	-
	7	+ 23	0-30	10YR 4/2	3/3	2 m, f sbk	v hard	firm	gradual s
			30-60	10YR 4/2	3/3	2 m, f bk	x hard	v firm	diffuse
			60-90	10YR 4/2	3/3	2 m, f bk	x hard	m firm	gradual s
			90-120	10YR 5/3	4/3	2 m, f bk	hard	m firm	-
Low Terraces	8	+22	0-30	10YR 4/2	3/3	2 m, f bk to gr	v hard	friable	diffuse
			30-60	10YR 4/2	3/3	2 m, f bk	v hard	friable	diffuse
			60-90	10YR 4/2	3/3	2 m, f bk	v hard	friable	diffuse
			90-120	10YR 4/2	3/3	2 m, f bk	x hard	firm	-
	9	+23	0-30	10YR 4/2	3/3	3 m bk	x hard	friable	diffuse
			30-60	10YR 4/2	3/3	3 m bk	x hard	friable	gradual s
			60-90	10YR 4/1	3/2	3 m, f bk	x hard	friable	diffuse
			90-120	10YR 4/1	3/2	3 m, f bk	x hard	friable	diffuse
			120-150	10YR 4/1	3/2	3 m, f bk	x hard	friable	-
	10	+21	0-30	10YR 4/2	3/2	2 m, f bk	x hard	firm	diffuse
			30-60	10YR 4/2	3/2	2 m, f bk	x hard	firm	diffuse
			60-90	10YR 4/2	3/2	2 m, f bk	x hard	firm	diffuse
			90-120	10YR 4/2	3/2	2 m, f bk	x hard	firm	diffuse
			120-150	10YR 4/2	3/2	2 m, f bk	x hard	firm	-
Depression	11	+25	0-30	10YR 3/2	2/2	3 m, c bk	x hard	firm	diffuse
			30-60	10YR 3/2	2/2	3 m, c bk	x hard	firm	diffuse
			60-90	10YR 4/2	3/3	3 m, c bk	x hard	firm	gradual s
			90-120	10YR 4/2	3/3	3 m, c bk	x hard	firm	diffuse
			120-150	10YR 4/2	3/3	3 m, c bk	x hard	firm	-
	12	+22	0-30	10YR 5/2	4/3	2 m, f sbk	v hard	v firm	clear
			30-60	10YR 6/3	4/3	2 m, f sbk	m hard	friable	diffuse
			60-90	10YR 6/3	4/3	2 m, f sbk	v hard	friable	diffuse
			90-120	10YR 6/3	4/3	2 m, f sbk	x hard	firm	-

Abbreviations: Structure[1]: 1=weak, 2 =moderate, v = very, f = fine, m = medium, co=coarse, gr = granular, sbk = sub angular blocky; Consistence[2]: s = slightly, v = very, x =extremely; Boundary[3]: s= smooth.

Table 2: Cont.

Landform	P No.	Elevation m, asl	Depth cm	Color		Structure[1]	Consistence[2]		Boundary[3]
				Dry	Moist		Dry	Moist	
Decantation basin	13	+17	0-30	10YR 5/2	4/2	3 m bk	v hard	friable	gradual s
			30-60	10YR 4/2	3/3	3 m bk	x hard	friable	diffuse
			60-90	10YR 4/2	3/3	3 m bk	v hard	friable	diffuse
			90-120	10YR 4/2	3/3	3 m bk	v hard	friable	diffuse
			120-150	10YR 4/2	3/3	3 m bk	v hard	friable	-
Over flow basin	14	+23	0-30	10YR 4/3	3/3	3 m bk	v hard	friable	diffuse
			30-60	10YR 4/3	3/3	3 m bk	x hard	v friable	diffuse
			60-90	10YR 4/3	3/3	3 m bk	v hard	friable	diffuse
			90-120	10YR 4/3	3/3	3 m bk	v hard	friable	diffuse
			120-140	10YR 4/3	3/3	3 m bk	v hard	friable	-
	15	+26	0-30	10YR 4/2	3/3	2 m, f sbk to gr	s hard	v friable	diffuse
			30-60	10YR 4/2	3/3	2 m, f bk	s hard	firm	diffuse
			60-90	10YR 4/2	3/2	2 m, f bk	s hard	firm	diffuse
			90-120	10YR 4/2	3/3	2 m, f bk	m hard	firm	diffuse
			120-150	10YR 4/2	3/3	2 m, f bk	m hard	firm	-
Meandering belt	16	+ 22	0-30	10YR 5/3	4/3	2 m, f sbk to gr	hard	v friable	clear
			30-66	10YR 5/3	4/4	2 m, f sbk	s hard	v friable	gradual s
			66-110	10YR 5/3	4/3	1 m g to s g	soft	loose	diffuse
			110-150	10YR 5/4	4/4	1 f sbk to s g	soft	loose	diffuse
	17	+ 27	0-30	10YR 5/3	4/3	2 m, f sbk	hard	firm	diffuse
			30-60	10YR 5/3	4/3	2 m, f sbk	hard	firm	gradual s
			60-90	10YR 5/4	3/4	1 m, f sbk	s hard	v friable	gradual s
			90-120	10YR 6/4	3/4	1 m, f sbk	s hard	v friable	diffuse
			120-150	10YR 5/2	4/3	1 m,f sbk	s hard	v friable	-
	18	+22	0-30	10YR 5/3	3/3	2 m, f sbk	s hard	v friable	clear
			30-60	10YR 7/4	5/4	sg	loose	loose	diffuse
			60-90	10YR 7/4	5/4	sg	loose	loose	diffuse
			90-120	10YR 7/4	5/4	sg	loose	loose	diffuse
			120-150	10YR 7/4	5/4	sg	loose	loose	-
Levee	19	+19	0-30	10YR 5/3	3/3	2 m, f sbk	S hard	v friable	clear
			30-60	10YR 6/3	3/3	2 m, f sbk	S hard	v friable	diffuse
			60-90	10YR 6/3	3/3	2 m, f bk	S hard	v friable	diffuse
			90-120	10YR 6/3	3/3	2 m, f sbk	hard	friable	diffuse
			120-150	10YR 6/3	3/3	2 m, f sbk	hard	v friable	-
	20	+24	0-30	10YR 4/3	3/3	3 m, f bk	x hard	firm	diffuse
			30-60	10YR 4/2	3/3	3 m, f bk	x hard	firm	gradual s
			60-90	10YR 5/4	4/3	3 m, f bk	x hard	firm	diffuse
			90-120	10YR 5/3	3/3	3 m, f bk	x hard	firm	-

