PRELIMINARY STUDT OF AGRICULTURE LAND USE AND QUALITY OF WATER RESOURCES IN PALEODRAINAGE DELTA, EASTERN-SOUTH AL- QATTARA DEPRESSION, EGYPT.

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ABSTRACT

The Paleodrainage Delta soils are located between longitude 27^0 $00^\backslash$ to 31^0 $00^\backslash$ East and latitude 27^0 $00^\backslash$ to 30^0 $00^\backslash$ North, covering about 44000.0 km2. This study aims to give a preliminary vision pertinent agriculture land evaluation and quality of water resources using GIS techniques, Land sat ETM images and digital elevation model (DEM).

Fifty five soil profiles were taken to represent the main physiographic units, and soil samples were performed for physical and chemical analyses. Also, water resource samples were collected from two wells and chemically analysed.

Data reveal that landscapes include five physiographic units within the countor lines of delta belts as follows:

1- Highest belt of the delta > 225 m a.s.l.
2- High belt of the delta 150 – 225 m a.s.l.
3- Medium high belt of the delta 75 – 150 m a.s.l.
4- Lower belt of the delta 0 – 75 m a.s.l.
5- Longitudinal dunes.

The studied soils could be classified into two Taxonomic orders; Entisols and Aridisols within 26 soil family levels. The surface features are mainly almost flat to gently undulating relief partly with rock outcrop. These soils are deep to moderately deep, sand to sandy loam texture locally with high gravel content or shallow depth. The lime and gypsum content were relatively high with more percentage in the medium-high and lower belt of the delta. Soil salinity varied widely from non-saline to extremely saline.

Data showed that high current suitability values were in very high belt of delta, whereas moderate potential suitability values were in some low belt of delta. While, low current and potential suitabilities were in sand dunes unit. The obtained classes could be changed to the better as potential suitability.

Data revealed that waters quality of the two wells, No. 1 and 2 are not suitable for drinking usage, however iron content is mostly above the critical limits for such use. On the other hand, waters of well No. 1 have marginally suitable class (C3-C2) for irrigation use and may cause more restrictions when

used for a long-term. While, waters of well No. 2 have highly suitable class (C1-C1) for crop irrigation without any restrictions, hence when used for a long-term.

Key Words : Paleodrainage Delta, GIS, Western Desert, Qattara Depression, Geomorphology.

Introduction

The identification of the land resources for agricultural development justifies the importance of producing a collective physiographic soil maps for building up database of land information system. The land resources may be divided into three groups: (1) very stable resources (climate, relief, geological formations), (2) moderately stable resources (soils and water, some artificial elements of the land), and (3) relatively unstable resources (vegetation and related biological features);(**Vink,1975**).

Physiographic approach can provide a good basis for explaining geomorphology through aerospace image interpretation (**Goosen, 1967**). The physiographic genesis was performed to find a land attribute illustration for a vast area, considering the parent rock and the inherited parent material, which can be traced by the paleo and recent drainage patterns as mediators between the highlands and lowlands. The availability of data sources in a digital form and increased capability of computers to handle large volumes of data have allowed to create attributes data of soils, as with soil survey. Spatial mapping usually involves the interpolation of point data across surfaces to depict condition at all positions on the land surface. Remote sensing should be used as an aid to distinguish landscape element. Qualitative models derived from modification of soil landscape models are efficient means of interpolation point data based on conceptual relationship between observation of the soil property or condition being mapped and easily observable landscape features (**Peterson** et al. 1996). Geographic Information System (GIS) is considered as organized collection of computer hardware, software, spatial and non-spatial data that can help users for the efficient capture, storage, update, manipulation, analysis and management of all geographically referenced information. Features on the map are linked to records in the database which contain a multitude of attributes and values. These components (digital map and database) serve as a storehouse of information. The map stores physical features and the database stores information about them. The result of having these two components linked is that both spatial data (map features) and attribute data can be queried and retrieved. This is important for planners, who rely on data about geographic space. Additional mathematical functions can allow statistical analysis of data, create new data and create predictive models.

The aims of this study were to using remote sensing data for identify the landforms, their soil attributes and quality of irrigation water as land resources, in a vast area that has important situation for development and introduce it to one of the agriculture extension project.

Location of study area

The study area are located between longitude 27^0 $00^\backslash$ to 31^0 $00^\backslash$ East and latitude 27^0 $00^\backslash$ to 30^0 $00^\backslash$ North, and occupies a vast region that covers about 10 482 000 fadden (44000.0 km^2), from east El-Qattara depression to west of Gabel Qatrani and west of Dyrout aligning of El-Menia and El-Fayoum provinces (Fig.1).

Geology

Issawi and Mc Cauley (1992) attributed the origin of these Paleodrainage (undulating delta apex) to the downstream parts of the Qena system, which formed by northward lateral erosion in the early Oligocene as the Red Sea Mountains rise. The eroded materials removed from the Red Sea Mountains to the northwest of El Fayoum basin depositing a delta across El Fayoum in huge quantities of deep fossiliferous Oligocene Fluvial sands and gravel. **Albritton et al. (1990)** proposed that Qattara Depression originated as a stream valley that was dismembered by Karstic processes during the late Miocene epoch, and after word it was by Fluvial processes. A major stream issuing from the Gilf Kebir highlands in the south, showed northward may have done so by route through the Qattara to an exit near the head of the Ras Alam or Rum submarine canyon offshore near Alexandria **Map (1).**

Issawi et al. (2001) stated that the part of the Paleodeltaic sediments represents the Miocene transgression reached to about 60 km south of Cairo, and its sediments make up the surface of the desert to the north of El Fayoum basin. The degradation first removed the Oligocene sands and conglomerates of Gabel Qatrani formation, and Eocene bedrock of the depression bottom. It was accomplished when the Mediterranean was desiccated the late Miocene and streams cut deep canyons toward the sea bed, and the final phase took place in the Quarternary.

Data in the Geological map of Egypt (1987) reveal that apex of delta belong to tertiary (Miocene, Oligocene and Eocene), Quaternary (Undivided Quarternary and sand dunes), while enter and pro delta belong to Eocene era only.

Climate

The climatic data of studied area (CLAC, 2010), show a very low annual precipitations or nearly absent (about 7.5 mm/y). The mean annual temperature is above 22.0°C with. Minimum temperature is recorded in January, while maximum temperature is recorded in August. According to USDA (2010) the studied area has hyperthermic temperature regime with aridic and torric soil moisture regime.

Water resources

Nubian Sandstone Aquifer System (NASA) occupying much areas of Egypt and extended to the border of westward direction into Libya, in the south and southwestward direction into Sudan and chad, **Shata(1987)**. The water resources which recorded in the studied area are demonated by El-Moghra aquifer system which have an average thickness of 300m (200 million m^3/y), and Salinity >3000 ppm, with associated aquifers such as fractured carbonate aquifers and Nubian Sandstone aquifer, **Allam et al. (2002).**

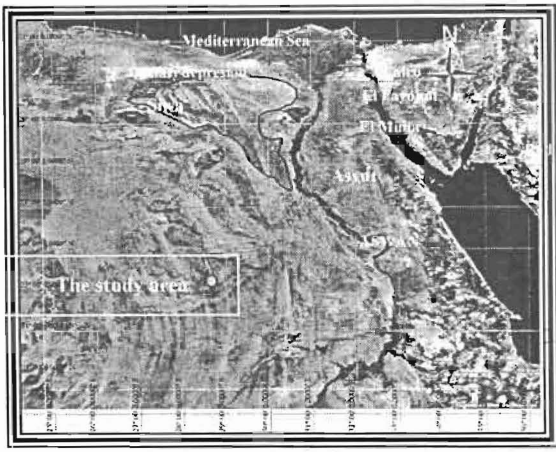
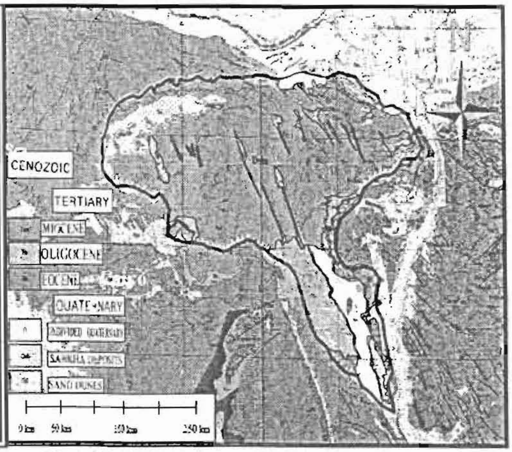


Figure 1: Location map of the study area



Map (1) THE EGYPTIAN GEOLOGLCAL SURVEYAND MINING AUTHORITY 1981.

To achieve the aforementioned target, analysis of landsat images covering the area under investigation was done to identify the different physiographic units. Also, fieldwork was performed to describe the soils developed on these physiographic units as well as to collect soil samples for laboratory analyses to recognize the soil properties, which were used as guidelines for soil classification, hence land suitability for irrigated agriculture.

