LANDSAT IMAGERY TECHNIQUE FOR LAND EVALUATION IN AGRICULTURAL PURPOSES AT SOME AREAS OF EL-MENYA GOVERNORATE , EGYPT

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ABSTRACT:

The studied area lies between latitudes 28^{o} 22' to 28^{o} 28' north and longitudes 30^{o} 26' to 31^{o} 03' east. By applying the technique of Landsat Imagery (ETM7, Enhanced Thematic Mapper 7) and the physiographic approach, the area under study at El-Menya Governorate could be identified as a best model for representing many landscape features in Egypt. The studied area includes both the continental alluvium deposits of River Nile and desert sediments that were derived from the local parent rocks. These deposits are developed on many physiographic units such as the Nile alluvial plain, River bank, Islands, Alluvial terraces, Aeolian plain and Wadis. In addition, the rock structures are delineated as a rock outcrops. The differences between the studied physiographic units are represented by twelve soil profiles. The studied soil profiles were fully described and soil samples were collected for laboratory analysis.

Soil taxa were categorized into three orders according to **USDA (1999 and 2003)**, and many soil families as follows:

i) Vertisols: Typic Haplotorrerts, clayey and *Halic Haplotorrerts, clayey* in the Nile alluvial plain.

ii) Aridisols: Typic Calcigypsids, fine loamy, mixed, hyperthermic and *Typic Haplocalcids, fine loamy, mixed, hypertherm*ic in alluvial terraces unit.

iii) ***Entisols:*** *Typic Torriorthents, fine loamy* in the River bank unit; *Typic Torriorthents, sandy* and *Typic Torriorthents, coarse loamy* in the Island unit; *Typic Torrifluvents, fine loamy over sandy, (calcareous)* and *Typic Torrifluvents, loamy skeletal* in Wadis unit; *Typic Torripsamments, siliceous* and *Typic Torriorthents, coarse loamy* in Aeolian plain unit.

The soils of the identified physiographic units were evaluated to assess the suitability classes of agricultural irrigated soils, which categorized into the different categories of highly (S1), moderately (S2), marginally suitable (S3) as well as not suitable (N). Also, the studied soils were evaluated according to their suitability for specific crops, *i.e.*, cereal crops (wheat, barley and maize), field crops (cotton and sunflower), vegetables (tomato), fodder crops (alfalfa and sorghum) and fruit trees (banana, citrus, guava, mango and olive) to identify their supreme current and potential suitability.

Key words: Landsat Imagery, El Menya soils, land evaluation, soil taxa, supreme current and potential suitability for specific crops.

INTRODUCTION:

About one million square kilometers is the area of Egypt, which representing 238 million feddans, of which only 4% is cultivated. Reclamation and utilization of the newly soils in Egypt is the only hope for the horizontal expansion of our cultivated land.

Space images proved to be a useful tool for reconnaissance inventories for large area of many types of landscapes. Landsat imagery has been widely accepted as a basis for soil surveys at small scales **(Mayers, 1975)**. **Siegel and Abrams (1976)** concluded that Landsat data were useful for mapping major geomorphic units.

The objectives of this study were at identifying the physiographic features of a unique area in Egypt (El Menya Governorate) by mapping them to be a digital model in a harmony of physiographic and soil data set. It is also to find the best adaptation between certain land units with specific crop to give the maximum output. For this purpose, the harmony of descriptive and processing systems, established by **Sys (1991) and Sys *et al*. (1993)** were considered, being highly required in this study.

MATERIALS AND METHODS:

I. Landsat image-interpretation:

Space images interpretation was performed to delineate the different physiographic-soil units in the studied area of El Menya Governorate based on the physiographic analysis as proposed by **Burnigh (1960) and Gossen (1967)**. This approach used to identify soil bodies on the context of dynamic processes, as the deposition types and development modes. This step was helpful for detecting the differences of the micro relief within the almost flat areas.

Landsat image composite of Enhanced Thematic Mapper (ETM7) with bands 2, 3 and 4 was used to add an extra landscape assessment to the soil map. The image was helpful for getting a collective overall view of the study area as well as using the spectral signatures of the used bands in detecting the cultivated areas and drainage conditions.

2) Visual analysis of Thematic Mapper landsat (TM):

The studied area lies between latitudes 28^o 22' to 28^o 28' north and longitudes 30^o 26' to 31^o 03' east. Images of Landsat 7 Thematic Mapper (TM) were used for the purpose of visual analysis. The pixel size is a mixture of 28.5 and 30 meters. The composite output was of benefit especially when focusing on the infrared bands that permit the detection and discrimination of broad combinations of different vegetation cover types and identification of water bodies, active drainage, drainage conditions, cultivated areas, and rock types. The Landsat 7 was acquired during the year 2000 (path 175 rows 42, resolution 28.5 to 30 m).

3. Field work:

The preliminary interpretation map was checked in the field to confirm the boundaries of the physiographic units. Soil profiles, representing different physiographic units of the studied area were taken in sites representing the predominant characteristics of each unit. Twelve soil profiles were dug to the depth of 150 cm, or lithic contact, Map (1).

Soil profiles were described, using **Soil Survey Division Staff Manual (USDA, 2003)**. Soil samples were air dried, crushed, with wooden hammer, sieved through a 2 mm sieve to obtain the fine earth used for physical and chemical analysis

4. Laboratory analyses:

Particle size distribution was carried out according to method undertaken by **Piper (1950)**, $CaCO_3$ content by using the Collin's Calcimeter **(Black *et al.,* 1965)**. The chemical analysis of soil paste extract was determined according to **Jackson (1969)**. Soil pH was measured in the saturated soil paste **(Richards, 1954)**. Gypsum was determined by the acetone method **(Bower and Huss, 1948)**. Cation exchange capacity (CEC) and the exchangeable cations were determined according to **Tucker (1954)**.