Abbreviations: Structure[1]: 1=weak, 2 =moderate, v = very, f = fine, m = medium, co=coarse, gr = granular, sbk = sub angular blocky, sg= single grains; Consistence[2]: s = slightly, v = very, x =extremely; Boundary[3]: s= smooth.

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

Landform	Profile No	Depth cm	Particle size distribution %			Texture class	pH 1:2.5	EC dSm^{-1}	CEC meq/100 g soil	ESP	$CaCO_3$ %	Gypsum %	OM %
			Sand	Silt	Clay								
High Terraces	1	**0-30**	26.60	37.5	35.90	Clay L	7.78	2.20	27.50	13.30	5.20	0.11	0.41
		30-60	25.90	38.10	36.00	Clay L	7.74	2.20	24.10	12.90	4.70	0.16	0.12
		60-90	25.11	38.10	38.80	Clay L	7.77	2.30	23.60	12.50	4.30	0.16	0.09
		90-120	24.40	38.80	36.80	Clay L	7.50	2.40	23.40	11.60	2.60	0.18	0.01
		120-150	24.10	38.20	37.70	Clay L	7.65	2.50	24.65	12.58	4.20	0.15	0.06
		W.P.M	**24.82**	**38.14**	**37.04**	**Clay L**	**7.69**	**2.32**	**24.65**	**12.57**	**4.20**	**0.15**	**0.13**
	2	**0-40**	23.60	38.60	37.80	Clay L	7.78	1.00	20.90	10.40	3.90	0.09	0.51
		40-60	55.90	25.30	18.80	Sandy L	7.79	2.40	11.60	7.85	11.5	0.15	0.28
		60-90	21.10	37.20	41.70	Clay	7.84	2.00	33.20	12.50	4.10	0.12	0.56
		90-120	21.90	37.20	40.90	Clay	7.40	2.40	32.90	11.10	4.20	0.12	0.21
		120-150	23.10	36.60	40.34	Clay	7.81	2.60	32.60	10.70	3.50	0.15	0.16
		W.P.M	26.97	**35.86**	**37.17**	**Clay L**	**7.72**	**1.99**	**26.24**	**10.51**	**5.44**	**0.13**	**0.34**
	3	**0-30**	21.30	37.20	41.50	Clay	7.70	3.00	28.50	12.00	5.10	0.12	0.53
		30-60	21.50	37.00	42.50	Clay	7.74	3.00	28.70	12.90	4.60	0.12	0.46
		60-90	21.70	37.00	42.30	Clay	7.79	2.90	31.20	13.50	4.20	0.11	0.46
		90-120	20.60	37.00	42.50	Clay	7.75	2.90	29.80	11.70	5.40	0.13	0.25
		120-140	20.60	36.90	42.50	Clay	7.75	2.95	29.80	11.60	5.30	0.13	0.25
		W.P.M	**21.14**	**37.02**	**42.04**	**Clay**	**7.75**	**2.95**	**29.06**	**12.34**	**4.92**	**0.12**	**0.39**
Medium Terraces	4	**0-30**	24.10	38.40	37.50	Clay L	7.76	2.50	28.30	11.60	4.30	0.13	0.36
		30-60	24.60	38.20	37.20	Clay L	7.70	2.50	9.18	11.30	4.30	0.13	0.21
		60-90	26.00	38.20	35.80	Clay L	7.70	2.30	8.50	7.50	4.90	0.11	0.11
		90-120	26.60	37.50	35.90	Clay L	7.78	2.20	27.50	13.30	5.20	0.11	0.05
		W.P.M	**25.33**	**38.08**	**36.60**	**Clay L**	**7.74**	**2.38**	**18.37**	**10.93**	**4.68**	**0.12**	**0.18**
	5	**0-30**	27.60	36.80	35.60	Clay L	7.82	2.00	27.50	11.60	4.40	0.08	0.24
		30-60	30.10	35.60	34.50	Clay L	7.79	2.20	25.60	12.50	4.60	0.09	0.35
		60-90	30.60	34.10	35.30	Clay L	7.00	2.30	24.20	12.90	4.70	0.12	0.07