GIS work

The Geographic information system (GIS) was used for analytical and data management features including data input for reprocessing and output for final maps and useful arrays of digitizing operations for provide vector or raster based modeling capabilities for overlay and buffer analysis creation. All vector layers were imported into GIS. GIS is used for design spatial modeling of the soil properties of study area .The average weight values were calculated for each property of each profile using all profile depth. Data acquired in year 2010 of landsat Enhanced Thematic Mapper (ETM) which have spatial resolution 28-30 m were used for delineation the physiographic units of the studied area. The physiographic analysis detailed by **Goosen (1967)**. Updating of the physiographic map was carried out using the American landsat 7 image (path 176 row 41, path 177 row39, path 177 row40, path 178 row 41, path 178 row 40, path 179 row 39, and path 179 row 40), Fig. 2, and map contour line Fig. 3. . The hardware which were used to carrying out the work are: PC (I7), GPS, scanner, and printers, software have been using to construct the geographic data are, Arc Gis 9.3 and Erdas Imagine 9.1.

Fieldwork and sampling

The preliminary image-interpretation map was checked in the field by different ground observation points to confirm the boundaries of the physiographic units or to revise what were shifted.

The different physiographic units were represented through 55 soil profiles and 2 water samples. The soil profiles were dug to a depth 150 cm or to lithic contact (bedrock). Soil samples were collected to represent the different morphological variations throughout the soil profile layers and were described according to the nomenclature of **FAO (2006) and the Munsell Color (2010)**. The disturbed soil samples were air-dried, crushed, sieved through a 2 mm sieve, then, the obtained fine earth samples (less than 2 mm) were kept for laboratory analysis.

Longitudes and latitudes of the studied profiles as well as their elevations were defined in the field using GPS.

Laboratory analysis

Particle size distribution was determined using the International Pipette method (**Piper, 1950**) and sodium hexametaphosphate as dispersing agent as described by **Baruah and Barthakur (1997)**. Calcium carbonate content was measured using the Collin's Calcimeter method (**Wright, 1939**). Saturation soil paste extract and soil pH in the soil water suspension of 1:2.5 were determined according to the methods described by **Jackson (1973)**.

Gypsum content, and the exchangeable sodium percentage were determined according to the methods described by **Richards (1954)**. Soils under study were classified into taxonomic units according to Soil Taxonomy System (**USDA, 1975**) and using the keys to Soil Taxonomy (**USDA, 2010**). Soils under investigation were evaluated using the parametric system for irrigated agriculture land evaluation namely "land Capability Classification" undertaken by **Sys and Verheye (1978)**, water resource samples were collected from two wells and chemically analysed. Well No.1 is located in 29° 09\ 37\\ E & 28° 43\ 23 N, having + 119 a.s.l. (above sea level), Well No.2 is located in 29° 26\ 36\\ E & 28° 33\ 47\\ N, having + 101 a.s.l. Water quality and its suitability have been compared with the standard guide line values of both drinking and irrigation water uses, issued by **Richards (1954), El-Ghandour <u>et al.</u> (1983),Ayers and Westcot**

(1985), Egyptian Ministry of Health (1995), Ministry of Environment (1999) and WHO (2008).

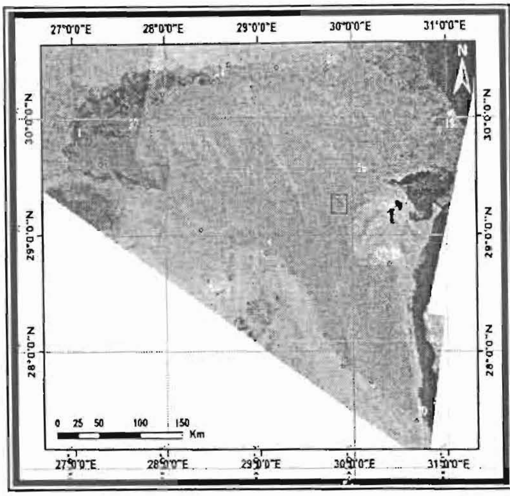


Figure 2: **Landsat TM 7 image of the studied**

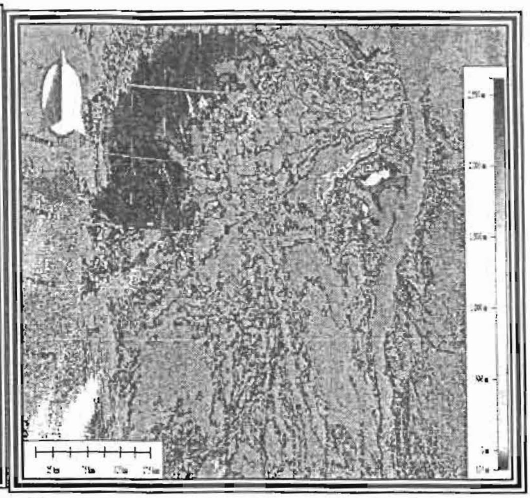


Figure 3: shows contour lines in the study area

Results and Discussion

Data cited from **Issawi and McCauley (1992)**, and **Albritton et al. (1990)**, which illustrated previously in introduction, reveal to the studied area have different parent materials and multi origin.

On the other hand, the geological map of Egypt 1981(map1), cleared that studied area belong to five geological eras, while enter and prodelta belong to one era (Eocene).

Afify (2009) concluded that the studied area is a Paleodrainage delta, and the delta consist of three units, i.e. delta apex, inter delta and prodelta but have the same parent material and precipitate in the same era.

Delta apex, enter delta and prodelta have a descending elevation, respectively while, delta recorded by 34m to 311m a.s.l. Elevation model program appear that inter delta is higher than delta apex in most area, return to Figure (3).We can concluded that the studied area have not the pattern of the delta but we can describe it as a false delta, because it have the delta form only.

Tracing the landscape genesis for very vast area, such as the studied one, begin from Gable Qatrani Formation which its elevation tends to decrease gently to reach sea

level at El-Quattara depression in its west side, which intimate that the delineated main physiographic units are :

1- Highest belt of the delta (> 225 m a.s.l.)

2- High belt of the delta (150 – 225 m a.s.l.)
3- Medium-high belt of the delta (75 – 150 m a.s.l.)
4- Lower belt of the delta (0 – 75 m a.s.l.)
5- Longitudinal dunes
a.s.l. = (above sea level)

The main physiographic units are illustrated in map (2), the morphological description of the studied soil profiles are summarized in Table (1), while physical and chemical attributes are recorded in Table (2). The delineated physiographic units are described as follows:-

1- Highest belt of the delta (> 225 m a.s.l.)

Soils of this unit are located in the central part of the study area surrounded with soils of high belt of delta and mountains. The surface features are characterized by almost flat to gently undulating relief and covered mainly by dark coloured coarse fragments as gravel. Most of the examined soil profiles are deep to moderately deep sandy to sandy loam texture mainly in subsurface reddish colour (7.5YR and 5YR). The clay content ranges of the most between 3 and 15% and the gravel content vary widely from nil to more than 50%. Soil structure is massive in slightly hard to very hard consistence by depth. The lime and gypsum content range from 2 to about 20% and from <1 to about 15%, respectively, that were observed in the field as few to common secondary accumulation. The soil reaction (pH) range from 7.6 to 8.2, that indicate moderate alkaline while soil salinity as determined by the Electrical conductivity, values (ECe) range from very slightly saline (2 to 4 dS/m) to strongly saline (16 to 32 dS/m)

By using the **Soil Taxonomy Key manual (USDA, 2010),** the examined profiles in these soils were classified to the family level and the following taxonomic units were indentified as an associations kind:

-Weakly developed soils (Entisols order):

- Sandy soils: *Typic Torriorthents,* sandy, mixed, hyperthermic.
- Gravelly loam soils: *Typic Torriorthents*, loamy-skeletal, mixed, hyperthermic.

- Soils developed under arid conditions (Aridisols order):

- Lime accumulated /gravelly loam soils:
:*Typic Haplocalcids*, loamy-skeletal, mixed, hyperthermic.
- Calcigypsy sandy or gravelly sand soils:
:*Typic Calcigypsids*, sandy, mixed, hyperthermic.
:*Typic Calcigypsids*, sandy-skeletal, mixed, hyperthermic.

And the following taxonomic units as inclusions:

- Lime accumulated sandy or gravelly sand soils:
:*Typic Haplocalcids*, sandy, mixed, hyperthermic.
:*Typic Haplocalcids*, sandy-skeletal, mixed,hyperthermic.
- Gypsiferous gravelly loamy soils:
:*Typic Haplogypsids*, loamy skeletal , mixed, hyperthermic.

Table (1) Morphological description of the studied Soil profile.