5. Soil classification:

Soils were categorized from soil order to the family level according to the **Soil Taxonomy (USDA, 1999) and the Key of Soil Taxonomy (USDA, 2003)**.

6. Land suitability classification:

Land suitability classification for specific crops was done according **to Sys *et al.* (1991)**, which based on matching the land characteristics with the crop requirements, considering the limitation intensity.

RESULTS AND DISCUSSION:

1). Physiographic-soil units:

Physiographic-soil legend has been set up, associated with the morphological description of the representative soil profiles, as shown in Table (1). Soil taxa after soil physical and chemical analyses, which are presented in Tables 2, 3 and 4, respectively. The physiographic soil units were delineated in Map (1), and they were categorized as follows:

a. Nile alluvial plain (A):

The Nile alluvial plain is produced by lateral movement of a stream and by over bank deposition **(Kimber, 2004**). Land surface is flat, almost flat and a slightly undulating, which produced by extensive deposition of the Nile alluvium. With other wards, it was formed after seasonal and periodic flooding of the stream, with somewhat well drained soils of heavy-textured parent material. The soils of this unit are subjected to the swelling and shrinkage process fitting the main requirement to be *Vertisols*. The plain soils of this plain are cultivated and separated from the River Nile channel by levees.

Table (1): Morphological description of the studied soil profiles.

Physiographic units	Profile No.	Depth (cm)	Soil taxonomic unit	Slope gradient	Horizon	Soil colour	Modified texture class	Soil structure	Soil consistency
Nile alluvial plain	1	0-25	Typic Haplotorrerts clayey, semectitic, hyperthermic	Flat	AP	10YR4/2m	C	Medium moderate subangular blocky	Firm
		25-40			C1	10YR4/3m	C		Firm
		40-60			C2	10YR4/2m	C		Firm
		60-150			C3	10YR4/2m	C		Firm
	2	0-20	Halic Haplotorrerts, clayey, semectitic , hyperthermic	Almost flat	AP	10YR5/2m	C	Weak medium subangular blocky	Firm
		20-50			C1	10YR5/2m	C		Firm
		50-100			C2	10YR4/2m	C		Firm
River bank	3	0-30	Typic Torriorthents, coarse loamy, mixed, hyperthermic	Almost flat	AP	10YR5/2m	SCL	Weak medium subangular blocky	Firm
		30-50			C1	10YR5/2m	SCL		Firm
		50-100			C2	10YR4/2m	SCL		Firm
Islands	4	0-15	Typic Torriorthents, sandy, mixed, hyperthermic	Almost flat	AP	10YR7/6m	LS	Single grain	Very friable
		15-40			C1	10YR7/6m	LS	Single grain	Very friable
		40-60			C2	10YR7/4m	LS	Single grain	Very friable
		60-150			C2	10YR7/3m	LS	Single grain	Very friable
	5	0-15	Typic Torriorthents, coarse loamy, mixed, hyperthermic	Almost flat	AP	10YR7/6m	LS	Single grain	Very friable
		15-40			C1	10YR7/6m	LS	Massive	Very friable
		40-60			C2	10YR8/4m	SL	Massive	Friable
		60-150			C3	10YR8/4m	SL	Massive	Friable
Alluvial terraces	6	0-20	Typic Calcigypsids, fine loamy, mixed, hyperthermic	Gently undulating	A	10YR7/4d	GSCL	Massive	Slightly hard
		20-40			C1	10YR8/4d	VGSC	Massive	Slightly hard
		40-75			C2	10YR7/4d	GSCL	Massive	Hard
		75-150			C3	10YR7/4d	GSCL	Massive	Hard
	7	0-20	Typic Haplocalcids, fine loamy, mixed, hyperthermic	Gently undulating	A	10YR7/4d	GSCL	Massive	Slightly hard
		20-P70			C1	10YR8/4d	VGSC	Massive	Hard
		70-			C2	10YR7/4d	GSCL	Massive	Hard
Aeolian deposits	8	0-15	Typic Torripsamments, siliceous, hyperthermic	Gently undulating	C1	10YR7/6d	S	Single grain	Loose
		15-35			C2	10YR7/6d	S	Single grain	Loose
		35-150			C3	10YR7/6d	S	Single grain	Loose
	9	0-20		Almost flat	C1	10YR7/6d	S	Single grain	Loose
		20-60			C2	10YR7/6d	S	Single grain	Loose
		60-150			C3	10YR7/6d	S	Single grain	Loose
	10	0-20	Typic Torriorthents, coarse loamy, mixed, hyperthermic	Almost flat	C1	10YR7/6d	SL	Massive	Friable
		20.55			C2	10YR7/6d	SL	Massive	Friable
		55-150			C3	10YR7/6d	S	Single grain	Loose
Wadi	11	0-15	Typic Torrifluvents, fine loamy over sandy, mixed, hyperthermic	Almost flat	C1	10YR7/6d	SGLS	Single grain	Loose
		15-35			C2	10YR7/6d	SGSCL	Massive	Hard
		35-65			C3	10YR7/6d	SGS	Massive	Slightly hard
		65-150			C4	10YR7/6d	SGS	Massive	Slightly hard
	12	0-25	Typic Torrifluvents, loamy skeletal, mixed, hyperthermic	Almost flat	C1	10YR7/4m	VGSCL	Massive	Slightly hard
		24-75			C2	10YR8/4m	GSCL	Massive	Slightly hard
		75-150			C3	10YR6/4m	GSL	Massive	Slightly hard

Soil texture: S=Sand, LS=Loamy sand, SL=Sandy loam, SL=Gravely sandy loam, SCL=Sandy clay loam, C=Clay, G=Gravelly, SG=Slightly gravelly, VG=Very gravelly

Table (2): Particle size distribution, $CaCO_3$ and gypsum contents of the studied soil profiles.

