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Geomatics Based Soil Mapping and Degradation Risk Assessment of the Cultivated Land in El-Fayoum Depression, Egypt

R. R. Ali
Soils and Water Use Department, National Research Centre, Cairo, Egypt.

GEOMATICS technique was used in this study for producing physiographic – soil map of El-Fayoum Depression at large scale (1:250,000). Landsat ETM images and digital elevation model (DEM) are used in ENVI 4.2 software to produce the physiographic map of the studied area at the landform level. The obtained map shows that the area comprises three distinct landscapes; *i.e.*, alluvial plain (12.22%), fluvio-lacustrine plain (34.20%) and lacustrine plain (53.58%). The terraces of various origin and elevation are the main landforms (64.99% of the total area), while the overflow and decantation basins represent the rest of the area. The soils were classified to the sub-great group level on the basis of the Key to Soil Taxonomy. The correlations between the physiographic and taxonomic units were designed in order to produce the map of physiography and soils. The different soil units were represented by 16 soil profiles and 51 disturbed soil samples were collected and analyzed. The results were used for assessing the degradation hazard according to FAO guidelines. The hazard of each type was defined as low, moderate, high, and very high. The obtained data show that salinity, alkalinity and water logging are the main encountered degradation hazard. Values such as EC, ESP, and ground water level could reach 16.33 dS/m, 31.05 % and 40 cm respectively. These results will be of great help and basic sources for the planners and decision makers in sustainable planning.

Keywords: Geomatics, Physiographic and Soil mapping, Land degradation and El Fayoum Depression.

Fayoum Governorate is occupying a depression west of the Nile at 90 kilometers southwest of Cairo between latitudes 29° 02′ and 29° 35′ N and longitudes 30° 23′ and 31° 05′ E (Fig. 1). The climatic data of Fayoum district indicate that the total rainfalls does not exceed 7.2 mm/year and the mean minimum and maximum annual temperatures are 14.5 and 31.0°, respectively. The evaporation rates are coinciding with temperatures where the lowest evaporation rate (1.9mm/day) was recorded in January while the highest value (7.3 mm/day) was recorded in June (CLAC, 2004). According to the aridity index classes (Hulme & Marche, 1990) the area is located under arid climatic condition.

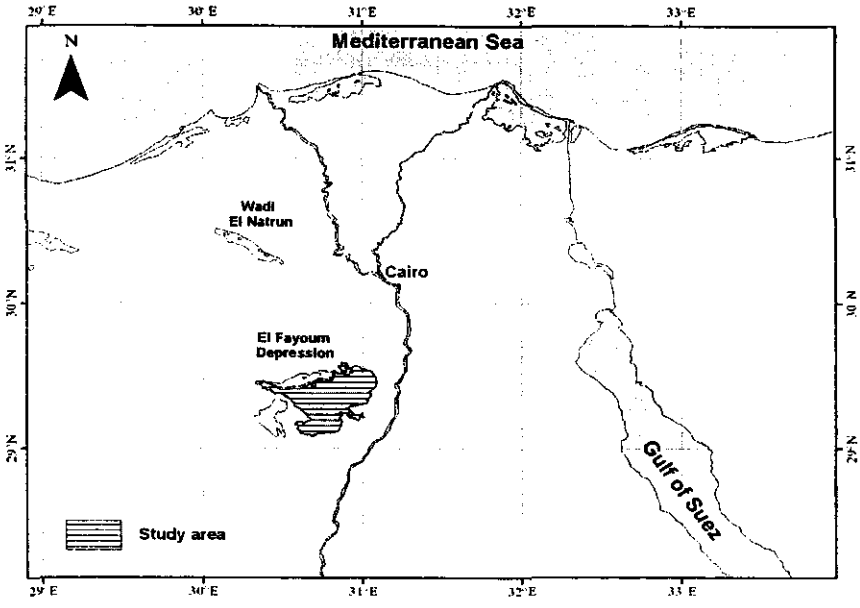

Fig. 1. Location of the study area .

The depression has a particular nature, differing from the Delta and Upper Egypt and from the oases as well. The differences are not limited to agriculture, they extend to geographical and topographical features as the environment vary between agricultural, desert and coastal. It occupies a portion of the Eocene limestone plateau at the northern part of the western desert and the subsurface lithology consists of marine sedimentary strata, which has undergone alternating periods of erosion and deposition. The present depression has been formed when the basin was subsided relative to the Nile River, allowing it to break through and to flood the area. This led to the formation of a thick fertile alluvium (Euroconsult, 1992). The main identified landforms in Fayoum depression are fans, resent and old lake terraces, depression, plain, and basins (Abo El- Enean, 1985).