Physiographic units	Profile No.	Depth (cm)	Gravel %	Color		Structure	Consistency (Dry)	Effervescence	Secondary formation		Boundary
				dry	moist				CaSO4. 2H2O	CaCO3 %	
Highest belt of the delta > 225 m a.s.l.	8	0 - 10	0.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	m	sh	st	few	common	as
		10-55	60.0	5YR5/6	5YR4/6	m	sh	st	common	common	gs
		55-120	55.0	2.5YR5/8	2.5YR4/8	m	vh	st	few	common	
	11	0 - 20	0.0	10YR7/4 10YR4/5 10YR4/5	10YR5/6	m	s	st	Very few	few	cw
		20-110	0.0	7.5YR5/8	7.5YR5/6	m	s	mo	Very few	few	
	12	0 - 10	0.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	m	s	st	few	many	cs
		10-30	0.0	5YR5/8	5YR4/6	m	h	sl	Very few	few	aw
		30-60	10.0	7.5YR5/8	7.5YR5/6	m	h	st	common	few	gw
		60-100	0.0	7.5YR7/6	7.5YR4/6	m	vh	st	few	many	
	13	0 - 15	0.0	7.5YR6/8 10YR4/5 10YR4/5	7.5YR5/6	m	sh	st	Very few	common	aw
		15-55	40.0	5YR5/8	5YR4/4	m	sh	st	few	many	gw
		55-110	35.0	5YR5/8	5YR4/6	m	sh	st	few	common	
	14	0 - 20	15.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	m	s	mo	Very few	few	aw
		20-100	55.0	2.5YR4/8	2.5YR4/6	m	sh	st	Very few	many	
	15	0 - 20	15.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	sg	l	sl	Very few	common	as -
		20-60	25.0	5YR5/8	5YR4/6	m	sh	st	many	common	gw
		60-120	60.0	5YR5/8	5YR4/6	m	h	st	Very few	common	
	16	0 - 15	0.0	10YR6/6	10YR5/6	sg	l	st	few	few	as
		15-100	0.0	10YR6/8	10YR5/8	m	h	st	few	few	
	17	0 - 15	0.0	10YR7/6 10YR4/5 10YR4/5	10YR5/6	m	s	st	few	few	aw
		15-80	45.0	2.5YR4/8	2.5YR3/6	m	h	st	many	few	
	18	0 - 10	5.0	10YR6/8 10YR4/5 10YR4/5	10YR6/6	m	h	st	Very few	few	as
		10-35	45.0	5YR5/6	5YR4/6	m	vh	st	many	many	cw
		35-70	15.0	5YR5/8	5YR4/6	m	vh	st	many	common	
	19	0 – 50 - Rock	0.0	10YR7/6	10YR6/6	sg	l	sl	Very few	Few	- -
	20	0 - 20	15.0	7.5YR6/6 10YR4/5 10YR4/5	7,5YR5/6	m	h	st	Very few	few	aw
		20-100	35.0	7.5YR5/6	7.5YR4/6	m	h	st	few	few	

Cont.

Highest belt of the delta > 225 m a.s.l.	21	0 - 15	10.0	10YR7/6 10YR4/5 10YR4/5	10YR5/6	sg	s	st	Very few	few	cs
		15-100	45.0	10YR6/8	10YR5/8	m	sh	st	Very few	many	
	32	0 -10	0.0	10YR7/6 10YR4/5 10YR4/5	10YR5/8	m	s	sl	Very few	few	gs
		10-30	0.0	7.5YR6/6 10YR4/5 10YR4/5	7.5YR5/6	m	h	st	Very few	few	as
		30-55	60.0	7.5YR5/8	7.5YR4/6	m	sh	st	common	few	as
		55-100	20.0	7.5YR5/6	7.5YR5/8	m	h	st	Very few	common	
	33	0 - 10	5.0	10YR6/6 10YR4/5 10YR4/5	10YR5/8	m	s	mo	Very few	few	aw
		10-40	55.0	5YR5/6	5YR4/6	m	sh	st	few	many	aw
		40-90	20.0	5YR4/6	5YR4/4	bw	h	mo	Very few	common	
	34	0 - 10	0.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	m	s	sl	Very few	few	aw
		10-35	25.0	10YR8/6	10YR6/8	m	h	sl	Very few	common	cw
		35-110	15.0	10YR7/6	10YR6/8	m	sh	sl	few	few	

Table (1) Cont.

Physiographic units	Profile No.	Depth (cm)	Gravel %	Color		Structure	Consistency (Dry)	Effervescence	Secondary formation		Boundary
				dry	moist				$CaSO_4.2H_2O$	$CaCO_3$ %	
High belt of the delta 225-150 m a.s.l.	6	0 - 15	15.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	m	s	st	few	many	as
		15-60	5.0	5YR7/6	5YR5/6	m	sh	st	few	many	gs
		60-130	0.0	5YR6/6	5YR5/6	m	sh	st	few	many	
	7	0 - 10	10.0	7.5YR7/6	7.5YR5/8	m	sh	mo	few	few	as
		10-50 - Rock	40.0	5YR5/6	5YR4/6	m	sh	mo	few	few	
	9	0 - 20	70.0	5YR6/6 10YR4/5 10YR4/5	5YR5/6	m	s	st	few	few	as
		20-40	40.0	10YR7/6	10YR5/8	m	s	st	few	few	aw
		40-110	60.0	7.5YR7/6	7.5YR4/6	m	sh	st	few	few	
	10	0 -10	0.0	10YR7/6 10YR4/5 10YR4/5	10YR5/6	m	sh	st	common	few	cw
		10-130	40.0	2.5YR4/8	2.5YR3/6	m	sh	st	common	few	
	22	0 - 35	0.0	7.5YR7/8	7.5YR5/6	m	sh	st	few	few	gw
		35-100	15.0	10YR8/6 10YR4/5 10YR4/5	10YR5/8	m	sh	st	few	few	
	23	0 - 20	0.0	10YR7/6 10YR4/5 10YR4/5	10YR6/8	m	s	st	few	few	cw
		20-120	25.0	7.5YR6/5	7.5YR5/6	m	h	st	few	few	
	24	0 - 10	0.0	10YR6/6 10YR4/5 10YR4/5	10YR5/6	m	s	st	few	few	cw
		10-45	10.0	7.5YR6/6	7.5YR5/6	m	s	st	few	few	aw
		45-100	60.0	7.5YR5/6	7.5YR4/6	m	sh	st	common	few	
	25	0 - 25	10.0	10YR6/8 10YR4/5 10YR4/5	10YR5/8	m	s	st	few	many	aw
		25-120	60.0	7.5YR5/8	7.5YR4/6	m	sh	st	common	many	
	26	0 - 20	0.0	10YR7/6	10YR6/6	m	s	sl	few	few	as
		20-40 Rock	0.0	10YR7/4	10YR6/4	m	h	sl	common	few	
	27	0 - 45	0.0	10YR7/6	10YR7/6	m	s	mo	common	few	cs
		45-100	0.0	10YR7/8	10YR7/8	m	sh	mo	common	few	
	28	0 - 20	0.0	10YR6/8 10YR4/5 10YR4/5	10YR5/8	m	h	st	common	few	aw
		20-60	0.0	7.5YR6/4	7.5YR5/4	p	h	sl	few	few	
	29	0 - 10	0.0	10YR7/8	10YR6/8	sg	l	st	few	few	as
		10-35	0.0	10YR8/6 10YR4/5 10YR4/5	10YR7/6	m	sh	st	few	few	

Cont.

High belt of the delta 225-150 m a.s.l.	30	0 - 10	7.0	10YR7/6	10YR6/6	m	s	mo	few	few	aw
		10-40 - Rock	0.0	10YR8/2	10YR7/4	m	s	sl	few	few	
	31	0 - 40	0.0	10YR7/6	10YR6/6	m	s	mo	few	few	aw
		40-120	0.0	10YR6/6	10YR5/6	m	h	st	few	common	
	36	0 - 10	0.0	7.5YR7/6 10YR4/5	7.5YR6/6	bm	sh	sl	common	few	cw
		10-40	0.0	10YR8/6	10YR6/6	m	s	st	common	few	cw
		40-110	0.0	10YR7/6	10YR7/8	m	s	st	common	few	
	37	0 - 30	15.0	7.5YR6/6 10YR4/5 10YR4/5	7.5YR5/8	bm	h	st	few	few	cw
		30-120	35.0	7.5YR6/8	7.5YR5/8	m	sh	st	few	few	
	38	0 - 30	0.0	10YR6/6	10YR5/8	m	s	st	few	many	cw
		30-50	5.0	10YR6/6 10YR4/5 10YR4/5	10YR6/8	m	s	st	few	many	gw
		50-90	0.0	10YR7/6	10YR6/6	m	sh	st	few	many	

Table (1) Cont.

Physiogra-phic units	Profile No.	Depth (cm)	Gravel %	Color		Structure	Consistency (Dry)	Effervescence	Secondary formation		Boundary
				dry	moist				CaSO4. 2H2O	CaCO3 %	
Medium- High belt of the delta 75 – 150 m a.s.l.	1	0-30	40.0	10YR7/4	10YR6/8	m	s	st	many	many	gw
		30-70	25.0	10YR7/3	10YR5/8	sg	l	st	many	many	gw
		75-120	40.0	10YR8/4	10YR6/6	m	s	st	many	many	
	2	0 - 40	10.0	10YR7/6	10YR6/6	sg	l	st	few	many	aw
		40 -130	60.0	10YR6/4	10YR6/6	m	h	st	many	many	
	3	0 - 20	5.0	7.5YR6/6 10YR4/5 10YR4/5	7.5YR5/6	m	h	st	few	many	aw
		20 - 80	75.0	5YR6/8	5YR4/6	m	h	st	few	many	aw
		80-150	25.0	5YR7/6	5YR4/6	m	vh	st	many	many	
	4	0 - 25	0.0	10YR7/6 10YR4/5 10YR4/5	10YR5/8	m	h	st	few	many	aw
		25-75	70.0	5YR5/6	5YR4/6	m	h	st	few	many	cw
		75-150	0.0	5YR6/6	5YR5/6	m	h	st	few	many	
	5	0 - 20	50.0	10YR7/4	10YR5/6	m	s	st	few	many	cs
		20-85	65.0	7.5YR6/6 10YR4/5 10YR4/5	7.5YR5/6	m	s	st	few	many	aw
		85-130	50.0	7.5YR6/8	7.5YR5/6	m	s	st	few	many	
	39	0 - 50	0.0	10YR7/4	10YR6/8	m	s	mo	many	few	as
		50-120	0.0	10YR7/6 10YR4/5 10YR4/5	10YR6/6	m	l	sl	many	Very few	
	40	0 - 10	0.0	10YR7/6	10YR6/6	m	s	mo	few	few	aw
		10-50	0.0	10YR7/4 10YR4/5 10YR4/5	10YR7/6	m	sh	st	few	few	gw
		50-100	0.0	10YR7/3	10YR6/3	m	sh	sl	few	few	
	41	0 - 10	0.0	10YR7/6	10YR6/6	m	s	mo	few	few	cw
		10-100	0.0	10YR7/4 10YR4/5 10YR4/5	10YR6/4	m	s	sl	many	few	
	42	0 - 15	0.0	10YR7/6	10YR6/6	m	sh	st	Very few	common	as
		15-100	0.0	10YR7/4	10YR6/4	m	sh	st	Very few	few	
	49	0 - 10	15.0	10YR7/8 10YR4/5 10YR4/5	10YR5/8	m	s	st	many	many	as
		10-20	0.0	10YR6/8	10YR5/8	m	s	st	common	many	cs

Cont.