		90-120	36.60	33.00	30.30	Clay L	7.81	2.40	23.50	13.00	5.20	0.13	0.04
		120-150	37.40	32.80	29.80	Clay L	7.90	2.60	22.50	12.80	5.10	0.15	0.02
		W.P.M	**32.44**	**34.46**	**33.10**	**Clay L**	**7.66**	**2.30**	**24.66**	**12.56**	**4.80**	**0.11**	**0.14**
	6	**0-30**	19.40	39.70	40.90	Clay	7.83	2.30	34.80	10.19	4.70	0.11	0.35
		30-60	19.80	38.20	42.00	Clay	7.81	2.50	32.5	11.60	3.90	0.13	0.22
		60-90	21.20	36.80	42.00	Clay	7.81	1.80	35.10	13.00	3.60	0.14	0.14
		90-120	21.80	36.50	41.70	Clay	7.82	2.90	32.40	12.50	3.50	0.12	0.11
		120-150	22.00	35.90	42.10	Clay	7.85	2.90	32.20	12.55	3.45	0.12	0.10
		W.P.M	**20.84**	**37.42**	**41.74**	**Clay**	**7.82**	**2.48**	**33.40**	**11.97**	**3.83**	**0.12**	**0.18**
	7	**0-30**	21.10	36.80	42.10	Clay	7.68	2.91	30.60	11.40	4.80	0.11	0.53
		30-60	21.20	36.70	42.10	Clay	7.72	2.50	30.40	9.60	4.50	0.14	0.21
		60-90	21.50	36.90	41.60	Clay	7.84	2.50	30.40	9.90	4.50	0.16	0.17
		90-120	21.30	37.50	41.20	Clay	7.90	2.00	30.50	10.30	4.30	0.17	0.08
		W.P.M	**21.28**	**36.98**	**41.75**	**Clay**	**7.79**	**2.48**	**30.48**	**10.30**	**4.53**	**0.15**	**0.25**
Low Terraces	8	**0-30**	20.90	36.20	42.90	Clay	7.74	1.00	28.50	12.00	4.40	0.11	0.46
		30-60	21.00	36.20	42.80	Clay	7.74	1.20	9.60	8.20	4.90	0.12	0.21
		60-90	21.50	36.40	42.10	Clay	7.69	1.90	7.40	5.40	5.00	0.14	0.09
		90-120	22.00	36.50	41.50	Clay	7.68	2.50	12.40	9.80	5.30	0.14	0.08
		W.P.M	**21.35**	**36.33**	**42.33**	**Clay**	**7.71**	**1.65**	**14.48**	**8.85**	**4.90**	**0.13**	**0.21**
	9	**0-30**	22.20	37.40	40.40	Clay	7.74	2.10	30.60	12.80	4.50	0.90	0.31
		30-60	24.00	37.20	38.80	Clay L	7.76	2.20	22.60	10.20	4.20	0.16	0.28
		60-90	25.20	38.50	36.30	Clay L	7.78	2.20	28.60	13.40	4.20	0.12	0.28
		90-120	20.40	37.60	42.00	Clay	7.82	2.50	29.20	12.30	3.50	0.13	0.12
		120-150	20.90	37.80	41.30	Clay	7.73	2.90	31.00	10.60	3.00	0.15	0.10
		W.P.M	**22.54**	**37.70**	**39.76**	Clay L	**7.77**	**2.38**	**28.40**	**11.86**	**3.88**	**0.29**	**0.22**
	10	**0-20**	21.00	37.00	42.40	Clay	7.10	2.80	28.9	11.20	4.10	0.11	0.51
		20-50	21.40	36.90	41.70	Clay	7.50	2.86	28.70	11.60	3.70	0.13	0.23
		50-80	21.60	36.90	41.50	Clay	7.71	2.83	29.30	10.90	3.20	0.13	0.12
		80-120	21.90	36.80	41.30	Clay	7.73	2.79	29.70	10.50	4.50	0.06	0.09
		120-150	22.20	36.60	41.30	Clay	7.82	2.70	29.50	10.70	5.00	0.09	0.01
		W.P.M	**21.62**	**36.84**	**41.64**	**Clay**	**7.72**	**1.99**	**29.22**	**10.98**	**4.10**	**0.10**	**0.19**