With the present regime of irrigation provided to the Fayoum province rising of water level in the lake would endanger surrounding lands. Future developments should therefore concentrate on solving the problem of peak supplies for agricultural use. It has been proposed to increasing the system capacity by 20% (Bichara & Baldwin, 1985).

The total area of El - Fayoum Depression is 6068.70 km^2; the land use in this area includes only 1849.64 km^2 (*i.e.*, 30.48 % of the total area). The agricultural land in the depression amount to 1609.34 km^2 classified into five grades according to their production capacity. The first and second grades do not exceed 20.2 % of the total cultivated area, whereas about 70.2 % are accommodating the third and fourth classes (ASRT, 1991).

The geomatics technique was primarily used in this study for mapping. This technique is involved with gathering, analyzing, interpreting, and using geographic information. It encompasses a broad range of disciplines that can be brought together to create a detailed picture of the area. These disciplines include land surveying, mapping, remote sensing, geographic information systems (GIS) and global positioning systems (Walf & Ghilani, 2002).

The aim of this study is to use geomatics techniques for degradation hazard assessment at El - Fayoum Depression throughout:

- Producing the physiographic - soil map of the study area scale 1/250,000.
- Assessing the soil degradation risk in the different soil unites.

Material and Methods

Physiographic mapping, soil survey and soil analysis stages

- Digital elevation model (DEM) of the study area has been generated from the elevation points (recorded during the field survey by GPS), and the vector contour lines; Arc-View GIS 3.2 software was used for this function.
- Landsat ETM images (2001) and digital elevation model (DEM) were used in ENVI 4.2 software to produce the physiographic map of the study area (Dobos *et al.*, 2002).
- Morphological description of 16 soil profiles representing the different physiographic units (Fig. 2) were carried out according to the field book for describing and sampling soils (USDA, 2002).
- Representative 51 disturbed soil samples have been collected from the studied soil profiles according to the morphological variations and were used for laboratory analyses. The laboratory analyses were carried out using the soil survey laboratory methods manual (USDA, 2004).

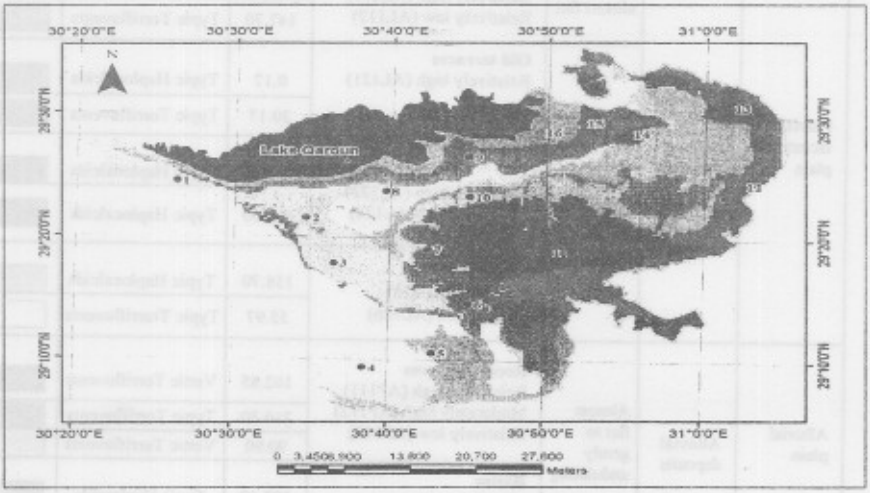

Fig. 2: Distribution of the studied soil profiles.

Soil classification and degradation hazard assessment

- The soils were classified to the sub great group level on the basis of the key to soil taxonomy (USDA, 2003).
- The correlations between physiographic and taxonomic units were carried out in order to produce the physiographic - soil map of the studied area (Elberson & Catalon, 1987).
- The natural vulnerability and soil degradation were assessed using FAO guidelines (1979).

Results and Discussion

Physiography and soils of El-Fayoum Depression

Field survey data, Landsat ETM images and digital elevation model (DEM) were used to define the physiographic units in El- Fayoum Depression as shown in Fig. 3 and Table 1. The correlation between physiography and soils were carried out, the produced data reveal that the soils of the main physiographic units in the area could be arranged under the landscape level in the following:

TABLE .1. Legend of physiographic and soils map of El- Fayoum Depression.