		20-40 40- rock	0.0	10YR7/6	10YR7/8	m	sh	st	common	many	
	50	0 - 15	0.0	10YR6/8 10YR4/5 10YR4/5	10YR5/8	bm	sh	st	few	common	as
		15-30	0.0	10YR7/6	10YR5/8	m	sh	st	few	common	as
		30-55	0.0	10YR7/4	10YR6/6	m	sh	st	many	few	cw
		55-100	0.0	7.5YR6/6	7.5YR5/6	m	sh	st	many	many	
	51	0 - 20	0.0	7.5YR7/6	7.5YR5/8	bm	s	mo	few	many	as
		20-40	0.0	10YR7/4	10YR7/6	bm	s	st	many	many	cw
		40-60	0.0	10YR8/6 10YR4/5 10YR4/5	10YR6/6	m	sh	sl	many	many	aw
		-60 Rock	Indurate gypsum layer							-	
	52	0 - 20	0.0	10YR7/6	10YR6/6	m	s	st	few	common	cw
		20-45	0.0	10YR7/4 10YR4/5 10YR4/5	10YR6/8	m	sh	st	many	many	gw
		45-70 -70 rock	3.0	7.5YR7/6 Indurate gypsum layer	7.5YR6/6	m	s	st	many	many	
	53	0 - 20	0.0	10YR7/4	10YR6/4	m	h	st	many	many	cw
		20-60	10.0	7.5YR7/6 10YR4/5 10YR4/5	7.5YR6/8	m	h	mo	many	many	gw
		60-110	5.0	7.5YR7/6	7.5YR6/6	m	h	mo	many	many	
	54	0 - 20	0.0	10YR7/6	10YR6/8	m	s	st	common	few	as
		20-25	70.0	10YR7/6 10YR4/5 10YR4/5	10YR6/8	m	l	st	few	few	as
		25-60 60- roock	60.0	7.5YR7/6	7.5YR5/6	m	h	mo	common	many	

Table (1) Cont.

Physiographic units	Profile No.	Depth (cm)	Gravel %	Color		Structure	Consistency (Dry)	Effervescence	Secondary Formation %		Boundary
				dry	moist				CaSO4. 2H2O	CaCO3 %	
Lower belt of the delta 0 – 75 m a.s.l	43	0 - 20	0.0	10YR7/6	10YR6/6	m	s	mo	Very few	few	as
		20-50	0.0	10YR7/3	10YR6/4	m	s	sl	many	few	
	44	0 - 20	0.0	10YR7/6	10YR6/8	m	l	st	Very few	few	as
		20-45	0.0	10YR5/4	10YR5/8	m	h	mo	many	few	
	45	0 - 25	5.0	10YR7/6	10YR6/6	m	s	st	Very few	few	aw
		25-70	0.0	10YR7/4	10YR6/4	m	h	sl	many	few	
	46	0 - 25	15.0	10YR6/4	10YR5/6	m	sh	st	Very few	common	cs
		25-65	10.0	7.5YR7/6	7.5YR8/6	m	sh	st	many	common	cw
		65-130	0.0	7.5YR7/6	7.5YR6/6	m	v.h	st	many	many	
	47	0 - 20	10.0	10YR6/4	10YR5/6	m	s	st	few	many	cw
		20-70	25.0	10YR6/4	10YR5/6	m	s	mo	many	many	gw
		70-130	5.0	7.5YR7/6	7.5YR6/4	m	v.h	sl	many	many	

Table (1) Cont.

Physiographic units	Profile No.	Depth (cm)	Gravel %	Color		Structure	Consistency	Effervescence	Secondary formation		Boundary
				dry	moist				CaSO4 . 2H2O	CaCO3 %	
Longitudinal dunes.	35	0 - 150	0.0	10YR٧/6	10YR6/6	sg	lo	sl	-	-	-
	48	0 - 150	0.0	10YR٧/6	10YR6/6	sg	lo	sl	-	-	-
	55	0 - 150	0.0	10YR٧/٤	10YR6/6	sg	lo	sl	-	-	-

Soil structure: gr=granular(single grain), bw: blocky wreak grain , bm: blocky medium, pm: platy medium. .
Consistency: v.h=very hard,h=hard, f=friable, lo=loose, so=soft, vs=very sticky, ss=slightly sticky, vp=very plastic and sp=slightly plastic.

Effervescence: st: strong, mo:moderate, sl: slightly effervescence.
Consistency: vh= very hard, h=hard, sh= slightly hard, so=soft, lo=loose.
Lower boundary: cs=clear smooth, cs: clear smooth, cw: clear wavey, aw : abrupt wavey, , as : abrupt smooth, and gw: gradual Wavy .

Table (2) Some physio-chemical analyses of the studied soil profiles

Physiographic units	Profile No.	Depth (cm)	Grain size distribution % Sand %	Slit %	Clay %	Modified Texture Class	pH (1:2.5)	EC (dS/m) Soil past	ESP	$CaSO_4.2H_2O$ %	$CaCO_3$ %
Highest belt of the delta > 225 m a.s.l.	8	0-10	82.11	13.21	4.68	LS	7.96	3.32	8.36	2.9	14.13
		10-55	70.86	15.87	13.27	SL	7.84	31.68	29.84	4.5	12.75
		55-120	71.40	11.35	17.25	SL	7.6	36.27	23.45	2.32	15.54
	11	0-20	89.87	7.26	2.87	S	7.71	23.24	20.69	0.17	2.59
		20-110	81.95	13.74	4.31	LS	8.13	3.38	5.29	0.80	2.43
	12	0-10	91.60	5.38	3.02	S	7.98	11.75	20.21	2.02	29.07
		10-30	75.53	12.12	12.35	SL	7.96	20.55	20.34	0.24	3.73
		30-60	75.51	13.25	11.24	SL	7.77	28.97	36.46	6.78	2.67
		60-100	90.04	8.09	1.87	S	7.83	25.09	29.11	1.91	17.30
	13	0-15	83.29	11.47	5.24	LS	8	11.73	16.57	0.44	6.97
		15-55	81.97	14.02	4.01	LS	7.64	34.02	22.85	2.68	25.96
		55-110	75.86	13.79	10.35	SL	7.72	16.83	11.54	1.97	2.93
	14	0-20	89.76	7.89	2.35	S	8.32	2.02	3.97	0.26	2.01
		20-100	49.45	23.31	27.24	SCL	7.82	10.04	12.39	0.43	29.28
	15	0-20	88.63	7.62	3.75	S	8.08	2.01	2.11	0.25	12.17
		20-60	70.43	18.88	10.69	SL	7.75	13.02	12.01	11.68	15.68
		60-120	39.31	34.34	26.35	L	7.68	27.23	26.82	0.80	13.59
	16	0-15	89.68	5.64	4.68	S	7.66	28.27	32.44	3.52	5.10
		15-100	87.49	8.86	3.65	S	8.04	28.60	24.54	4.85	3.18
	17	0-15	78.77	14.91	6.32	SL	7.89	7.72	15.71	1.56	4.93
		15-80	74.40	15.35	10.25	SL	7.72	43.54	18.49	16.18	4.26
	18	0-10	83.27	11.72	5.01	LS	8.08	15.92	14.12	0.03	5.77
		10-35	89.79	5.83	4.38	S	8.22	25.00	29.76	8.19	39.86
		35-70	89.51	7.23	3.26	S	7.91	30.20	30.73	13.58	14.60
	19	0-50	89.15	6.77	4.08	S	8.55	1.09	1.45	0.51	0.67
	20	0-20	75.30	12.35	12.35	SL	7.98	4.45	5.45	0.32	3.26
		20-100	74.68	13.98	11.34	SL	7.72	27.78	22.01	4.03	3.43
	21	0-15	89.26	6.68	4.06	S	7.96	2.96	3.68	0.29	5.43
		15-100	72.94	12.71	14.35	SL	8.27	2.46	6.69	0.28	29.20
	32	0-10	88.53	7.34	4.13	S	7.48	22.50	14.43	0.19	3.83
		10-30	91.60	6.24	2.16	S	7.93	17.01	19.44	0.24	9.03
		30-55	89.78	6.67	3.55	S	7.92	18.34	18.45	7.13	10.14
		55-100	90.16	7.35	2.49	S	7.89	17.31	18.18	0.36	11.58
	33	0-10	72.42	14.54	13.04	SL	8.2	1.68	3.26	0.25	6.65
		10-40	73.94	13.48	12.58	SL	7.95	18.74	21.62	2.87	31.33
		40-90	81.18	11.84	6.98	LS	7.74	25.52	15.35	0.50	16.39
	34	0-10	90.53	5.59	3.88	S	8.24	1.27	2.77	0.34	3.58
		10-35	91.94	4.99	3.07	S	8.04	3.56	7.00	0.43	13.49
		35-110	89.48	6.58	3.94	S	7.98	3.93	3.20	1.28	10.85

Table (2) Cont.