Physiographic units	Profile No.	Depth (cm)	Gravel %	Particle size distribution %				Modified texture class	$CaCO_3$ %	$CaSO_4.2H_2O$%
				C. sand	F. sand	Silt	Clay			
Nile alluvial plain	1	0-25	0.0	6.0	25.8	26.0	42.2	C	3.2	1.32
		25-40	0.0	5.4	20.9	27.9	45.8	C	2.4	1.70
		40-60	0.0	4.4	23.1	23.0	49.5	C	3.0	1.64
		60-150	0.0	4.3	20.1	26.1	49.5	C	3.4	1.55
	2	0-20	0.0	6.0	18.1	20.2	55.7	C	0.2	0.20
		20-50	0.0	6.2	17.9	15.2	60.7	C	2.7	1.97
		50-100	0.0	5.4	16.2	15.0	63.4	C	3.2	1.93
River bank	3	0-30	0.0	26.0	37.8	18.0	18.4	VGSC	6.1	0.40
		30-50	0.0	28.5	24.6	20.9	26.5	VGSCL	3.8	0.40
		50-100	0.0	17.4	36.0	18.1	28.5	GSCL	5.9	0.50
Islands	4	0-15	0.0	15.2	67.6	8.0	9.2	LS	2.0	1.36
		15-40	0.0	33.0	47.2	9.1	9.7	LS	1.4	1.35
		40-60	0.0	54.8	25.5	12.4	7.3	LS	1.4	1.64
		60-150	0.0	62.5	18.1	8.3	11.1	LS	1.2	1.66
	5	0-15	0.0	51.6	35.0	8.3	5.1	LS	1.9	1.8
		15-40	0.0	33.4	50.7	13.5	2.4	LS	1.8	1.48
		40-60	0.0	25.6	42.9	16.2	15.3	SL	1.9	1.30
		60-150	0.0	23.2	45.0	14.7	17.1	SL	1.6	1.55
Alluvial terraces	6	0-20	35.0	39.1	17.6	14.8	28.5	VGSCL	10.6	1.35
		20-40	40.0	37.7	25.9	18.5	17.9	VGSC	28.4	9.40
		40-75	35.0	28.3	24.3	19.8	27.6	VGSCL	9.2	1.41
		75-150	30.0	36.1	17.3	18.1	28.5	GSCL	9.8	1.35
	7	0-20	35.0	22.8	27.2	21.2	28.8	VGSCL	35.0	2.80
		20-70	35.0	37.4	27.6	16.9	18.1	VGSL	51.7	2.50
		70-	35.0	27.9	37.1	17.2	17.8	VGSL	53.0	2.30
Aeolian deposits	8	0-15	0.0	86.2	5.3	5.8	2.7	S	7.5	1.40
		15-35	0.0	81.1	7.4	7.0	4.5	S	8.9	1.70
		35-150	0.0	84.1	5.0	6.8	4.1	S	9.7	1.60
	9	0-20	0.0	81.7	5.6	7.5	5.2	S	10.9	1.80
		20-60	0.0	80.7	5.5	8.0	5.9	S	12.0	1.90
		60-150	0.0	79.6	5.3	8.5	6.6	S	13.1	2.00
	10	0-20	0.0	40.6	27.9	16.0	15.5	SL	7.5	1.40
		20.55	0.0	45.2	23.0	15.7	16.1	SL	8.2	1.63
		55-150	0.0	80.1	9.0	6.4	4.5	S	9.0	1.41
Wadi	11	0-15	5.0	62.5	20.6	10.1	6.8	SGLS	30.8	2.15
		15-35	10.0	28.9	22.1	20.7	28.3	SGSCL	32.6	2.17
		35-65	5.0	31.0	24.5	16.3	28.2	SGSCL	36.4	1.74
		65-150	5.0	56.8	31.4	6.1	5.7	SGS	31.3	2.50
	12	0-25	40.0	32.3	22.8	16.8	28.1	VGSCL	9.6	1.25
		24-75	35.0	36.5	26.0	19.4	28.1	VGSC1	10.9	1.44
		75-150	30.0	27.0	27.1	22.7	23.2	GSCL	9.3	1.51

Soil texture: S=Sand, LS=Loamy sand, SL=Sandy loam, SL=Gravely sandy loam, SCL=Sandy clay loam, C=Clay, G=Gravelly, SG=Slightly gravelly, VG=Very gravelly