Landscape	Lithology/ Origin	Relief / Molding	Land form	Area (Km^2)	Taxonomic unit	Mapping unit
Lacustrie plain	Lacustrine deposits	Flat to almost flat	**Lacustrine terraces**			
			Relatively high (LP111)	74.13	Typic Haplosalids	
			Moderately high (LP112)	44.36	Vertic Torrifluvents	
			Relatively low (LP113)	75.71	Typic Haplosalids	
Fluvial - lacustrine plain	Alluvial mixed with lacustrine deposits	Flat to almost flat	**Recent terraces**			
			Relatively high (AL111)	38.16	Typic Haplocalcids	
			Relatively low (AL112)	147.70	Typic Torrifluvents	
		Gently undulating	**Old terraces**			
			Relatively high (AL121)	0.17	Typic Haplocalcids	
			Relatively low (AL122)	20.17	Typic Torrifluvents	
			Oldest terraces			
			Relatively high (AL123)	9.43	Typic Haplocalcids	
			Relatively low (AL124)	113.00	Typic Haplocalcids	
			Basins			
			Overflow (AL125)	158.70	Typic Haplocalcids	
			Decantation (AL126)	55.97	Typic Ttorrifluvents	
Alluvial plain	Alluvial deposits	Almost flat to gently undulating	**Recent terraces**			
			Relatively high (AP111)	162.85	Vertic Torrifluvents	
			Moderately high (AP112)	216.80	Typic Torrifluvents	
			Relatively low (AP113)	90.90	Vertic Torrifluvents	
			Basins			
			Overflow (AP114)	185.10	Typic Haplargids	
			Decantation (AP115)	195.90	Typic Torrifluvents	

TABLE 2. Some chemical and physical analysis of the studied soil profiles .

Mapping unit	Profile no.	Depth	pH 1:2.5	EC dS/m	CEC Meq/100g soil	ESP %	O.M %	$CaCO_3$ %	Particle size distribution				
									Coarse sand	Fine sand	Silt	Clay	Textur class
AL112	1	0 – 25	7.81	2.92	34.2	18.28	1.75	22.53	7.5	23.4	33.7	35.4	CL
		25 – 70	7.93	3.87	36.8	15.55	1.52	14.66	8.6	22.6	31.9	36.9	CL
		70 – 100	7.91	4.64	34.4	20.23	0.34	24.33	5.3	23.8	37.5	33.4	CL
Mean			7.88	3.81	35.13	18.02	1.20	20.51	7.13	23.27	34.37	35.23	CL
AL125	2	0 – 20	8.22	2.51	22.52	19.44	1.44	15.31	5.6	20.5	42.6	31.3	CL
		20 – 55	7.94	3.58	31.62	14.63	0.96	16.24	3.7	20.9	41.3	34.1	CL
		55 – 80	8.42	1.33	15.36	21.33	0.35	20.34	18.9	51.4	15.4	14.3	SL
Mean			8.19	2.47	23.17	18.47	0.92	17.30	9.40	30.93	33.10	26.57	L
AL111	3	0 – 20	8.31	1.53	29.57	14.51	1.23	7.11	6.1	24.8	38.6	30.5	CL
		20 – 45	8.11	1.55	30.25	13.42	1.12	11.47	3.9	29.7	29.7	36.7	CL
		45 – 70	7.98	2.67	43.21	13.61	0.58	14.92	4.5	37.6	32.7	25.2	L
		70 – 110	7.61	2.13	27.32	10.54	0.21	19.28	5.8	42.3	36.8	15.1	L
Mean			8.00	1.97	32.59	13.02	0.79	13.20	5.08	33.60	34.45	26.88	L
AP115	4	0 – 25	7.85	4.61	34.25	22.64	1.75	14.31	7.3	40.3	23.5	28.9	SCL
		25 – 60	8.22	3.37	25.69	24.51	0.91	13.65	17.5	37.6	29.6	15.3	SL
		60 – 100	8.14	2.41	19.62	27.15	0.52	12.46	26.8	43.5	18.4	11.3	SL
Mean			8.07	3.46	26.52	24.77	1.06	13.47	17.20	40.47	23.83	18.50	SL
AP114	5	0 – 25	7.75	2.64	42.18	14.54	1.74	11.65	20.3	25.1	16.7	37.9	SC
		25 – 45	7.95	3.52	46.23	15.74	0.83	14.52	14.6	21.4	20.8	43.2	C
		45 – 85	8.35	2.88	47.59	10.65	0.52	14.63	18.2	19.7	22.5	39.6	CL
		85 – 120	8.50	1.73	55.36	12.37	0.37	16.12	14.3	22.8	16.5	46.4	C
Mean			8.14	2.69	47.84	13.33	0.87	14.23	16.85	22.25	19.13	41.78	C
AL122	6	0 – 35	7.85	2.75	41.58	18.71	1.87	6.14	9.5	21.6	30.4	38.5	CL
		35 – 70	8.21	3.51	54.26	16.22	1.54	5.22	5.8	16.2	28.5	49.5	C
		70 – 95	8.45	2.15	47.16	17.42	0.71	8.96	6.6	20.3	33.5	39.6	CL
		95 – 120	8.50	1.50	48.55	23.18	0.36	8.17	7.2	12.5	36.4	43.9	C
Mean			8.25	2.48	47.89	18.88	1.12	7.12	7.28	17.65	32.20	42.88	C
AP112	7	0 – 30	8.41	1.62	24.36	15.22	1.61	5.21	23.5	35.4	14.6	26.5	SCL
		30 – 60	8.22	2.53	26.23	16.41	1.10	4.23	22.5	38.4	17.8	21.3	SCL
		60 – 85	8.61	2.74	23.41	12.65	0.66	4.84	20.3	37.6	24.6	17.5	SL
		85 – 125	8.52	3.42	24.85	13.72	0.14	3.42	19.6	39.2	25.6	15.6	SL
Mean			8.44	2.58	24.71	14.50	0.88	4.43	21.48	37.65	20.65	20.23	SCL