Physiographic units	Profile No.	Depth (cm)	Grain size distribution % Sand %	Slit %	Clay %	Modified Texture Class	pH (1:2.5)	EC (dS/m) Soil past	ESP	CaSO4. 2H2O %	$CaCO_3$ %
High belt of the delta ٢٢٠ - ١٠٠ m a.s.l	6	0 - 15	88.97	7.02	4.01	S	7.86	10.88	16.77	0.32	19.32
		15-60	90.81	5.65	3.54	S	7.71	19.65	17.69	0.28	23.08
		60-130	88.65	7.11	4.24	S	8.0	13.59	15.82	1.40	10.53
	7	0 - 10	82.07	11.61	6.32	LS	8.3	8.15	10.43	0.20	3.40
		10-50	79.24	13.58	7.18	LS	7.64	37.83	23.39	0.14	3.97
	9	0 - 20	88.03	6.68	3.18	S	7.5	14.73	19.77	2.57	4.68
		20-40	82.91	5.65	4.57	S	7.88	10.28	13.15	1.96	3.73
		40-110	89.87	12.87	11.88	SL	8.05	10.62	16.13	1.28	2.51
	10	0 -10	81.95	8.99	2.98	S	7.95	2.96	4.94	6.03	2.35
		10-130	88.03	12.78	4.31	LS	7.65	30.01	28.73	8.81	1.13
	22	0 - 35	50.02	22.67	27.31	SCL	8.08	8.57	15.09	1.23	8.08
		35-100	72.64	16.01	11.35	SL	7.92	7.65	12.31	9.74	3.26
	23	0 - 20	89.90	6.45	3.65	S	7.96	6.58	5.14	1.26	8.69
		20-120	89.95	7.73	2.32	S	7.48	33.04	23.15	3.86	5.18
	24	0 - 10	89.60	7.96	2.44	S	7.94	3.41	5.17	0.29	6.44
		10-45	90.12	8.01	1.87	S	7.88	27.45	28.52	0.35	5.68
		45-100	89.84	6.98	3.18	S	7.76	40.67	25.48	4.72	0.75
	25	0 - 25	83.64	13.49	2.87	LS	8.02	5.61	9.24	0.76	18.28
		25-120	90.11	7.88	2.01	S	7.75	54.40	43.20	4.93	27.12
	26	0 - 20	88.53	7.89	3.58	S	8.1	3.62	6.78	0.22	1.56
		20-40	89.00	8.02	2.98	S	8.32	1.46	6.87	11.23	2.43
	27	0 - 45	88.25	7.68	4.07	S	7.96	7.29	10.79	10.73	7.79
		45-100	89.33	8.08	2.59	S	8.03	14.63	19.43	8.53	9.86
	28	0 - 20	46.84	22.01	31.15	SCL	7.7	32.60	32.71	4.15	4.68
		20-60	43.84	21.48	34.68	SCL	6.78	117.02	35.60	0.49	0.92
	29	0 - 10	90.54	7.09	2.37	S	7.4	52.27	38.12	0.44	2.86
		10-35	89.61	8.06	2.33	S	7.32	84.74	61.46	0.69	4.41
	30	0 - 10	46.50	6.78	3.19	S	8.16	4.97	4.94	3.94	4.98
		10-40	89.11	7.66	4.61	S	7.97	4.52	4.83	0.47	4.86
	31	0 - 40	89.25	8.31	2.44	S	7.94	8.35	12.16	0.33	5.62
		40-120	89.27	8.05	2.68	S	8.15	1.53	4.80	0.81	15.51
	36	0 - 10	89.07	23.35	30.15	SCL	7.94	16.75	21.58	5.98	4.17
		10-40	76.21	7.88	3.01	S	7.61	32.27	25.37	4.32	1.79
		40-110	71.87	8.34	2.59	S	7.65	33.84	25.93	8.11	1.19
	37	0 - 30	90.55	13.55	10.24	SL	7.94	11.58	18.77	1.28	4.52
		30-120	89.88	15.87	12.26	SL	7.99	18.07	16.72	0.38	4.77
	38	0 - 30	89.70	7.68	1.77	S	7.85	22.06	26.07	0.20	18.51
		30-50	46.50	8.11	2.01	S	7.62	23.31	17.63	0.37	21.02
		50-90	89.11	7.57	2.73	S	7.86	19.47	18.30	0.97	10.43

Table (2) Cont.

Physiographic units	Profile No.	Depth (cm)	Grain size distribution % Sand %	Slit %	Clay %	Modified Texture Class	pH (1:2.5)	EC (dS/m) Soil past	ESP	CaSO4. 2H2O %	$CaCO_3$ %
Medium- High belt of the delta 75 – 150 m a.s.l.	*1*	0-30	76.68	12.68	10.64	SL	7.48	40.01	25.52	20.73	23.57
		30-70	73.97	14.68	11.35	SL	7.7	42.62	15.76	25.82	35.07
		75-120	74.41	11.24	14.35	SL	7.67	40.45	22.92	17.09	38.48
	2	0 - 40	78.45	13.64	7.91	LS	7.74	10.97	8.91	2.31	9.64
		40 -130	47.42	20.1	32.48	SCL	7.85	5.94	4.89	14.95	39.93
	3	0 - 20	71.97	15.68	12.35	SL	8.57	1.62	2.84	0.29	33.45
		20 - 80	77.30	12.35	10.35	SL	8.59	5.34	10.12	1.25	24.06
		80-150	73.46	14.29	12.25	SL	7.71	10.15	10.01	19.39	29.61
	4	0 - 25	92.14	4.65	3.21	S	8.3	4.35	9.23	0.19	33.20
		25-75	75.00	12.35	12.65	SL	7.67	21.62	20.25	0.72	29.24
		75-150	76.87	11.88	11.25	SL	7.6	20.80	16.94	3.15	18.39
	5	0 - 20	90.84	5.05	4.11	S	7.8	2.79	3.53	0.24	38.83
		20-85	89.72	7.64	2.64	S	7.78	14.57	14.69	1.17	39.15
		85-130	90.16	6.69	3.15	S	7.65	24.60	16.39	0.53	34.69
	39	0 - 50	89.91	6.98	3.11	S	8.6	2.05	7.34	22.22	2.47
		50-120	88.73	7.25	4.02	S	8.75	1.84	4.65	15.25	0.22
	40	0 - 10	90.78	6.86	2.36	S	8.3	2.49	11.98	0.29	3.24
		10-50	90.05	7.08	2.87	S	7.98	24.66	25.77	1.35	0.77
		50-100	88.65	9.01	2.34	S	7.89	25.64	27.90	1.27	1.62
	41	0 - 10	88.32	8.57	3.11	S	7.82	7.03	9.63	1.76	0.94
		10-100	88.34	7.64	4.02	S	8.08	7.56	9.98	18.49	9.85
	42	0 - 15	89.34	8.18	2.48	S	7.99	4.38	4.91	0.55	4.35
		15-100	44.56	30.35	25.09	L	8.66	2.07	6.80	0.23	1.53
	49	0 - 10	90.36	6.99	2.65	S	7.82	14.17	18.74	10.36	37.35
		10-20	88.90	9.13	1.97	S	7.73	26.80	17.32	8.76	36.61
		20-40	78.77	11.22	10.01	SL	7.35	61.20	23.04	9.40	29.29
	50	0 - 15	88.90	9.02	2.08	S	8.05	5.00	4.65	١.22	9.29
		15-30	89.94	6.85	3.21	S	7.06	4.30	4.32	٢.33	9.80
		30-55	81.96	12.01	6.03	LS	8	11.84	15.23	17.52	7.75
		55-100	74.07	14.09	11.84	SL	7.98	25.50	28.44	14.37	34.60
	51	0 - 20	89.11	8.24	2.65	S	7.91	6.83	9.50	0.63	24.52
		20-40	44.99	21.02	33.99	SCL	8	25.60	26.38	29.48	48.78
		40-60	76.51	13.36	10.13	SL	8.07	47.70	47.20	17.68	32.64
		60-rock									
	52	0 - 20	80.70	1	6.88	LS	7.94	4.12	4.19	2.51	12
		20-45	77.14	1	10.08	SL	7.9	6.95	7.26	20.93	33
		45-70	81.21	1	7.01	LS	7.82	64.70	54.50	18.73	25
	53	0 - 20	82.78	1	5.74	LS	8.05	5.40	5.15	19.53	34
		20-60	88.71	8.	3.28	S	7.99	13.00	22.28	31.33	24
		60-110	89.38	6.	4.05	S	8	49.10	41.82	16.63	31
	54	0 - 10	90.43	7.	2.56	S	8.04	3.34	4.38	4.25	4.
		10-25	90.58	6.	2.78	S	8	2.94	4.63	1.30	7.
		25-120	88.46	7.	4.08	S	8.25	1.00	1.85	12.38	39

Table (2) Cont.