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

Physiographic units	Profile No.	Depth (cm)	pH (soil paste)	EC (dS/m)	Cations (mmol$_c$ L^{-1})				Anions (mmol$_c$ L^{-1})		
					Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
Nile alluvial plain	1	0-25	7.7	4.5	11.90	8.90	22.50	2.10	3.70	30.40	11.30
		25-40	7.9	2.4	7.60	6.40	8.60	1.30	2.70	13.60	7.60
		40-60	8.0	2.8	8.10	6.30	11.30	1.40	2.40	16.40	8.30
		60-150	7.8	2.6	8.80	6.70	8.10	1.90	2.90	14.10	8.50
	2	0-20	8.0	20.3	59.50	31.20	123.20	4.20	4.90	130.90	82.30
		20-50	7.8	17.6	32.50	18.70	126.20	4.20	4.30	113.40	63.90
		50-100	7.9	179.3	31.70	17.40	143.80	6.40	4.30	138.80	56.20
River bank	3	0-30	7.9	2.8	8.00	6.10	11.50	1.55	2.40	16.00	8.80
		30-50	8.0	2.3	7.40	5.20	7.10	1.60	2.30	12.00	8.40
		50-100	7.8	2.5	7.30	6.20	9.50	1.30	2.50	13.00	8.70
Islands	4	0-15	7.7	2.5	7.60	6.70	8.40	1.45	2.10	14.50	7.55
		15-40	7.8	3.2	11.10	6.10	12.70	1.50	2.50	16.60	12.30
		40-60	7.8	3.1	8.70	5.90	14.10	1.35	2.05	18.70	9.30
		60-150	8.0	4.6	12.10	9.10	22.90	2.20	2.90	29.40	14.00
	5	0-15	7.5	2.5	7.70	7.30	8.20	1.05	2.20	13.90	8.15
		15-40	7.7	2.8	8.10	5.90	11.70	1.45	2.40	16.30	8.45
		40-60	8.0	2.2	7.10	5.50	8.10	1.25	2.30	11.50	8.15
		60-150	7.7	2.5	8.30	5.10	9.45	1.15	2.60	14.10	7.30
Alluvial terraces	6	0-20	8.0	6.2	19.80	13.10	27.40	2.50	3.30	42.10	17.40
		20-40	8.2	5.0	14.20	8.40	26.90	2.10	3.90	37.00	10.70
		40-75	8.3	6.2	18.00	7.70	36.60	2.70	5.30	39.30	20.40
		75-150	7.9	6.1	20.80	10.70	30.20	2.70	3.70	42.70	18.00
	7	0-20	7.8	6.87	24.27	11.23	34.53	3.10	4.10	45.37	23.67
		20-70	7.7	7.42	27.57	12.38	36.18	3.40	4.00	48.22	27.32
		70-	7.5	7.97	30.87	13.53	37.83	3.70	3.90	51.07	30.97
Aeolian deposits	8	0-15	8.0	2.6	8.60	5.00	9.90	1.50	2.05	15.60	7.35
		15-35	8.0	3.0	9.90	5.00	12.57	1.53	2.50	19.50	7.00
		35-150	8.3	2.8	8.80	5.90	10.85	1.45	2.90	17.00	7.10
	9	0-20	8.0	2.9	10.40	5.50	12.00	2.10	2.40	19.50	7.00
		20-60	8.1	3.0	10.80	5.95	8.80	1.55	2.80	17.00	7.10
		60-150	7.9	2.8	9.60	5.50	11.70	1.70	2.65	17.70	7.75
	10	0-20	7.5	8.10	32.00	15.00	37.83	3.70	3.90	51.07	30.97
		20.55	7.8	6.60	23.00	12.50	36.00	3.00	4.10	47.00	20.00
		55-150	7.7	7.60	28.00	13.00	35.00	2.50	3.40	46.00	30.00
Wadi	11	0-15	7.7	4.9	11.70	8.40	30.20	2.00	3.60	32.00	16.70
		15-35	7.6	5.2	12.60	6.70	29.20	2.70	4.40	35.10	11.70
		35-65	7.5	3.8	10.20	6.30	18.20	2.30	4.70	24.90	7.40
		65-150	7.7	5.1	11.60	7.40	27.70	2.90	3.30	25.50	20.80
	12	0-25	8	5.2	16.40	12.10	21.10	3.50	2.90	41.10	9.10
		24-75	8.2	5.1	14.10	8.40	23.90	2.00	4.00	38.00	6.40
		75-150	8.3	5.8	17.00	7.70	33.60	2.30	5.00	39.00	16.60

CO_3^{--} not detected

Table (4): Cation exchange capacity and exchangeable cations of the studied soil profiles.

Physiographic units	Profile No.	Depth (cm)	CEC ($cmol_c\,kg^{-1}$)	Exchangeable cations ($cmol_c\,kg^{-1}$)				ESP
				Ca++	Mg++	Na+	K+	
Nile alluvial plain	1	0-25	41.80	20.00	15.35	3.52	3.45	8.42
		25-40	44.10	22.60	15.74	4.04	3.29	9.16
		40-60	48.20	25.61	15.30	4.93	4.01	10.23
		60-150	48.40	24.50	16.80	3.36	3.39	6.94
	2	0-20	48.20	22.85	14.85	9.78	2.37	20.29
		20-50	50.11	23.83	14.79	10.65	2.49	21.25
		50-100	53.79	25.01	15.65	10.94	3.84	20.34
River bank	3	0-30	14.79	8.89	3.69	2.02	1.84	13.66
		30-50	13.29	8.33	3.50	1.38	1.74	10.38
		50-100	13.29	8.33	3.50	1.38	1.74	10.38
islands	4	0-15	7.20	2.80	3.08	0.75	1.60	10.42
		15-40	8.30	2.78	3.18	0.16	1.60	1.93
		40-60	5.93	1.78	2.19	0.20	1.60	3.37
		60-150	9.04	2.80	3.35	0.16	2.02	1.77
	5	0-15	3.40	2.60	0.90	0.30	1.95	8.82
		15-40	2.76	1.78	0.80	0.33	1.80	11.96
		40-60	11.17	8.49	4.94	0.41	1.98	3.67
		60-150	13.73	8.00	4.91	0.57	1.90	4.15
Alluvial terraces	6	0-20	15.42	8.02	5.60	1.40	2.05	9.08
		20-40	13.55	7.20	5.90	0.50	1.60	3.69
		40-75	15.70	9.00	5.70	1.05	1.60	6.69
		75-150	14.40	7.95	5.70	0.70	1.70	4.86
	7	0-20	15.40	8.80	5.57	0.95	1.73	6.17
		20-70	15.83	9.18	5.47	1.05	1.78	6.64
		70-	16.25	9.55	5.37	1.15	1.83	7.08
Aeolian deposits	8	0-15	5.20	3.20	1.90	0.20	1.55	3.85
		15-35	3.00	1.33	1.80	0.32	1.54	10.67
		35-150	3.48	2.58	0.90	0.25	1.50	7.18
	9	0-20	5.40	3.00	1.80	0.20	1.55	3.70
		20-60	4.00	2.00	1.70	0.32	1.30	8.00
		60-150	4.20	3.00	1.50	3.00	1.30	71.43
	10	0-20	10.10	5.20	3.70	0.60	0.55	7.02
		20.55	9.45	4.50	3.90	0.50	0.50	6.33
		55-150	4.00	2.70	1.30	0.30	1.50	7.50
Wadi	11	0-15	3.75	2.19	1.50	0.30	1.71	8.00
		15-35	15.85	7.80	5.80	0.95	2.95	5.99
		35-65	16.00	7.62	6.51	0.82	2.70	5.13
		65-150	2.08	1.53	0.80	0.41	1.51	19.71
	12	0-25	14.20	7.02	5.53	1.38	1.92	9.72
		24-75	14.40	7.82	5.91	0.34	1.98	2.36
		75-150	13.91	6.62	5.89	1.05	2.00	7.55