TABLE 2. Contd.

Mapping unit	Profile no.	Depth	pH 1:2.5	EC dS/m	CEC Meq/100 g soil	ESP %	O.M %	$CaCO_3$ %	Particle size distribution				
									Coarse sand	Fine sand	Silt	Clay	Texture
AL126	8	0 – 20	8.21	1.20	33.24	27.51	1.87	22.14	16.4	31.6	21.4	30.6	SCL
		20 – 45	8.11	2.55	36.41	31.05	1.20	17.69	19.8	38.7	20.1	21.4	SCL
		45 – 100	7.90	3.16	46.17	29.33	0.68	15.24	16.8	14.3	24.6	44.3	C
Mean			8.07	2.30	38.61	29.30	1.25	18.36	17.67	28.20	22.03	32.10	SCL
LP111	9	0 – 25	8.20	11.35	35.22	13.44	1.81	22.61	5.60	41.3	18.3	34.8	SCL
		25 – 60	8.10	31.54	37.55	9.14	1.04	21.58	3.70	20.4	26.5	49.4	C
		60 – 90	7.95	16.33	46.39	9.63	0.41	28.91	12.6	36.7	16.2	34.5	SCL
Mean			8.08	19.74	39.72	10.74	1.09	24.37	7.30	32.80	20.33	39.57	CL
AP113	10	0 – 20	8.20	2.047	29.54	15.84	1.20	19.64	21.9	37.4	17.3	23.4	SCL
		20 – 40	8.31	2.58	53.71	14.25	1.56	24.86	7.50	14.6	29.1	48.8	C
		40 – 70	8.50	1.67	52.16	12.84	0.71	29.44	9.6	19.3	27.6	43.5	C
		70 – 100	8.11	2.39	50.33	10.24	0.21	21.42	11.3	20.2	26.3	42.2	C
Mean			8.28	2.17	46.44	13.29	0.92	23.84	12.58	22.88	25.08	39.48	CL
AP111	11	0 – 30	7.82	3.11	42.66	9.60	2.30	6.55	4.1	22.4	24.3	49.2	C
		30 – 55	7.65	2.64	42.50	11.35	1.22	8.14	6.3	23.8	24.7	45.2	C
		55 – 80	8.23	2.31	45.17	14.27	0.65	9.47	4.3	24.9	17.3	53.5	C
		80 – 125	8.41	1.42	48.78	12.84	0.43	8.33	3.7	18.3	18.5	59.5	C
Mean			8.03	2.37	44.78	12.02	1.15	8.12	4.60	22.35	21.20	51.85	C
AL123	12	0 – 35	7.50	1.40	37.25	22.45	1.62	18.63	6.5	10.9	41.5	41.1	SiC
		35 – 80	8.24	2.43	33.45	24.84	0.74	15.27	10.1	12.6	39.5	37.8	CL
Mean			7.87	1.92	35.35	23.65	1.18	16.95	8.30	11.75	40.50	39.45	SiCL
AL124	13	0 – 35	7.75	2.54	31.25	15.40	1.66	20.43	7.2	40.2	20.7	31.9	SCL
		35 – 65	8.10	2.85	25.38	19.33	0.97	25.19	15.4	45.8	16.2	22.6	SCL
		65 – 120	8.10	3.50	21.50	23.47	0.31	23.17	20.4	46.5	13.7	19.4	SL
Mean			7.98	2.96	26.04	19.40	0.98	22.93	14.33	44.17	16.87	24.63	SCL
AL121	14	0 – 30	8.05	1.56	30.25	16.44	1.48	17.28	21.3	23.6	18.6	36.5	CL
		30 – 60	8.21	2.14	36.14	20.72	1.10	14.35	16.2	25.1	22.3	36.4	CL
		60 – 110	8.10	1.48	40.15	21.33	0.60	11.61	13.6	30.2	15.3	40.9	C
Mean			8.12	1.73	35.51	19.50	1.06	14.41	17.03	26.30	18.73	37.93	CL
LP112	15	0 – 35	8.31	16.52	34.50	9.55	1.80	5.60	3.9	22.5	26.4	47.2	C
		35 – 65	8.42	36.22	39.75	14.73	0.55	9.84	2.8	20.6	15.2	61.4	C
Mean			8.37	26.37	37.13	12.14	1.18	7.72	3.35	21.55	20.80	54.30	C
LP113	16	0 – 25	8.25	12.50	35.40	17.26	1.55	21.66	6.9	22.3	24.6	46.2	C
		25 – 50	8.34	32.44	39.18	12.40	0.64	14.80	3.2	21.6	31.6	43.6	C
Mean			8.30	22.47	37.29	14.83	1.10	18.23	5.05	21.95	28.10	44.90	C