Physiographic units	Profile No.	Depth (cm)	Grain size distribution %			Modified Texture Class	pH (1:2.5)	EC (dS/m)	ESP	CaSO4. 2H2O %	$CaCO_3$ %
			Sand %	Slit %	Clay %			Soil past			
Lower belt of the delta 0 – 75 m a.s.l	43	0 - 20	89.47	6.21	4.32	S	7.71	30.67	24.90	0.12	3.49
		20-50	46.32	24.34	29.34	SCL	7.98	48.54	54.94	15.25	2.73
	44	0 - 20	90.51	6.45	3.04	S	8.69	81.11	33.54	0.21	1.62
		20-80	46.90	19.89	33.21	SCL	7.83	167.93	50.93	33.53	0.85
	45	0 - 25	88.71	7.08	4.21	S	7.9	8.78	6.26	0.19	5.79
		25-70	50.69	19.67	29.64	SCL	7.89	9.29	14.07	16.16	2.98
	46	0 - 25	79.49	13.64	6.87	LS	7.55	46.76	42.13	0.54	10.00
		25-65	79.93	13.02	7.05	LS	7.82	37.96	33.24	16.44	13.35
		65-130	25.85	29.37	44.78	C	7.27	39.32	35.28	17.51	19.61
	47	0 - 20	78.12	14.87	7.01	LS	7.89	54.44	39.97	2.90	29.29
		20-70	79.64	13.08	7.28	LS	7.73	48.98	47.89	24.85	28.02
		70-130	22.56	32.67	44.77	C	7.39	43.76	31.72	19.53	29.80

Table (2) Cont.

Physiographic units	Profile No.	Depth (cm)	Grain size distribution %			Modified Texture Class	pH (1:2.5)	EC (dS/m)	ESP	CaSO4. 2H2O %	$CaCO_3$ %
			Sand %	Slit %	Clay %			Soil past			
Longitudinal dunes.	35	0 - 150	92.68	4.68	2.64	S	8.2	2.23	4.68	0.00	0.00
	48	0 - 150	89.03	7.64	3.33	S	8.15	1.08	1.33	0.43	0.00
	55	0 - 150	91.96	6.03	2.01	S	8.2	2.23	4.37	0.15	0.52

Fine earth: S=Sand, LS=Loamy sand, SL=Sandy loam, SCL=Sandy clay loam, CL=Clay loam and C=Clay.

2- High belt of the delta (150 – 225 m a.s.l)

Soils of this unit are located in the central part of the study area surrounded with soils of highest belt of delta and bordered from north and south with medium-high belt of the delta. The surface features and soil attributes are almost similar to that of highest belt unit but differ in the range of some soil characteristics. The topography is relatively less undulating and also for surface dark coloured gravel. The examined profiles indicate more coarser texture in most locations but in less gravel content and locally with shallow soil depth over rock. Both lime and

gypsum seem to be in relatively lower content, but soil salinity ranges mainly from moderately (8 to 16 dS/m) to very strongly saline (32 to 64 dS/m).
According to the characteristics of the examined soil profiles, the following association taxonomic units were indentified:

-Weakly developed soils (Entisols order):

- Sandy or Gravelly sand soils: *Typic Torriorthents*, sandy, mixed, hyperthermic.

:*Typic Torriorthents*, sandy-skeletal, mixed, hyperthermic.

-Loamy or Gravelly loam soils: *Typic Torriorthents*, coarse-loamy, mixed, hyperthermic.

:*Typic Torriorthents*, loamy -skeletal, mixed, hyperthermic.

- Soils developed under arid conditions (Aridisols order):

- Lime accumulated sandy soils:

:*Typic Haplocalcids*, sandy, mixed, hyperthermic.

- Gypsiferous sandy or gravelly sand soils:

:*Typic Haplogypsids*, sandy, mixed, hyperthermic.

:*Typic Haplogypsids*, sandy -skeletal , mixed, hyperthermic.

:*Leptic Haplogypsids*, sandy, mixed, hyperthermic.

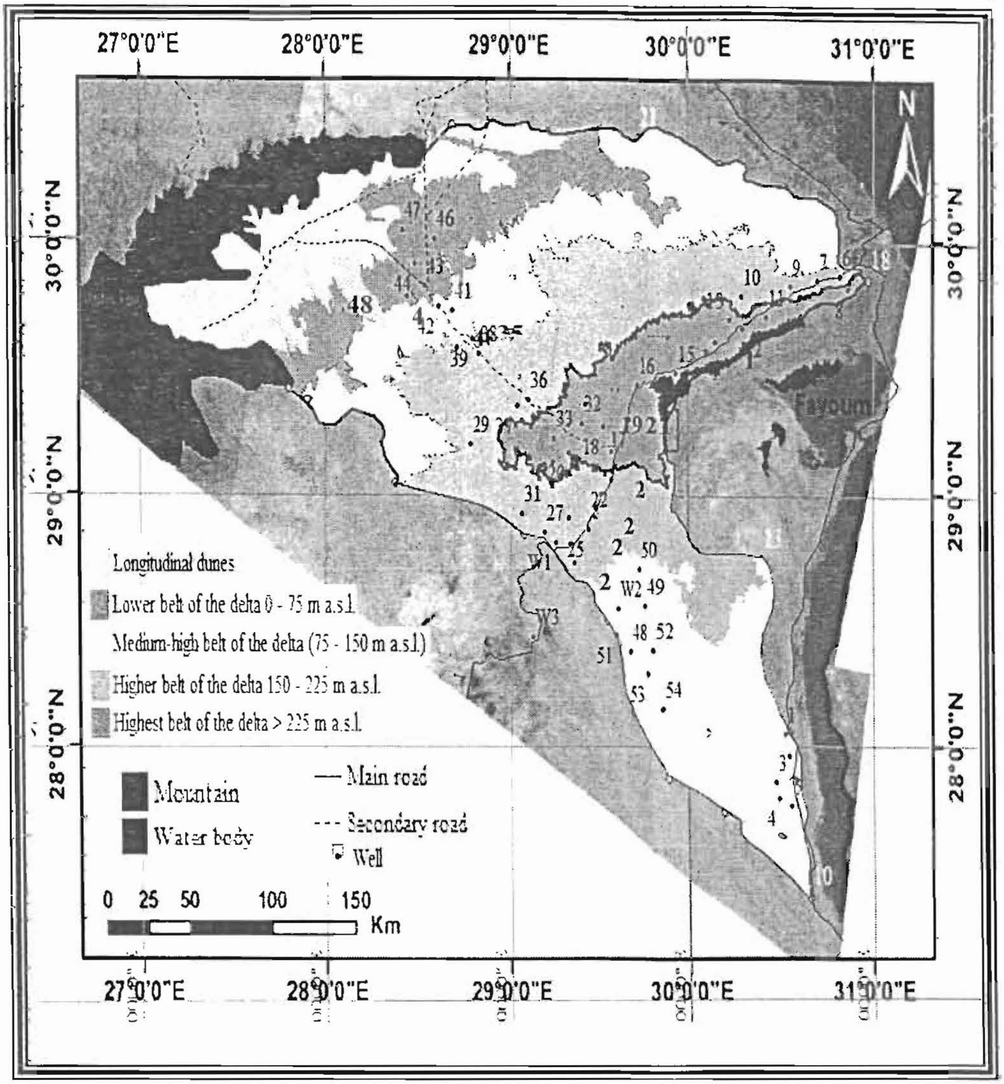
And the following taxonomic units as inclusions:

- Shallow sandy soils: :*Lithic Torriorthents*, sandy, mixed, hyperthermic.

- Shallow Gypsiferous gravelly sandy soils:*Lithic Haplogypsids*, sandy-skeletal, mixed, hyperthermic.

- Calcigypsy gravelly sand soils:

:Typic Calcigypsids, sandy-skeletal, mixed, hyperthermic.



Map. (2): Physiographic units map of the studied area- Eastern-South Desert Outskirt of Al-Qattara depression, Egypt

3- Medium- high belt of the delta (75 – 150 m a.s.l.)

Soils of this unit are surrounding the high belt unit and bordered from north with lower belt unit. The surface features are characterized by almost flat relief covered by common relatively light coloured gravel. Also, the surface is mainly dissected by many shallow gullies and the scattered rock outcrops were observed. The depth of the examined soil profiles vary from deep to shallow over rock or idurated layer. The soil texture is dominated by sandy to sandy loam in 10YR to 7.5YR hue colour and mixed with high gravel content in some profiles. The relatively high lime and gypsum content were indicated in the most of soil layers that observed in the field as common to many secondary accumulation with indurated gypsum in some subsoil layers. The soils are moderately alkaline and salt content varied widely from slightly to very strongly saline. Accordingly, the following taxonomic unit could be indentified the studied soil profiles:

- Calcigypsy gravelly loam soils:

Typic Calcigypsids, sandy-skeletal, gypsic, hyperthermic.