Abbreviations: Texture*: L=loamy, S= sandy,

Table 3: Cont.

Landform	Profile No	Depth cm	Particle size distribution %			Texture class	pH 1:2.5	EC dSm^{-1}	CEC meq/100 g soil	ESP	$CaCO_3$ %	Gypsum %	OM %
			Sand	Silt	Clay								
Depression	11	**0-30**	27.60	36.80	35.60	Clay L	7.97	0.40	34.50	13.13	3.63	0.14	2.44
		30-60	29.40	36.70	33.90	Clay L	7.97	0.51	31.50	13.40	1.98	0.18	1.65
		60-90	29.50	36.10	34.40	Clay L	8.15	0.61	27.50	14.60	1.31	0.12	0.71
		90-120	30.70	35.10	34.20	Clay L	8.14	0.50	23.20	14.93	1.39	0.16	0.68
		120-150	32.20	32.60	35.20	Clay L	8.25	0.57	20.20	16.10	0.73	0.16	0.50
		W.P.M	**29.88**	**35.46**	**34.66**	**Clay L**	**8.10**	**0.54**	**27.38**	**14.43**	**1.81**	**0.15**	**1.20**
	12	**0-30**	21.60	33.60	44.80	Clay L	7.75	1.80	25.80	13.40	8.50	0.19	0.22
		40-60	44.10	27.40	28.50	Clay L	7.73	1.70	18.96	8.60	8.80	0.21	0.25
		60-90	43.80	27.50	28.70	Clay L	7.75	1.75	19.22	8.25	9.30	0.23	0.12
		90-120	46.00	27.60	26.40	S Clay L	7.79	1.90	23.60	12.60	9.40	0.23	0.09
		W.P.M	**38.88**	**29.03**	**32.10**	**Clay L**	**7.76**	**1.79**	**21.90**	**10.71**	**9.00**	**0.22**	**0.17**
Decantation basin	13	**0-30**	21.20	32.40	46.40	Clay	7.80	2.80	28.60	9.50	4.20	0.13	0.35
		30-60	21.80	32.60	45.60	Clay	7.80	2.80	12.80	7.30	4.60	0.09	0.29
		60-90	22.60	34.10	43.30	Clay	7.79	2.50	9.40	7.40	4.60	0.08	0.37
		90-120	21.50	36.00	42.50	Clay	7.78	2.30	6.90	6.50	4.90	0.08	0.40
		120-150	21.20	36.50	42.30	Clay	7.74	2.20	6.90	6.50	5.00	0.08	0.49
		W.P.M	**21.66**	**34.32**	**44.02**	**Clay**	**7.78**	**2.52**	**12.92**	**7.44**	**4.66**	**0.09**	**0.38**
Over flow basin	14	**0-30**	22.30	37.10	40.60	Clay	7.78	2.50	32.40	13.20	4.90	0.12	0.41
		30-60	21.70	37.00	41.30	Clay	7.74	2.50	22.50	13.40	4.70	0.09	0.26
		60-90	22.40	37.70	39.90	Clay L	7.80	2.50	8.50	12.90	5.20	0.11	0.12
		90-120	19.50	38.00	42.50	Clay	7.80	2.50	5.40	12.40	5.00	0.15	0.10
		120-140	19.60	39.50	40.90	Clay	7.81	2.40	32.50	11.60	5.30	0.15	0.10
		W.P.M	**22.61**	**40.56**	**43.97**	**Clay L**	**7.78**	**2.49**	**21.71**	**12.61**	**5.38**	**0.13**	**0.21**
	15	**0-30**	23.20	38.20	36.30	Clay L	7.77	2.30	22.50	13.00	3.80	0.12	0.25
		30-60	23.70	37.60	38.70	Clay L	7.75	2.40	9.50	11.20	4.60	0.11	0.16
		60-90	24.30	36.20	39.50	Clay L	7.78	2.40	8.90	7.50	4.20	0.09	0.11
		90-120	24.90	36.10	39.00	Clay L	7.70	2.40	8.40	6.20	4.80	0.09	0.09
		120-150	25.50	36.10	38.60	Clay L	7.79	2.40	6.90	5.20	5.00	0.09	0.01
		W.P.M	**24.32**	**36.24**	**38.42**	**Clay L**	**7.76**	**2.38**	**11.24**	**8.62**	**4.48**	**0.10**	**0.12**
Meandering belt	16	**0-30**	25.30	36.10	38.60	Clay L	7.75	2.51	27.60	12.20	5.00	0.09	0.37
		30-66	34.00	33.80	32.20	Clay L	7.76	1.80	26.40	10.60	3.60	0.13	0.35
		66-110	36.90	35.20	27.90	Clay L	7.73	1.80	7.60	9.90	5.30	0.13	0.10
		110-150	86.80	10.40	3.20	L Sand	7.75	1.90	6.20	9.70	5.80	0.16	0.09
		W.P.M	**47.19**	**28.43**	**24.49**	**Loam**	**7.75**	**1.97**	**15.74**	**10.17**	**4.97**	**0.13**	**0.21**
	17	**0-30**	23.00	34.40	42.60	Clay	7.74	2.20	29.40	10.60	4.90	0.06	0.31
		30-60	22.50	37.80	39.70	Clay L	7.7	2.20	18.90	8.90	4.70	0.08	0.19
		60-90	26.30	35.60	38.10	Clay L	7.78	2.00	18.40	8.20	5.20	0.13	0.19
		90-120	48.60	25.80	25.60	S Clay L	7.81	2.00	18.30	8.40	4.30	0.13	0.18
		120-150	48.20	26.50	25.30	S Clay L	7.73	1.10	19.50	9.60	5.60	0.15	0.10
		W.P.M	**33.72**	**32.02**	**34.26**	**Clay L**	**7.76**	**1.90**	**20.90**	**9.14**	**4.94**	**0.11**	**0.19**
	18	**0-30**	23.00	39.40	37.60	Clay L	7.81	1.40	23.60	12.60	4.70	0.11	0.45
		30-60	87.90	9.50	2.60	Sand	7.79	0.90	5.30	2.90	3.80	0.17	0.13
		60-90	88.60	8.90	2.50	Sand	7.73	0.90	5.70	2.40	3.10	0.09	0.10
		90-120	88.80	8.90	2.30	Sand	7.75	0.95	5.30	2.40	3.10	0.12	0.09
		120-150	88.50	8.70	2.80	Sand	7.75	1.00	5.50	2.50	3.20	0.15	0.03
		W.P.M	**75.36**	**34.26**	**9.56**	**S loam**	**7.77**	**1.03**	**9.08**	**4.56**	**3.58**	**0.13**	**0.16**
Levee	19	**0-30**	39.50	36.10	24.40	Clay L	7.80	2.20	25.60	10.00	6.20	0.13	0.46
		30-60	37.70	36.20	26.10	Loam	7.80	2.00	18.20	6.30	6.10	0.13	0.35
		60-90	34.20	39.20	26.60	Loam	7.80	2.00	20.40	5.90	5.30	0.12	0.21
		90-120	31.40	34.00	34.60	Clay L	7.80	2.00	22.10	5.99	5.10	0.14	0.18
		120-150	32.10	34.10	33.80	Clay L	7.79	2.00	22.80	10.80	5.10	0.11	0.06
		W.P.M	**34.98**	**35.92**	**29.10**	Clay L	**7.80**	**2.04**	**21.82**	**7.80**	**5.56**	**0.13**	**0.25**
	20	**0-20**	22.90	36.50	40.60	Clay	7.84	2.10	33.40	10.20	4.20	0.12	0.48
		20-50	23.40	36.90	39.70	Clay L	7.80	2.10	33.50	8.60	4.10	0.12	0.23
		50-80	22.40	37.70	39.90	Clay L	7.79	2.20	34.10	6.30	3.50	0.16	0.11
		80-120	20.40	38.30	41.30	Clay	7.79	2.00	34.50	10.45	3.80	0.14	0.06
		W.P.M	**22.28**	**37.35**	**40.38**	**Clay**	**7.16**	**1.93**	**33.88**	**8.89**	**3.90**	**0.14**	**0.22**