b. River bank (B):

According to **Mount (1995)**, in asymmetric channels, the velocities and gradients of the Nile water always are located adjacent to the steep-walled cut banks. The concentration of bed shear stress along the cut bank margin of asymmetric channels will cause them to erode the channel wall and expand laterally. In asymmetric channels, deposition is usually restricted to the low-velocity margin of the channel opposite the most intense erosion. Bank is located at the opposite site of levee

c. Island (I):

This bar appears inside meander bends as asymmetrical islands, surrounded by water, with different elevations.

d. Alluvial terraces (T):

In general, the terraces that are highest and furthest away from a river are the oldest whereas the modern floodplain or terrace is the lowest one and the present riverbank. They are remnants of formerly deposited floodplain during a process preceded the recent River Nile deposits of Holocene Era **(Said, 1990)**.

This unit is characterized with many surfaces, which differ in features, elevations and the degree of parent material development. These terraces are deposited by water action and include tow sub units, old alluvial terraces and young alluvial terraces. Old terraces are higher, more developed and having more fragments compared with the young terraces.

- Old alluvial terraces:

They are dissected by drainage pattern of channels and gullies. The surface of this sub-unit covered by stones and gravel. Parent materials were derived from sedimentary rocks (limestone), and include fragments, related to those rocks and a drainage network.

- Young Alluvial Terraces:

This physiographic sub-unit has riled, gravelly and gently undulating surfaces. Parent materials of sub-unit were derived from the limestone rocks and transported by water during the fluvial periods. The surface level is a resultant of erosion processes. They are relatively low, having less undulation and less developed parent material, compared with those of the old terraces.

e. Aeolian plain (E) or Eolian:

Aeolian plain is found in areas of the Earth where erosion and deposition by wind are the dominant geomorphic forces. Areas influenced by wind include most of the dry climates of the Earth and are classified as arid deserts and semi-arid steppe. Different processes are responsible for the transport of sediment by wind as rolling motion that called traction and suspension. This type of transport is called saltation.

Sand dunes are formed in the environments that favor the deposition of sand. Deposition occurs in areas where a pocket of slower moving air forms next to much faster moving air. Such pockets typically form behind obstacles like the leeward sides of slopes. As the fast air slides over the calm zone, saltating grains fall out of the air stream and accumulate on the ground surface.

f. Wadis:

This unit is also called Wadi, Wash, Dry Wash, or Coulee, Arabic Wadi, and it is found as a dry channel lying in a semi-arid or desert area and subject to flash flooding during seasonal or irregular rainstorms. Such transitory streams, rivers, or creeks are noted for their gullying effects and especially for their rapid rates of erosion, transportation, and deposition. There have been reports of up to 8 feet (2 m) of deposition in 60 years and like amounts of erosion arroyo. Wadis are the streams in a desert environment and generally are dry year round, except after a rain. The deposition of wadi is rapid because of the sudden loss of the velocity and absorption of the water into the ground. Fluvial activity in a desert environment is also characterized by the flash flood. Wadi ranges in size from small gullies, through large, broad valleys, to large, deep canyons

The surface of wadi is almost flat, partly vegetated with very open zerophytic herbaceous as natural vegetation on well-drained soils. They appear as dry wadis that seasonally receive flush flooding, running from east to west or northwest, draining into the River Nile, causing seasonally flooding hazards.