- Calcigypsy sandy soils: *Typic Calcigypsids*, sandy, mixed, hyperthermic.
- Shallow Gypsiferous soils:
- *Calcic Petrogypsids*, fine loamy, gypsic, and hyperthermic.
- *Lithic Calcigypsids*, sandy, carbonatic, hyperthermic.
- Lime accumulated gravelly soils:
- *Typic Haplocalcids*, loamy-skeletal, mixed, hyperthermic.
- *Typic Haplocalcids*, sandy-skeletal, mixed, hyperthermic.

-And the following taxonomic units as inclusions:

- Weakly developed soils: *Typic Torriorthents*, sandy, mixed, hyperthermic.
- *Typic Torriorthents*, fine loamy, mixed, hyperthermic.
- Gypsiferous sandy soils:
- *Typic Haplogypsids*, sandy skeletal, gypsic, hyperthermic.

4- Lower belt of the delta (0 – 75 m a.s.l)

This unit is found in the northern portion of the study area. The surface features are dominated by almost flat to gently undulating relief covered with few to common dark coloured gravel. The soil profiles are characterized by deep to moderately deep loamy or clayey texture mainly in 10YR hue colour, with coarse texture in the surface layers. Soil structure is massive mainly in hard and very hard consistence. The subsurface layers indicate high gypsum content with lime varied widely from 3 to 30%. The soils are very strongly to extremely saline with moderately soil reaction. The soil profiles indicate the following taxonomic units:

- Gypsiferous loamy soils: *Typic Haplogypsids*, fine loamy, mixed, hyperthermic.
- Calcigypsy soils: *Typic Calcigypsids*, sandy over clayey, gypsic, hyperthermic .
- Salt accumulated soils: *Gypsic Haplosalids*, fine loamy, gypsic, hyperthermic .

5- Longitudinal dunes

This unit are located over all previous units. It formed by the action of windblown sand as high longitudinal dunes that extend from the west-north to east south direction. It characterized by homogeneous yellow loose sand almost free from lime and gypsum that classified as : -*Typic Torripsamments,* siliceous, hyperthermic.

Land suitability Evaluation:

Land evaluation was calculated based on the concepts of Sys & Verheye (1978), data in Table (3) show that current and potential suitability classes vary between Non suitable and highly suitable with dominance low suitability levels, the soil Texture including gravel is the main factor for decreasing the suitability class, followed by soil salinity and alkalinity while lime and gypsum content as well as soil depth indicate different severity degree . The higher suitability values were in highest belt of delta in the current state and in lower belt of delta in the potential state because of its high salinity levels which can be fixed by using the optimum cultivation methods, while the lowest values of current and potential suitabilities were in sand dunes unit. The major land improvement accelerates the utilization of the soil under consideration as follow:

a- Using the organic matter as the soil conditioner and fertilizers.

b- Application system of irrigation control of water percolation and wetting the root zone only such as drip irrigation, for sprinkler irrigation systems decreases the importance of soil texture as a main factor of land evaluation.

c- Selection more suitable crops which are in agreement with soil components.

Water quality and its Suitability:

Data in Table (4) showed that the TDS and major ions content of the sampled wells (No.1 and No.2) are below the critical limits for drinking water guide line values, but the trace element content of ions is mostly above the critical limits of such use according to **Ministry of Health (1995)** and **WHO (2008)**. Therefore, water resources of the two wells are not suitable for drinking usages.

According to **Richards (1954) and El-Ghandour et al.(1983),** the sampled water corresponding to their TDS, EC and SAR values are characterized by high salinity levels with medium alkalinity hazard (C_3-S_2); having marginally suitable class for irrigation use, (well No.1). Therefore, it may cause more restrictions when used in irrigation for a long-term. On the other hand, the sampled waters of well No.2 are characterized by low salinity levels with low alkalinity hazard (C_1-C_1), having highly suitable class for crop irrigation, hence when used for long-term.

According to **Ayers Westcot (1985),** water quality of well.No.1 appears increasing problem level of salinity (1.2 dS/m) effect on grown crops, while its effect on soil permeability is no problem while values of adj SAR>9.00 reveal to sever problem of permeability and sever problem of sodium toxicity, increasing problem for chloride ions specially Foliar absorption from leaves wetted by sprinkler applied water. No problem level due to boron contents (0.193 ppm).

Table (3): Rating of suitability index after Sys &Verheye (1978) for the studied soil profiles

Physiographic units	Profile No.	Topography (t)		Wetness (w)		Physical characteristics					Salinity & Alkalinity		SuitabilityIndex (Ci)		Suitability Class	
						Texture(S_1)		Depth	$CaCO_3$	$CaSO_4$						
		C	P	C	P	C	P	S_2	S_3	S_4	C	P	C	P	C	P
Highest belt of the delta > 225 m a.s.l.	8	95	100	100	100	35	45	90	100	100	90	100	26.93	40.50	S3	S3
	11	95	100	100	100	55	65	90	95	90	85	100	34.18	50.02	S3	S2
	12	95	100	100	100	55	65	90	100	100	58	100	27.27	58.50	S3	S2
	13	95	100	100	100	50	60	90	100	90	75	100	28.86	48.60	S3	S3
	14	95	100	100	100	75	75	90	100	100	75	100	48.09	67.50	S3	S2
	15	95	100	100	100	75	75	90	100	100	90	100	57.71	67.50	S2	S2
	16	95	100	100	100	30	55	90	95	80	58	100	11.31	37.62	N	S3
	17	95	100	100	100	45	55	75	95	80	58	100	14.13	31.35	N	S3
	18	95	100	100	100	25	45	75	100	100	75	100	13.36	33.75	N	S3
	19	95	100	100	100	30	55	55	85	100	100	100	13.32	25.71	N	S3
	20	95	100	100	100	65	75	90	95	90	80	100	38.01	57.71	S3	S2
	21	95	100	100	100	55	60	90	90	90	100	100	38.09	43.74	S3	S3
	32	95	100	100	100	25	50	90	95	100	58	100	11.78	42.75	N	S3
	33	95	100	100	100	60	70	90	100	100	58	100	29.75	63.00	S3	S2
	34	100	100	100	100	25	50	90	100	100	98	100	22.05	45.00	N	S3

Table (3): Cont.

Physiographic units	Profile No.	Topography (t)		Wetness (w)		Physical characteristics					Salinity & Alkalinity		SuitabilityIndex (Ci)		Suitability Class	
						Texture(S_1)		Depth (S_1)	$CaCO_3$	$CaSO_4$						
		C	P	C	P	C	P	S_2	S_3	S_4	C	P	C	P	C	P
High belt of the delta150 - 225 m a.s.l.	6	95	100	100	100	30	55	100	100	90	90	100	23.09	49.50	N	S3
	7	95	100	100	100	50	60	75	95	90	90	100	27.41	38.48	S3	S3
	9	95	100	100	100	35	50	90	95	100	90	100	25.59	42.75	S3	S3
	10	95	100	100	100	50	60	100	95	100	90	100	40.61	57.00	S3	S2
	22	95	100	100	100	65	75	90	95	100	85	100	44.88	64.13	S3	S2
	23	95	100	100	100	25	50	90	95	100	58	100	11.78	42.75	N	S3
	24	95	100	100	100	25	35	90	95	90	58	100	10.60	26.93	N	S3
	25	95	100	100	100	25	35	100	90	100	45	100	9.62	31.50	N	S3
	26	95	100	100	100	30	55	55	95	100	100	100	14.89	28.74	N	S3
	27	95	100	100	100	30	55	90	95	100	80	100	19.49	47.03	N	S3
	28	95	100	100	100	80	80	75	95	100	45	100	24.37	57.00	N	S2
	29	95	100	100	100	30	55	55	95	90	45	100	6.03	25.86	N	S3
	30	95	100	100	100	30	55	55	95	100	98	100	14.59	28.74	N	S3
	31	95	100	100	100	30	55	90	100	100	95	100	24.37	49.50	N	S3
	36	95	100	100	100	55	65	90	95	100	58	100	25.91	55.58	S3	S2
	37	95	100	100	100	75	75	90	95	90	75	100	41.12	57.71	S3	S2
	38	95	100	100	100	30	55	90	100	90	58	100	13.39	44.55	N	S3

Cont.

Physiographic units	Profile No.	Topography (t)		Wetness (w)		Physical characteristics Texture(S1)		Depth	CaCO3	CaSO4	Salinity & Alkalinity		SuitabilityIndex (Ci)		Suitability Class	
		C	P	C	P	C	P	S_2	S_3	S_4	C	P	C	P	C	P
Medium High belt of the delta150 - 75 m a.s.l.	1	95	100	80	90	60	65	100	90	80	58	100	19.04	42.12	N	S3
	2	95	100	80	90	75	75	100	90	80	90	100	34.88	48.60	S3	S3
	3	95	100	100	100	70	75	100	90	100	85	100	53.87	67.50	S2	S2
	4	95	100	100	100	60	70	100	100	100	85	100	48.45	70.00	S3	S2
	5	95	100	100	100	25	45	100	90	90	75	100	14.43	36.45	N	S3
	39	95	100	100	100	30	55	100	95	100	100	100	27.08	52.25	S3	S2
	40	95	100	100	100	30	55	90	95	100	58	100	14.13	47.03	N	S3
	41	95	100	100	100	30	55	90	95	100	90	100	21.93	47.03	N	S3
	42	95	100	100	100	75	75	90	95	100	100	100	60.92	64.13	S2	S2
	49	95	100	100	100	55	65	55	90	100	58	100	15.00	32.18	N	S3
	50	95	100	100	100	55	65	90	100	80	75	100	28.22	46.80	S3	S3
	51	95	100	100	100	75	75	75	100	80	75	100	32.06	45.00	S3	S3
	52	95	100	100	100	55	65	75	90	80	45	100	12.70	35.10	N	S3
	53	95	100	100	100	30	55	90	95	80	58	100	11.31	37.62	N	S3
	54	95	100	100	100	30	45	100	100	100	100	100	28.50	45.00	S3	S3

Table (3): Cont.