Soils of the lacustrine plain

This landscape includes the lacustrine terraces of different elevation. It covers an area of 194.20 km^2 (*i.e.*, 19420.00 hectare), Including soils of relatively high terraces (7413.00 hectare), soils of the moderately high terraces (4436.00 hectare) and soils of the relatively low terraces (7571.00 hectare). These are represented by soil profiles 9, 15 and 16 respectively and are classified to the sub great group level as *Typic Haplosalids* (representing 100% of the lacustrine plain). The correlation between physiography and soils indicates that the mapping unit in this landscape is consociation at this survey level. The soil depth, salinity, ESP, and $CaCO_3$ of this landscape ranges from (50 to 90 cm), (11.35 to 36.22 dS/m), (9.14 to 17.26 %) and (5.60 to 28.91 %) respectively (Table 2).

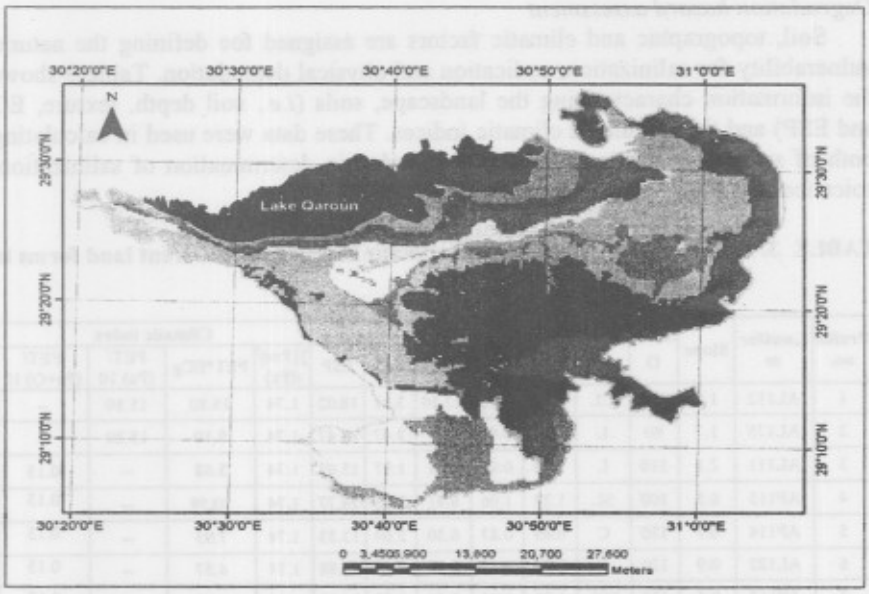

Fig. 3. Physiographic – soils map of El - Fayoum Depression .