II. Soil classification:

a. Soils of the Nile alluvial plain (A):

The Nile alluvial plains are subdivided into two parts as follows:

- ***High parts (A1):*** Flat relatively young plain: The soils of this plain are classified within the *Vertisols* to be *Typic Haplotorrerts, clayey, semectitic, hyperthermic*. The soil of this family is clayey; being a control section is fully characterized by clayey layers. This soil is represented by profile No. 1.
- ***Low parts (A2):*** Almost flat relatively developed slightly depressed plain: The polygons of this unit occupy the far west areas of the broad Nile alluvial plain as slightly depressed spots, which are most probably represent an old river bed of decayed River Nile branch. The representative soils are classified as *Halic Haplotorrerts, clayey, semectitic, hyperthermic*. This soil family is highly saline, where the salinization process shift the taxonomic unit to be *Halic* rather than *Typic* (soil profile No. 2).

b. Soils of River bank (B):

The soils of the River banks are cultivated, flat and well drained soils. They occupy strips aligning the River Nile course, and are classified as *Typic Torriorthents, fine loamy, mixed hyperthermic.* The profile control section is dominated by sandy clay loams textural class. They are represented by profile No. 3.

c. Soils of Island (I):

This unit is subdivided into two main parts as follows:

- The bar is cultivated, and consists of excessively well drained coarse-grained soils, which are classified as *Typic Torriorthents, sandy, mixed*

hyperthermic. These soils are sandy; somewhat being the textural class dominated by loamy sands. They are represented by soil profile No. 4.
- The soils of the second part could be classified as *Typic Torriorthents, coarse loamy, mixed hyperthermic*. They are represented by profile No. 5.

d. Soils of Terraces (T):

These soils are characterized by sandy clay loams, and including more than 35% by volume coarse fragments. The soils are represented by soil profile Nos. 6 and 7.

- Old alluvial terraces:

The soils of this physiographic sub-unit are represented by profile No 6, and classified as T***ypic Calcigypsids, fine loamy, hyperthermic***.

- Young alluvial Terraces:

They are relatively low, having less undulation and less developed parent material as compared with those of the old terraces. This physiographic subunit is represented by profile No. 7, and classified as T***ypic Haplocalcids, fine loamy, hyperthermic***.

e. Soils of Aeolian plain (E):

The parent material of this physiographic unit is deposited by wind action, and it is divided into the following sub-units:

- Barchans dunes:

The representative soils are gently undulating, excessively well drained, and are represented by profile No. 8. They could be classified as: ***Typic Torripsamments, siliceous, hyperthermic***.

- Aeolian deposits:

The representative soils are almost flat, well drained, not cultivated and represented by profile No. 9. These soils are classified as ***Typic Torripsamment, siliceous, hyperthermic.***

- Aeolian plain:

The representative soils are almost flat, well drained, cultivated and represented by profile No. 10. The presence of a sandy loam texture layer within the sandy texture made effect to shift the taxonomic unit from psamments to orthents. So, These soils are classified as ***Typic Torriorthent, coarse loam, mixed, hyperthermic***.

f. Wadis:

The soils of wadis occur in a complex pattern and dominated by two taxonomic units of *Torrifluvents*. They are classified as *soil complex of Typic Torrifluvents, fine loamy skeletal over sandy, mixed, (calcareous).* The second *Fluvents* are *Typic Torifluvents, loamy skeletal, mixed, hyperthermic.* These soils are represented by soil profile Nos. 10 and 11.

III. Land evaluation:

In this study, the physiographic soil map was used as a base for presenting land suitability classes. The simple approach that proposed by **Sys (1991)** was selected for land suitability evaluation of the studied area, since it is valid for irrigation purposes in arid and semi arid regions. By using this approach, the classification was processed according to the **FAO Framework (1976)**, at the level of sub-classes.

The evaluation of land characteristics was done by rating them and specifying their limitations by matching the calculated rating with the crop requirements in different suitability levels as proposed by **Sys et al. (1993)**.

i) Current land suitability classification (CS):

Without major land improvement, the crop requirements were matched with the present land qualities for assessment the current land suitability of the different physiographic units in the studied area. This approach enables management of different alternatives for specific utilizations. These utilizations are adapted to the existing soil limitations to give maximum output. The overall current suitability assessments are shown in Table (5), whereas the supreme current land suitability assessments were tabulated.

ii) Potential land suitability classification (PS):

For this purpose, the land suitability classification was based on the suitability of certain land for specific crops. It is applicable after executing specified major land improvements as proposed in this study according to their necessity. For establishing potential land suitability classification, the main land improvements for the studied area are considered for the land qualities of drainage, salinity and sodicity. The minor soil limitations can be improved under specific land management, concerning each of them.

The obtained potential land suitability sub-classes were sorted for the maximum productive levels (supreme potential land suitability). The selected crop-land adaptations to be the supreme land suitability for specific utilized crops are shown in Table (5).

These adaptations could be described in a supreme potential suitability as follows:

a. Highly suitable (S1) adaptations:

- *Nile alluvial plain:* The soils of this unit are suitable for wheat, barley, maize, cotton, sunflower, tomato, alfalfa, sorghum, banana, citrus, guava, mango and olive.
- *River bank*: The soils of this unit are suitable for all the aforementioned crops, except of banana.
- *Island:* The soils of this unit are suitable for the previous crops.
- *Alluvial terraces*: The soils of this unit are suitable for sunflower and olive.
- *Aeolian plain*: The soils of this unit are suitable for olive.
- *Wadis:* The soils of this unit are suitable for olive and partly sunflower or sorghum.

b. Moderately suitable (S2) adaptations:

- *Nile alluvial plain:* The soils of this unit are suitable for wheat, barley, tomato and partly banana.
- *Island:* The soils of this unit are suitable for wheat, barley and partly tomato or banana.

- *Alluvial terraces*: The soils of this unit are suitable for wheat, barley, maize, cotton, tomato, alfalfa, sorghum, banana, citrus, guava and mango.
- *Aeolian plain*: The soils of this unit are suitable for maize, cotton, tomato, alfalfa, sorghum and citrus.
- *Wadis:* The soils of this unit are suitable for maize and guava as well as partly suitable for wheat, barley, cotton, tomato, alfalfa, sorghum, banana, citrus and mango.