Abbreviations: Texture*: L=loamy, S= sandy,

Rating scale:

The method of Bilzi and Ciolkosz (1977) modified by Zayed, *et al*. (2022) for the morphological rating scale can be used to compare adjacent horizons to give a comparison of the relative distinctness of horizons (RHD). Furthermore, it can be used to compare horizons in the solum to the C horizon to give a relative profile development (RPD) evaluation. The rating scales (RHD and RPD) presented in Tables (4 and 5) showed mostly relatively low to moderate values indicating a slight distinctness between horizons and weak profile development. The relative differences of values between layers mostly corresponded with color and/or structure could be mainly attributed to the stratification and depositional pattern of soil materials more than development.

Soil Classification:

The examination and analytical properties of the studied soils concluded that these soils are recent and immature without any diagnostic horizons. There are no evidence of pedogenic processes. The faint imprint changes are attributed to the recent pedological accumulation of particles transported by Nile water. Therefore, these soils could be affiliated to order Entisols up to the sub-great group level according to the bases outlined by Soil Survey Staff (2014) as presented in Table (6). The characteristics of the studied soils are allowed to classify them up to sub-great group level into Typic Torriorthents, Vertic Torriorthents and Typic Torripsamments. Classification of the studied soils and their maps are illustrated in Table (6) and Fig (3).

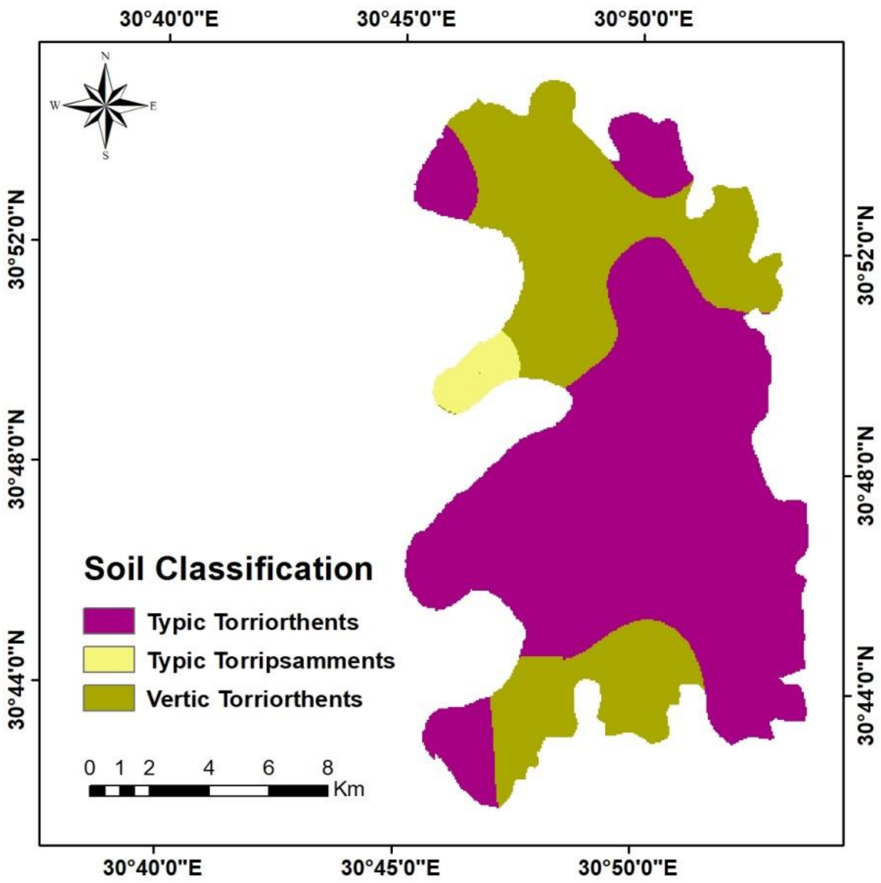

Fig (3): Soil classification map of the studied area.

Table 4: Relative horizon distinctness (RHD) ratings of the studied profiles.