Physiographic units	Profile No.	Topography (t)		Wetness (w)		Physical characteristics					Salinity & Alkalinity		SuitabilityIndex (Ci)		Suitability Class	
						Texture(S_1)		Depth	$CaCO_3$	$CaSO_4$						
		C	P	C	P	C	P	S_2	S_3	S_4	C	P	C	P	C	P
Lower belt delta 0-75m asl	43	95	100	80	90	75	75	75	95	100	45	100	18.28	48.09	N	S3
	44	95	100	90	95	75	75	55	95	80	45	80	12.06	29.78	N	S3
	45	95	100	90	95	75	75	75	95	100	85	100	36.55	50.77	S3	S2
	46	95	100	90	95	85	85	100	95	80	75	100	24.85	61.37	N	S2
	47	95	100	90	95	85	85	100	100	80	45	100	26.16	64.60	S3	S2

Table (3): Cont.

Physiographic units	Profile No.	Topography (t)		Wetness (w)		Physical characteristics					Salinity & Alkalinity		SuitabilityIndex (Ci)		Suitability Class	
						Texture(S_1)		Depth	$CaCO_3$	$CaSO_4$						
		C	P	C	P	S_1		S_2	S_3	S_4	C	P	C	P	C	P
Longitudinal Sand dunes	35	50	100	100	100	30	55	100	85	90	100	100	11.48	42.08	N	S3
	48	50	100	100	100	30	55	100	85	90	100	100	11.48	42.08	N	S3
	55	50	100	100	100	30	55	100	85	90	100	100	11.48	42.08	N	S3

Total contents of nitrogen (NO_3^- & NH_4^+) < 5 ppm reveal to no problem. Bicarbonate contents (4.85 me/L) may cause problems while deposits on fruit or leaves due to sprinkler irrigation. Values of pH in normal range, while, pHc values <8.4 indicate tendency to precipitate lime from waters applied.

Value of residual sodium carbonate >2.5 is considered not suitable for irrigation according to **Van Hoorn (1971)** where a high content of bicarbonate in irrigation water may lead to precipitation calcium and magnesium in the soil and thus to a relative increase of the sodium concentration.

Contents of soluble trace elements are as follow Iron 1.17 ppm Manganese 0.086 ppm, Zinc 0.005 ppm, and Copper nil. However the soil type should be taken in the consideration, whereas, most of soil under consideration sandy or gypsiferous soils.

The sampled waters of well No. 2 show that salinity and adj. SAR values appear no problem, for soil permeability, or specific ion toxicity for plant roots and foliar absorption.

Total contents of Nitrogen (NO_3^- & NH_4^+) have no problem (1.7 ppm), pH value in a normal range, while Bicarbonate contents reveal to increasing problem level. Residual sodium carbonate appears no-sodium hazard.

Soluble trace elements contents are present as follows: Fe 0.673 ppm, Mn 0.115 ppm, Zn 0.001 ppm and Cu 0.001 ppm. Therefore the second water well considers a good quality and suitability , when used for irrigation use for a long-term.

Table (4a): Some chemical analyses of the studied water resources.

Well No.	pH	EC (dS m⁻¹)	Soluble cations (meq/L)				Soluble anions (meq/L)				Boron	Zinc	Copper	Manganese	Iron	N	N	TSD (ppm)	pHc	SAR	adj. SAR
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	(ppm)					NH_4^+ ppm	NO_3^- ppm				
1	7.5	1.20	0.74	1.01	9.65	0.62	0.0	4.85	6.01	1.20	0.193	0.005	0.00	0.086	1.170	0.95	1.89	768.0	7.58	3.06	18.782
2	7.4	0.39	0.84	0.69	2.34	0.13	0.0	2,21	1.02	0.77	0.032	0.001	0.001	0.115	0.673	1.70	0.0	250.0	8	0.68	3.744

Well location	Salinity classification	Permeability Classification	pH	Specific ion toxicity
1	(Ip)	EC ------- (Ip) Adj SAR - (Sp)	(Nr)	(Np) for Na, Cl, Zn, M, Fe, Cu and B
2	(Np)	EC ------ (Np) Adj SAR - (Np)	(Nr)	(Np) for Na, Cl ,Zn, Mn. Fe, Cu and B

Np Np =No problem ,IP= Increasing problem,SP= Sever problem, RSC=Residual sodium carbonate, SAR= Sodium adsorption ratio, adj. SAR= adjusted sodium adsorption ratio , Nr= Normal range

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دراسة أولية لإستخدام الأرض للزراعة ونوعية مصادر المياه في دلتا الصرف القديم جنوب شرق منخفض القطارة - مصر

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تمتد اراضي دلتا الصرف القديم من شرق منخفض القطارة الي غرب جبل قطراني والي الغرب بمحاذاة محافظتي الفيوم والمنيا حتي ديروط ، حيث تشغل منطقة الدراسة مساحة شاسعة تغطي حوالي ١٠٤٨٢٠٠٠ فدان تقريبيا (km^2 ٤٤٠٠٠) . وتهدف الدراسة الي أعطاء رؤية أولية لتقييم الأرض الزراعية وتحديد نوعية مصادر المياه باستخدام تقنيات نظم المعلومات الجغرافية (GIS) و تكنيك التفسير المرئى لصور الأقمار الفضائية (Enhanced Thematic Mapper 7)، ونموذج الارتفاعات الرقمية (DEM) في انتاج خريطة عامة للاشكال الارضية كوحدات فيزيوجرافية تم تسميتها كالاتي:

١- حزام الدلتا المرتفع جدا (اكبر من ٢٢٥ م فوق سطح البحر).
٢- حزام الدلتا المرتفع (من ١٥٠ - ٢٢٥ م فوق سطح البحر).
٣- حزام الدلتا متوسط الارتفاع (من ٧٥ - ١٥٠ م فوق سطح البحر).
٤- حزام الدلتا المنخفضة (من ٠ - ٧٥ م فوق سطح البحر).
٥- الكثبان الرملية الممتدة.

وقد تم تحديد ودراسة اكثر من مائة وخمسون نقطة ملاحظة أرضية لوضع دليل ملامح الوحدات الخريطية (الوحدات الفيزوجرافية الرئيسية)، ثم حددت الإختلافات بين هذه الوحدات من خلال دراسة خمسة وخمسون قطاعا أرضيا تم وصفها مورفولوجيا وأخذت منها عينات تربة للتحليلات المعملية.

وتشير النتائج ان تحديد مظاهر السطح الذي يمثل الوحدات الفيزوجرافية كان متمشيا مع خطوط الكنتور المختلفة الارتفاعات عن سطح البحر لتمثل احزمة الدلتا القديمة.

وقد امكن تقسيم الاراضي المدروسة الي رتبتي (الاراضي التي تطورت تحت ظروف الجفاف)Aridisols، (الاراضي حديثة التكوين) Entisols متضمنة ستة وعشرون وحدة تقسيمية حتي مستوي العائلة – ويتضح ان مظاهر السطح بها ان مظاهر السطح بها تميل الي طبوغرافية شبة مستوية الي خفيفة التموج يتخللها جزئيا بروزات صخرية في بعض الوحدات وقطاعات التربة اتصفت غالبا بقوام رملي الي طمي رملي عميقة الي متوسط العمق بعضها ذات محتوي حصوي مرتفع او ضحلة العمق . والتربة غالبا تحتوي علي نسب مرتفعة نسبيا من الجير والجبس وتكون اكثر وضوحا في المناطق المتوسطة الارتفاع والاكثر انخفاضا من الدلتا ، كما تباينت ملوحة التربة كثيرا من الغير ملحية الي شديدة الملوحة.

وتوضح النتائج ان قيم درجات صلاحية الارض الحالية للزراعة يمثلها حزام الدلتا المرتفعة جدا والمرتفعة، في حين تمثل اعلي قيم متوسطة الصلاحية للأراضي المتوقعة لبعض أراضي حزام الدلتا المنخفضة – بينما اقل قيم الصلاحية الحالية والمتوقعة كانت لوحدة الكثبان الرملية، ويمكن القوا بأن درجات الصلاحية الحالية يمكن الوصول بها الي درجة الصلاحية الافضل لتمثل الحالة المتوقعة.

وقد اثبتت النتائج ان نوعية مياة الآبار رقم (١) و (٢) غير صالحة للشرب وذلك لإرتفاع المحتوي من عنصر الحديد بها عن الحد المسموح لأستخدامة ، ومن ناحية اخري فلن درجة نوعية مياه البئر رقم ١ تكون حدية الصلاحية للري وقد تسبب اضرارا بالغة عند استخدامها للري لفترات طويلة. بينما تمثل درجة نوعية مياه البئر رقم (٢) صلاحية عالية لري المحاصيل ولا تسبب اضرار متوقعة حتي مع الاستخدام لفترات طويلة ،وذلك باتباع النظام الكمى الرياضى الموضوع بمعرفة Sys and Verheye (1978).