Table (5): Current and potential suitability of the soils developed on the identified physiographic units for cereal crops, field crops, vegetables, fodder crops and fruit trees.

Physiographic units	Profile No.	Cereal crops						Field crops				Vegetables	
		Wheat		Barley		Maize		Cotton		Sunflower		Tomato	
		CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS
Nile alluvial plain	1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S2m	S1
	2	N1s	S1	S3s	S1	N1s	S1	S3s	S1	N1s	S1	N1s	S1
River bank	3	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S2m	S1
Island	4	S2x	S2x	S2x	S2x	S2m	S1	S2x	S2x	S2m	S1	S2m	S2m
	5	S2m	S2m	S2x	S2x	S1	S1	S1	S1	S2m	S1	S1	S1
Alluvial terraces	6	S3m	S2m	S2m	S2m	S2m	S2m	S2m	S2m	S2m	S1	S3m	S2m
	7	S3m	S2m	S2m	S2m	S2m	S2m	S2m	S2m	S2m	S1	S3m	S2m
Aeolian deposits	8	N1x,s	S3x	N1x,s	S3x	N1x,s	S2m	S3x,s	S2m	N1x,s	S3x	N1s	S2m
	9	N1x,s	S3x	N1x,s	S3x	N1x,s	S2m	S3x,s	S2m	N1x,s	S3x	N1s	S2m
	10	N1x,s	S3x	N1x,s	S3x	N1x,s	S2m	S3x,s	S2m	N1x,s	S3x	N1s	S2m
Wadi	11	S3x	S3x	S3x	S3x	S3m	S2m	S3c	S3c	N1c	S3c	S3c	S3c
	12	S3m	S2m	S2m	S2m	S2m	S2m	S2m	S2m	S2m	S1	S3c	S2m

Table (5): Cont.

Physiographic units	Profile No.	Fodder crops				Fruit trees									
		Alfalfa		Sorghum		Banana		Citrus		Guava		Mango		Olive	
		CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS	CS	PS
Nile alluvial plain	1	S1	S1	S1	S1	S3m	S1	S2m	S1	S2m	S1	S2m	S1	S1	S1
	2	N1s	S1	S3s	S1	N2s,n	S1	N1s,n	S1	N1s	S1	N1s	S1	S3s	S1
River bank	3	S1	S1	S1	S1	S3x	S2x	S2m	S1	S2m	S1	S1	S1	S1	S1
Island	4	S1	S1	S1	S1	S3x	S2x	S2m	S1	S3x	S2m	S2m	S1	S1	S1
	5	S1	S1	S1	S1	S3x	S2x	S2m	S1	S2m	S1	S1	S1	S1	S1
Alluvial terraces	6	S2m	S2m	S2m	S2m	S3c,s	S2m	S3c,s	S2m	S3s	S2m	S3c	S2m	S1	S1
	7	S2m	S2m	S2m	S2m	S3c,s	S2m	S3c,s	S2m	S3s	S2m	S3c	S2m	S1	S1
Aeolian deposits	8	N1x,s	S2x	S3x,s	S2m	N1x,s	N1x	N1s	S2m	N1x,s	S3x	N1x,c	S3x	S2m	S1
	9	N1x,s	S2x	S3x,s	S2m	N1x,s	N1x	N1s	S2m	N1x,s	S3x	N1x,c	S3x	S2m	S1
	10	N1x,s	S2x	S3x,s	S2m	N1x,s	N1x	N1s	S2m	N1x,s	S3x	N1x,c	S3x	S2m	S1
Wadi	11	S3c	S3c	S1	S1	N1x,c	N1x,c	N1c	S3c	S3c	S2m	N1c	S3c	S1	S1
	12	S2m	S2m	S2m	S2m	S3c,s	S2m	S3c,s	S2m	S3s	S2m	S3c	S2m	S1	S1

Suitability classes: CS=Current suitability, PS=Potential suitability, S1=Highly suitable, S2=Moderately suitable, S3=Marginally suitable, N1=Currently not suitable, N2=Potentially not suitable

Soil limitations: d=drainage, x=texture, g=gravel%, p=soil depth, c=calcium carbonate %, y=gypsum %, s=salinity (EC), n=ESP, m= accumulation of minor limitations]

c. Marginally suitable (S3) adaptations:

- *Aeolian plain*: The soils of this unit are suitable for wheat, barley, sunflower, guava and mango.
- *Wadis:* The soils of this unit are suitable for wheat and partly for barley, cotton, sunflower, tomato, alfalfa, citrus and mango.

REFERENCES:

Black, C.A.; D.D. Evans; L.E. Ensminger; J.L. White and F.E. Clark 1965. Methods of Soil Analysis. Am. Soc. of Agron. Inc., Madison, Wisconsin, USA.

Bower, C.A. and Huss, R.B. 1948. Rapid conductometric method for estimating gypsum in soils. Soil Sci., 66: 199.

Burnigh, P. 1960. The applications of aerial photographs in soil surveys. Man. of Photogr. Interpr., Washington, D.C., USA.

FAO 1976. A Framework for Land Evaluation. Soil Bull., No.32, Rome, Italy.

Goosen, A.A.I. 1967. Aerial photo-interpretation in soil survey. FAO, Soil Bull. No. 6, Rome, Italy.

Jackson, M.L. 1969. Soil Chemical Analysis. Advanced Course, Publ. by Author, Dept. of Soils, Univ. Wisc., Madison , USA.

Kimber, Clarissa 2004. Geographical Review, Iu12004, Vol. 94, Issue 3: 263-283.