Landform	Profile No	Transition	Texture	Structure	Color		Consistence		Boundary	EC	pH	Gypsum	$CaCO_3$	RHD	Average of RHD	Average of RHD
					Dry	Moist	Dry	Moist								
High Terraces	1	1st/2nd	0	0	0	0	3	2	0	0	0	0	0	5	2.5	3.3
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	0	0	0	3	2	0	0	0	0	0	5		
	2	1st/2nd	2	5	1	1	2	1	0	1	0	0	1	14	7.25	
		2nd/3rd	3	4	0	0	4	1	2	0	0	0	1	13		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	2	0	0	0	0	0	0	0	0	0	2		
	3	1st/2nd	0	0	0	0	0	1	0	0	0	0	0	1	0.25	
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
Medium Terraces	4	1st/2nd	0	0	0	1	0	2	0	0	0	0	0	3	1	2.13
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
	5	1st/2nd	0	0	0	0	4	0	0	0	0	0	0	4	3.25	
		2nd/3rd	0	0	1	1	2	1	0	0	1	0	0	6		
		3rd/4th	0	0	0	0	0	0	0	0	1	0	0	1		
		4th/5th	0	0	0	0	1	0	0	0	1	0	0	2		
	6	1st/2nd	0	0	1	1	0	0	0	0	0	0	0	2	1.0	
		2nd/3rd	0	0	0	0	0	0	0	1	0	0	0	1		
		3rd/4th	0	0	0	0	0	0	0	1	0	0	0	1		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
	7	1st/2nd	0	0	0	0	1	1	1	0	0	0	0	3	3.3	
		2nd/3rd	0	0	0	0	0	0	1	0	0	0	0	1		
		3rd/4th	0	0	2	1	2	0	1	0	0	0	0	6		
Low Terraces	8	1st/2nd	0	2	0	0	0	0	0	0	0	0	0	2	1.6	1.28
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	1	1	0	1	0	0	0	3		
	9	1st/2nd	1	0	0	0	0	0	1	0	0	0	0	2	2	
		2nd/3rd	0	2	1	1	0	0	1	0	0	0	0	5		
		3rd/4th	1	0	0	0	0	0	0	0	0	0	0	1		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
	10	1st/2nd	0	0	0	0	0	0	0	0	1	0	0	1	0.25	
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
Depression	11	1st/2nd	0	0	0	0	0	0	0	0	0	0	1	1	1.25	2.12
		2nd/3rd	0	1	2	0	0	0	1	0	0	0	0	4		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
	12	1st/2nd	0	0	2	0	0	2	2	0	0	0	0	6	3	
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	1	0	0	0	1	1	0	0	0	0	0	3		

Table 4: Cont.

Landform	Profile No	Transition	Texture	Structure	Color		Consistence		Boundary	EC	pH	Gypsum	$CaCO_3$	RHD	Average of RHD	Average of RHD
					Dry	Moist	Dry	Moist								
Decantation basin	13	1st/2nd	0	0	1	2	1	0	1	0	0	0	0	5	1.5	1.5
		2nd/3rd	0	0	0	0	1	0	0	0	0	0	0	1		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
Overflow basin	14	1st/2nd	0	0	0	0	1	1	0	0	0	0	0	2	1.5	1.5
		2nd/3rd	1	0	0	0	1	1	0	0	0	0	0	3		
		3rd/4th	1	0	0	0	0	0	0	0	0	0	0	1		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
	15	1st/2nd	0	2	0	0	0	2	0	0	0	0	0	4	1.5	
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	1	0	0	0	0	0	0	1		
		4th/5th	0	0	0	0	1	0	0	0	0	0	0	1		
Meandering belt	16	1st/2nd	0	2	0	1	0	0	1	1	0	0	0	5	6.3	5.6
		2nd/3rd	0	2	0	1	2	1	1	0	0	0	0	7		
		3rd/4th	1	2	1	1	2	0	0	0	0	0	0	7		
	17	1st/2nd	0	0	0	0	0	0	1	0	0	0	0	1	4.5	
		2nd/3rd	0	1	1	2	1	2	0	0	0	0	0	7		
		3rd/4th	2	0	1	0	0	0	1	0	0	0	0	4		
		4th/5th	0	0	3	2	0	0	0	1	0	0	0	6		
	18	1st/2nd	4	10	3	3	2	1	2	0	0	0	0	25	6.25	
		2nd/3rd	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd/4th	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/5th	0	0	0	0	0	0	0	0	0	0	0	0		
Levee	19	1st/2nd	1	0	1	0	1	0	2	0	0	0	0	5	2.5	3.08
		2nd/3rd	0	0	0	0	1	0	0	0	0	0	0	1		
		3rd/4th	1	0	0	0	1	1	0	0	0	0	0	3		
		4th/5th	0	0	0	0	0	1	0	0	0	0	0	1		
	20	1st/2nd	1	0	1	0	0	0	1	0	0	0	0	3	3.6	
		2nd/3rd	0	0	3	1	0	0	1	0	0	0	0	5		
		3rd/4th	1	0	1	1	0	0	0	0	0	0	0	5		

Table 5: Relative Profile Development (RPD) ratings of the studied profiles.