Soils of the fluvio - lacustrine plain

The total area of this landscape is 543.30 km2, including the landforms of recent terraces (185.86 km^2), old terraces (20.34 km^2), oldest terraces (122.43 km^2) and basins (214.67 km^2). These landforms are represented by the soil profiles 2, 3, 12, 13, 14, 1, 6, and 8 the first five profiles are *Typic Haplocalcids* and the latter three profiles are *Typic Torrifluvents*. The correlation between physiography and soils show that the kind of mapping unit in this landscape is complex where 58.8% of the area is *Typic Haplocalcids* and 41.2% is *Typic Torrifluvents*. In this landscape the following soil characteristics range in the following; soil depth (80 to 120 cm), soil salinity (1.2 to 4.64 dS/m), ESP (10.54 to 31.05 %) and $CaCO_3$ content (5.22 to 25.14%).

Soils of the alluvial plain

The alluvial plain dominates the south and southwest parts of the Depression with an area of 851.55 km^2 (*i.e.*, 85155.00 hectare). This landscape includes the landforms of recent terraces with different elevations (470.55 km^2) and the basins (381.00 km^2). The soils of these landforms are represented by the soil profiles 4, 5, 7, 10 and 11, and are classified under *Vertic Torrifluvents, Typic Torrifluvents* and *Typic Haplargids* representing 29.8%, 48.5% and 21.7% of the alluvial plain area. The mapping unit in this landscape is accordingly complex. The soils of this landscape are characterized by moderately deep-to-deep soil profiles (100 - 125 cm), low salinity (1.5 - 3.52 dS/m), low to high exchangeable sodium percent (9.6- 27.15%) and low to high $CaCO_3$ content (3.42 - 29.44 %). Table 2 shows some chemical and physical analysis of the studied soil profiles.

Degradation hazard assessment

Soil, topographic and climatic factors are assigned foe defining the natural vulnerability for salinization, sodication and physical degradation. Table 3 shows the information characterizing the landscape, soils (*i.e.*, soil depth, texture, EC and ESP) and the calculated climatic indices. These data were used in calculating both of soil and climatic rating factors needed in determination of salinization, soication and physical degradation risks (Table 4).

TABLE 3. Sope, soil characteristics and climatic index of the different land forms in El-Fayoum Depression .

Profile no.	Landform	Slope	Soil characteristics							Climatic index			
			D	T	Si/C	O.M	ECg	ECs	ESP	Σ(Pm)/(Pa)	PET*ECg	PET/(Pa) 10	PET/(Pa+Q) 10
1	AL112	1.5	100	CL	0.97	1.20	12.54	3.81	18.02	1.74	15.80	15.80	--
2	AL125	1.7	80	L	1.24	0.92	7.21	2.47	18.47	1.74	9.10	15.80	--
3	AL111	2.1	110	L	1.28	0.97	4.51	1.97	13.02	1.74	5.68	--	0.13
4	AP115	0.5	100	SL	1.28	1.06	8.41	3.46	24.77	1.74	10.59	--	0.13
5	AP114	0.7	120	C	0.45	0.87	6.30	2.69	13.33	1.74	7.93	--	0.13
6	AL122	0.9	120	C	0.75	1.12	3.63	2.48	18.88	1.74	4.57	--	0.13
7	AP112	0.6	125	SCL	1.02	0.88	3.46	2.58	14.50	1.74	4.35	--	0.13
8	AL126	1.3	100	SCL	0.68	1.25	14.22	2.30	29.30	1.74	17.91	15.80	--
9	LP111	1.4	90	CL	0.51	1.09	13.82	13.41	10.47	1.74	17.41	15.80	--
10	AP113	1.8	100	CL	0.66	0.92	3.21	2.17	13.29	1.74	4.04	--	0.13
11	AP111	0.6	125	C	0.40	1.15	2.11	2.37	12.02	1.74	2.65	--	0.13
12	AL123	2.2	80	SiCL	1.02	1.18	2.34	1.92	23.65	1.74	2.94	--	0.13
13	AL124	2.3	120	SCL	0.68	0.98	1.80	2.96	19.40	1.74	2.26	--	0.13
14	AL121	1.5	110	CL	0.49	1.06	7.10	1.73	19.50	1.74	8.94	15.80	--
15	LP112	1.1	65	C	0.27	1.18	6.75	7.37	12.14	1.74	8.50	15.80	--
16	LP113	0.9	50	C	0.62	1.10	10.12	12.47	14.83	1.74	12.75	15.80	--

S= slope (%), D= soil depth (cm), T= soil texture (class), Si= silt (%), C= clay (%), O.M= organic matter (%), ECg= ground water salinity (dS/m),
ECs= soil salinity (dS/m), ESP= exchangeable sodium percent (%), Pm= monthly precipitation (mm), Pa= annual precipitation (mm),
PET= potential evapotranspiration (mm), Q= irrigation water (mm/season).