Mayers, V.I. 1975. Crops and Soils. Manual of Remote Sensing, R.V. Ressve Ed., Am. Soc. of Photogramm, Fatts Church, Virginia, pp. 1715-1813.

Mount, J.F. 1995. California Rivers and Streams. The Conflict Between Fluvial Process and Land Use, Chapter 4, Publisher Univ. of California, USA.

Munsell Soil Color Charts, 1975. Edition Munsell Color, Macbeth Division of Kollmorgen Corp, 2441 North Calvert Street, Baltimore, Maryland, USA.

Piper, C.S. 1950. Soils and Plant Analysis. Inter Science Publishers Inc., New York, pp. 59-75.

Richards, L.A. 1954. Diagnosis and Improvement of Saline and Alkali Soils. U.S. Dep. of Agric., Hand Book, No.60, pp. 102.

Said, R. 1990. The Geology of Egypt. Published for the Egyptian Central Petroleum Corporation, Conoco Hurghada Inc. by Balkema, A.A., Roterdam, The Netherlands.

Siegal, B.S. and Abrams, M.J. 1976. Geological mapping using landsat data. Photogramm. Engin. and Remote Sensing, 44: 325.

Sys, C. 1991. Land evaluation. Parts I, II and III, Lecture Notes, Ghent Univ., Ghent, Belgium.

Sys, C.; E. Van Ranst; J. Debaveye and F. Beernaert 1993. Land Evaluation. Part III: Crop Requirements. Agricultural Publication No.7, General Administration for Development Cooperation, Ghent, Belgium.

Tucker, B.M. 1954. The determination of exchangeable calcium and magnesium in calcareous soils. Aust. J. Agric. Res., 5: 706-715.

USDA 1999. Soil Taxonomy: A basic system of soil classification for making and interpreting soil survey. A Revised 2nd Edition, USDA Handbook 436, U.S. Gov. Print., Washington, D.C., USA.

USDA 2003. Keys of Soil Taxonomy. 9th Edition, United States Department of Agriculture, USA.

USDA 2003. Soil Survey Manual. United States Department of Agriculture, Handbook 18, U.S. Gov. Print, Washington, D.C., USA.

إستخدام صور الأقمار الفضائية لتقييم الأراضى فى الأغراض الزراعية فى بعض مناطق محافظة المنيا - مصر

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تقع منطقة الدراسة بين خطى عرض بين خطي عرض ٢٢' ٢٨°، ٢٨' ٢٨° شمالاً وخطي طول ٢٦' ٣٠° ٣٠، ٠٣' ٣٠° شرقاً. وباستخدام التحليل المرئ لصور الأقمار الفضائية (ETM 7) اتضح أن منطقة الدراسة الواقعة بمحافظة المنيا تعتبر نموذجا جيدا لتمثيل العديد من معظم ملامح الوحدات الارضية في مصر. كما وأن منطقة الدراسة تشتمل على كلا الترسيبات القارية لنهر النيل والتكوينات الصحراوية المتخامنة لنهر النيل والتي اشتقت من الصخر الأم المحلي. وبتحليلها فيزيوجرافياً، وجد أن هذه الترسيبات قد تكونت على العديد من الوحدات الفيزيوجرافية ممثلة فى السهل الفيضى لنهر النيل، ضفاف النهر، الجزر النهرية، المصاطب الرسوبية، سهل الترسيبات الهوائية، الوديان. بالنسبة للتكوينات الصخرية فتتواجد فى شكل من بروزات صخرية. ولقد تم تمثيل التباينات بين الوحدات الفيزيوجرافية بدراسة تفصيلية لاثني عشرة قطاعا أرضيا أخذت منها عينات للتربة وتم تحليلها معمليا.

وصنفت خواص التربة حسب دليل نظام التصنيف الأمريكي لعامى ١٩٩٩، ٢٠٠٣ حتى مستوى عائلات التربة، حيث وجد ان الأراضي المتكونة تتبع ثلاث رتب تشتمل على العائلات التالية:

i) *<u>Vertisols:</u>* *Typic Haplotorrerts, clayey* and *Halic Haplotorrerts, clayey* in the Nile alluvial plain.

ii) *Aridisols: Typic Calcigypsids, fine loamy, mixed, hyperthermic* and *Typic Haplocalcids, fine loamy, mixed, hyperthermi*c in alluvial terraces unit.

iii) *<u>Entisols:</u>* *Typic Torriorthents, fine loamy* in the River bank unit; *Typic Torriorthents, sandy* and *Typic Torriorthents, coarse loamy* in the Island unit; *Typic Torrifluvents, fine loamy over sandy, (calcareous)* and *Typic Torrifluvents, loamy skeletal* in Wadis unit; *Typic Torripsamments, siliceous* and *Typic Torriorthents, coarse loamy* in Aeolian plain unit.

وتم تقييم أراضي الوحدات الفيزيوجرافية بغرض زراعة محاصيل معينة لتحديد درجة الصلاحية الأعلى لكل محصول في كل وحدة فيزيوجرافية سواء بالنسبة لصفات التربة الحالية أو بعد تحسينها، وقد اختير التقييم لحاصلات الحبوب (القمح، الشعير، الذرة)، للحاصلات الحقلية (القطن، دوار الشمس)، الخضر (الطماطم)، حاصلات العلف (البرسيم الحجازي، السورجم)، أشجار الفاكهة (الموز، الموالح، الجوافة، المانجو، الزيتون)، حيث قدمت هذه الموائمات بين الوحدات الفيزيوجرافية والمحاصيل المختلفة في شكل جداول لتكون دليلاً للاستخدام الافضل لأراضي منطقة الدراسة.