Landform	Profile No	Transition	Texture	Structure	Color		Consistence		Boundary	EC	pH	Gypsum	CaCO3	RPD	Average of RPD profile	Average of RPD unit
					Dry	Moist	Dry	Moist								
High Terraces	1	1st/Last	0	0	0	0	0	0	0	0	0	0	0	0	3.75	3.8
		2nd /Last	0	0	0	0	3	2	0	0	0	0	0	5		
		3rd /Last	0	0	0	0	3	2	0	0	0	0	0	5		
		4th/Last	0	0	0	0	3	2	0	0	0	0	0	5		
	2	1st/Last	1	1	0	0	2	0	2	1	0	0	0	7	7.5	
		2nd /Last	3	6	1	1	4	1	2	0	0	0	1	19		
		3rd /Last	0	2	0	0	0	0	0	0	0	0	0	2		
		4th/Last	0	2	0	0	0	0	0	0	0	0	0	2		
	3	1st /Last	0	0	0	0	0	1	0	0	0	0	0	1	0.25	
		2nd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/Last	0	0	0	0	0	0	0	0	0	0	0	0		
Medium Terraces	4	1st/Last	0	0	1	1	0	2	0	0	0	0	0	4	1.3	2.7
		2nd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
	5	1st /Last	0	0	1	1	1	1	0	0	1	0	0	5	4.25	
		2nd /Last	0	0	1	1	3	1	0	0	1	0	0	7		
		3rd /Last	0	0	0	0	1	0	0	0	2	0	0	3		
		4rd/Last	0	0	0	0	1	0	0	0	1	0	0	2		
	6	1st /Last	0	0	1	1	0	0	0	0	0	0	0	2	0.75	
		2nd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd /Last	0	0	0	0	0	0	0	1	0	0	0	1		
		4rd/Last	0	0	0	0	0	0	0	0	0	0	0	0		
	7	1st/Last	0	0	1	1	1	1	0	0	0	0	0	4	4.6	
		2nd /Last	0	0	1	1	2	0	1	0	0	0	0	5		
		3rd /Last	0	0	1	1	2	0	1	0	0	0	0	5		
Low Terraces	8	1st/Last	0	2	0	0	1	1	0	1	0	0	0	5	3.6	2.28
		2nd /Last	0	0	0	0	1	1	0	1	0	0	0	3		
		3rd /Last	0	0	0	0	1	1	0	1	0	0	0	3		
	9	1st /Last	0	2	1	1	0	0	1	0	0	0	0	5	3	
		2nd /Last	1	2	1	1	0	0	1	0	0	0	0	6		
		3rd /Last	1	0	0	0	0	0	0	0	0	0	0	1		
		4rd/Last	0	0	0	0	0	0	0	0	0	0	0	0		
	10	1st /Last	0	0	0	0	0	0	0	0	1	0	0	1	0.25	
		2nd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		4rd/Last	0	0	0	0	0	0	0	0	0	0	0	0		
Depression	11	1st /Last	0	0	2	2	0	0	0	0	0	0	1	5	2.5	3.05
		2nd /Last	0	0	2	2	0	0	0	0	0	0	0	4		
		3rd /Last	0	0	0	0	0	0	1	0	0	0	0	1		
		4rd/Last	0	0	0	0	0	0	0	0	0	0	0	0		
	12	1st/Last	1	0	0	0	1	1	2	0	0	0	0	5	3.6	
		2nd /Last	1	0	0	0	1	1	0	0	0	0	0	3		
		3rd /Last	1	0	0	0	1	1	0	0	0	0	0	3		

Table 5: Cont.

Landform	Profile No	Transition	Texture	Structure	Color		Consistence		Boundary	EC	pH	Gypsum	$CaCO_3$	RPD	Average of RPD profile	Average of RPD unit
					Dry	Moist	Dry	Moist								
Decantation basin	13	1st /Last	0	0	1	2	0	0	1	0	0	0	0	4	1.25	1.25
		2nd /Last	0	0	0	0	1	0	0	0	0	0	0	1		
		3rd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/Last	0	0	0	0	0	0	0	0	0	0	0	0		
Over flow basin	14	1st /Last	0	0	0	0	0	0	0	0	0	0	0	0	0.75	1.25
		2nd /Last	0	0	0	0	1	1	0	0	0	0	0	2		
		3rd /Last	1	0	0	0	0	0	0	0	0	0	0	1		
		4th/Last	0	0	0	0	0	0	0	0	0	0	0	0		
	15	1st /Last	0	2	0	0	1	2	0	0	0	0	0	5	1.75	
		2nd /Last	0	0	0	0	1	0	0	0	0	0	0	1		
		3rd /Last	0	0	0	0	1	0	0	0	0	0	0	1		
		4th/Last	0	0	0	0	0	0	0	0	0	0	0	0		
Meandering belt	16	1st /Last	1	6	1	1	0	1	2	1	0	0	0	13	9.3	7.6
		2nd /Last	1	4	1	0	0	1	1	0	0	0	0	8		
		3rd /Last	1	2	1	1	2	0	0	0	0	0	0	7		
	17	1st /Last	2	1	1	0	1	2	0	1	0	0	0	8	7.75	
		2nd /Last	2	1	1	0	1	2	1	1	0	0	0	9		
		3rd /Last	2	0	2	2	0	0	1	1	0	0	0	8		
		4th/Last	0	0	3	2	0	0	0	1	0	0	0	6		
	18	1st /Last	4	10	3	2	2	1	2	0	0	0	0	24	6	
		2nd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		3rd /Last	0	0	0	0	0	0	0	0	0	0	0	0		
		4th/Last	0	0	0	0	0	0	0	0	0	0	0	0		
Levee	19	1st /Last	0	0	1	0	1	0	2	0	0	0	0	4	2.5	2.4
		2nd /Last	1	0	0	0	1	0	0	0	0	0	0	2		
		3rd /Last	1	0	0	0	1	0	0	0	0	0	0	2		
		4th/Last	1	0	0	0	0	1	0	0	0	0	0	1		
	20	1st /Last	0	0	1	0	0	0	0	0	0	0	0	1	2.3	
		2nd/Last	1	0	1	0	0	0	1	0	0	0	0	3		
		3rd/Last	1	0	1	1	0	0	0	0	0	0	0	3		

Table 6: Classification of the studied soil profiles under order Entisols.