TABLE 4. Salinization, sodication and physical degradation risks in the studied area.

Mapping unit	Salinization(1)				Sodication(2)				Physical degradation(3)			
	SR	CR	Risk	Class	SR	CR	Risk	Class	SR	CR	Risk	Class
AL112	1.5	15.85	23.77	4	1.5	0.87	1.03	2	0.97	1.74	1.68	2
AL125	2	9.11	18.22	4	2	0.87	1.74	2	1.24	1.74	2.15	3
AL111	1	5.70	5.7	4	1	0.87	0.87	1	1.28	1.74	2.22	3
AP115	0.1	10.63	1.06	2	0.1	0.87	0.08	1	1.28	1.74	2.22	3
AP114	1.5	7.96	11.94	4	1.5	0.87	1.03	2	0.45	1.74	0.78	1
AL124	1.5	0.13	0.20	1	1.5	0.87	1.03	2	0.75	1.74	1.30	2
AP112	1	0.13	0.13	1	1	0.87	0.87	1	1.02	1.74	1.77	2
AL126	1	17.97	17.97	4	1	0.87	0.87	1	0.68	1.74	1.18	2
LP111	2	17.47	34.94	4	2	0.87	1.74	2	0.51	1.74	0.88	1
AP113	1	0.13	0.13	1	1	0.87	0.87	1	0.66	1.74	1.14	2
AP111	1.5	0.13	0.20	1	1.5	0.87	1.03	2	0.40	1.74	0.69	1
AL123	2	0.13	0.26	1	2	0.87	1.74	2	1.02	1.74	1.77	2
AL124	1	0.13	0.13	1	1	0.87	0.87	1	0.68	1.74	1.18	2
AL121	1	8.97	8.97	4	1	0.87	0.87	1	0.49	1.74	0.85	1
LP112	3	8.53	25.59	4	3	0.87	2.61	3	0.27	1.74	0.46	1
LP113	3	12.79	38.37	4	3	0.87	2.61	3	0.62	1.74	1.07	2

(1) Salinization: SR= soil texture rating (coarse= 0.1, medium=1 and fine= 1.5) in the case of shallow profiles the used soil rating is 1,2 and 3 for coarse, medium and fine texture respectively , climatic rating CR= PET/(p+q)*10 where PET = potential evapotranspiration (mm), p= annual precipitation (mm) and q= quantity of irrigation water used (mm). In the case of saline ground water the formula of CR= (PET / 1000)*ECgw is used, where ECgw is the ground water salinity. (2) Sodication: The soil ratings used in both deep and shallow profiles are the same as those given for salinization. Climatic rating CR = PET/ (p+q)*10. (3) Physical degradation: the soil rating SR =silt/clay ratio, climatic rating CR= $\sum (Pm)^2$ / (Pa) where Pm= monthly precipitation (mm), and Pa= annual precipitation (mm).

Field data indicate that the slope gradient in the study area ranges between 0.5 and 2.3%, which has a slight effect on natural vulnerability. Thus the topographic effect on the natural vulnerability was considered as 1.0 in different landforms.

The climatic factor is calculated using four different formulas adapted to different degradation processes. Evapotranspiration and precipitation rates are included in these formulas.

The obtained data reveal that the soils in the lacustrine, fluvio – lacustrine plains and overflow basins of the alluvial plain (AP114) are characterized by a very high risk of salinization. These soils are almost distributed along the Qarun Lake and at the borders of El – Fayoum Depression, covering a total area of 724.03 km^2, and representing 45.56% of the study area. Only the soils of decantation basin of the alluvial plain (AP115) are characterized by a moderate salinization risk and covered an area of 195.9 km^2 (12.33% of the studied territory). An area of 613.15 km^2 is facing a low risk of salinization. These soils exhibit areas in the alluvial and fluvio – lacustrine plains.

The risk of sodication processes ranges between low and high classes. The areas threatened by a high risk values are located only in the moderately high and relatively low lacustrine terraces, covering an area of 120.07 km^2. The alluvial and fluvio – lacutrine plains are subject to low and moderate sodication risk, covering areas of 710.9 and 758.08 km^2 respectively.

The risk of physical degradation is low to moderate in the lacustrine plain, while it is low to high in the alluvial and fluvio – lacustrine plains. The areas threatened by high, moderate and low risks are counting 392.76, 729.68 and 46.61 km^2 respectively.