Sub-order	Great group	Sub-great group	Profile No.	Area		
				Km^2	Feddan	%
Orthents	Torriorthents	Typic Torriorthents	1, 2, 4, 5, 9, 11, 12, 14, 15,16, 17, 19, 20	70.413	16737.51	33.70
		Vertic Torriorthents	3, 6, 7, 8, 10, 13	133.73	31840.92	64.11
Psamments	Torripsamments	Typic Torripsamments	18	4.44	1084.18	2.19
Total				208.58	49662.61	100.0

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.

Bilzi, A. F. and Ciolkosz, E. J. (1977). A field morphology rating scale for evaluating pedological development. Soil Sci. 124(1): 45-48.

Dehaan, R, L. and Taylor, G. R. (2003). Image-derived spectral endmembers as indicators of salinization, International Journal of Remote Sensing, 24(4): 775-794.

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

El Banna, M. and Frihy, O. (2009). Human-Induced Changes in the Geomorphology of the Northeastern Coast of the Nile Delta, Egypt. Geomorphology, 107: 72-78.

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

Mikhailova, M.V. (2001). Hydrological regime of the Nile delta and dynamics of its coastline. Water Resources, 28(5): 477–490.

Munsell Color (1992). Munsell Color Charts, Munsell Color Company, Baltimore, Maryland.

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

Zayed, A.A.; Ismail, M.I.; El-Tapey, H.M.; AL-Toukhy, A.A. and Yacoub, R.K. (2022). Rating Scale of Pedological Development in Aridic Moisture Regime of Some Western Nile Delta Soils, Egypt. Egypt. J. Soil Sci. 62 (4): 349 – 359.

Zeydan, B.A. (2005). The Nile Delta in a Global Vision. In: Proceedings of the Ninth International Water Technology Conference, IWTC9 2005, Sharm El-Sheikh, Egypt, 31–40.

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

خصائص وتقسيم بعض أراضي غرب محافظة الغربية، وسط دلتا نيل مصر، باستخدام الاستشعار عن بعد ونظم المعلومات الجغرافية

أسماء مختار متولي سليمان[١]، عبد العزيز بلال عبد المنطلب[٢]، محمد سمير عراقي عميرة[١]، هاجر عبد الفتاح حسن[١]

[١] قسم علوم الأراضى – كلية الزراعة – جامعة المنوفية

[٢] الهيئة الوقمية للاستشعار من البعد وعلوم الفضاء.

الملخص العربي

تم تنفيذ العمل الحالي في عام ٢٠٢٣ بهدف دراسة الخصائص الجيومورفولوجية والبيدولوجية وكذلك تصنيف أراضي منطقة كفر الزيات في محافظة الغربية، مصر، وتم الاستعانة بتقنيات الاستشعار عن بعد (RS) ونظم المعلومات الجغرافية (GIS) لتنفيذ هذا العمل.

تم انتاج الخريطة الجيومورفولوجية من معالجة وتفسير صورة القمر الصناعي Sentinel 2B وكذلك نموذج الارتفاع الرقمي DEM للمنطقة، وأوضحت الخريطة أن منطقة الدراسة عبارة وحدة جيومورفولوجية رئيسية هي السهل الفيضي (Alluvial Plain) الذي يضم ثمانية أشكال أرضية هي: الشرفات العليا (التي تمثل ١٩,٩٣%)، الشرفات الوسطي (٣٠,٦٢%)، الشرفات السفلي (٢١,٣٦%)، الوادي المنخفض (٤,٨٧%)، المصب (٤,٤١%)، حوض جريان الماء (٧,٣١%)، منطقة الالتواء (٤,٢٥%)، جسر النهر (٣,٣٠%)، ولقد تم اختيار عشرون قطاعاً أرضياً لتمثل أراضي تلك الوحدات، ودرست وسجلت الملامح الطبوغرافية والمورفولوجية المميزة لأراضي المنطقة، كما تم حفر القطاعات الأرضية، ووصفت مورفولوجياً وجمعت منها عينات ممثلة للطبقات المختلفة لإجراء التحليلات المعملية لتقدير الخواص الطبيعية والكيماوية.

تتمتع المنطقة المدروسة بطبوغرافيا شبه مستوية مع تربة عميقة وجيدة الصرف، وقوام هذه الأراضي يغلب عليه الطميي إلى الرمل طيني طميي، وبناءها متوسط من النوع الكتلي، وأظهرت نتائج التحليلات المعملية أن التربة المدروسة متوسطة القلوية وغير ملحية ولا يتضح فيها تأثير للصودية، ومحتوى الكربونات الكلية والجبس فيها قليل، ومنخفضة في المادة العضوية (OM) التي تتناقص مع العمق، وترتبط السعة التبادلية الكاتيونية مع محتواها من الحبيبات الدقيقة والمادة العضوية.

يشير المقياس التصنيفي المعدل للخصائص المورفولوجية بين الطبقات وبعضها (RHD) وبين كل طبقة ومادة الأصل (تطور القطاع RPD) إلى تمييز طفيف بين الطبقات وتطور القطاع، والذي يمكن أن يعزى بشكل أساسي إلى اختلاف ظروف ونظام الترسيب أكثر من التطور.

ونظراً لأنه لم يتضح في هذه الأراضي أي آفاق تشخيصية فلقد تم تقسيمها تبعا للتقسيم الأمريكي الحديث (٢٠١٤) تحت رتبة الأراضي غير المتطورة Entisols، وصنفت تحت مجموعات: Typic Torriorthents، Vertic Torriorthents، Typic Torripsamments.

الكلمات الدالة:

الاستشعار من البعد، نظم المعلومات الجغرافية، الوحدات الجيومورفولوجية، الخصائص البيدلولوجية، المقياس التصنيفي للخصائص المورفولوجية، تقسيم الأراضي.