Salinity, sodicity and water logging are the main degradation hazards in El – Fayoum Depression. They were defined in relation to the present value of electric conductivity (EC), exchangeable sodium percentage (ESP) and the depth of water table respectively. Accordingly, the high hazard of salinity, sodicity and water logging are facing 9.40, 16.44 and 7.55% of the total area of the depression respectively. The soils affected by a moderate hazard of salinity, sodicity and water logging in the depression represent 24.41, 27.67 and 15.25% of the total area respectively. Low hazard of salinity, sodicity and water logging is found in different landforms representing 66.19, 55.89 and 77.20% of the total area respectively. The soils of high salinity and water logging hazard are located in the lacustrine plain, while the moderately high hazard is found in the landscape of fluvio – lacustrine plain. The soils of high sodicity hazard are found only in the landscape of alluvial and fluvio – lacustrine plain.

Conclusion

The following conclusion could be pointed out

The use of Landsat ETM images and digital elevation model (DEM) is very important in elaborating the physiographic – soil maps. They facilitate the linkage between the soil unit and physiography on the bases of data extrapolation.

The main physiographic units in the area are lacustrine plain, fluvio - Lacustrine plain and alluvial plain covering an areas of 194.20 km^2, 543.30 km^2 and 851.55 km^2 respectively. The main taxonomic units in the studied area are *Typic Haplosalids, Typic Calciorthids, Typic Torrifluvents, Vertic Torrifluvents and Typic Haplargids.*

A very clear correlation was found in the study area between physiography and soil units especially in the lacusrine plain while it is low in the alluvial and fluvio – lacustrine plain.

The impact of topography on the natural vulnerability is slight due to the low degree of slope (less than 8%), where arid climate and soil properties have essential impacts on degradation hazards in the studied area.

About 45.56, 7.55 and 24.71% of the depression have a high risk due to salinization, sodication and physical degradation respectively. The high hazard of salinity, sodicity and water logging affect 9.40, 16.44 and 7.55% of the total area of the depression respectively.

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استخدام الجيوماتكس لعمل خرائط التربة وتقييم مخاطر تدهور الاراضى الزراعية بمنخفض الفيوم بمصر

رأفت رمضان على
قسم الاراضى واستغلال المياه – المركز القومى للبحوث – القاهرة – مصر.

استخدمت تقنيات الجيوماتكس فى هذه الدراسه بهدف انتاج الخريطة الفيزيوجرافية – الأرضية لمنخفض الفيوم بمقياس رسم ١: ٢٥٠،٠٠٠ وتقييم المخاطر التى تتعرض لها الاراضى الزراعية داخل كل وحدة خريطية. حيث تم استخدام صور القمر الصناعى لاندسات والنظام الرقمى ثلاثى الابعاد لتحديد الوحدات الفيزيوجرافية بواسطة برنامج ENVI 4.2 وأوضحت النتائج أن المنطقة تتكون من ثلاثة وحدات رئيسية هى الترسيبات النهرية وتغطى مساحة ١٩٤,٢ كم^{٢} والترسيبات النهريه البحيرية وتغطى مساحة ٥٤٣,٣ كم^{٢} والترسيبات البحيرية وتغطى مساحة قدرها ٨٥١,٥٥ كم^{٢}. وقد تم استخدام نظام التقسيم الأمريكى للأراضى لتقسيم اراضى المنطقة حتى مستوى تحت المجموعات الكبرى، ومن ثم تم عمل الارتباط بين الحدات الفيزيوجرافية والوحدات التقسيمية للاراضى لانتاج الخريطة الفيزيوجرافية – الأرضية. وقد استخدمت نتائج التحليل المعملى للقطاعات الارضية الممثلة للوحدات الأرضية والبيانات المناخية والطبوجرافية لتقييم مخاطر التدهور بمنطقة الدراسة طبقا للنظام المقترح بواسطة الفاو ١٩٧٦ . حيث وجد أن الملوحة والقلوية وارتفاع مستوى الماء الارضى هى أهم المخاطر التى تهدد الاراضى الزراعية حيث تصل قيم معامل التوصيل الكهربى ونسبة الصوديوم المتبادل وعمق الماء الأرضى الى ١٦,٣٣ dS/m و٣١,٠٥٪ و٤٠ سم على التوالى. تم توصيف درجات المخاطر لكل عامل من عوامل التدهور بالمناطق المختلفة الى منخفضة، متوسطة، عالية وعالية جدا حيث وجد ان المناطق التى تعانى من المخاطر العالية للملوحة ،القوية وارتفاع مستوى الماء الأرضى تمثل ٩,٤ ، ١٦,٤٤ و٧,٥٥ ٪ من اجمالى مساحة المنخفض على التوالى.