Ass. Univ. Bull. Environ. Res. Vol. 24 No. 2 October 2021

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EFFECTS OF TOPOGRAPHIC FACTOR AND GEOMORPHOLOGIC FEATURES ON SOIL CHARACTERISTICS OF THE WESTERN AREA OF BAHR YOUSEF, EL-MINYA, EGYPT

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ABSTRACT:

The integration between geomorphology and topography has been widely used in soil sciences, with topographic and geomorphologic features information being derived from digital elevation models (DEMs) that derived from photogrammetry and satellite images to calculate topographic attributes such as digital elevation, slope gradient and aspect were produced manually and applied to investigate spatial variability in soil characteristics and to produce soil maps. The current study aims to reveal the effect of the topography factor and geomorphologic features on the soil characteristics western of Bahr Yusef area, Minya Governorate. The study was based on taking 11 soil profiles (27 samples) which were distributed over four geomorphologic units: upper, back, toe slopes, and the flood plain. The four physiographic units were extracted and identified based on topographic attributes and Landsat 8 satellite image processing (radiometric enhancement and an atmospheric correction, replace bad value and classification), in addition, the vegetation cover density was determined by Normalized Difference Vegetation Index (NDVI) which was determined using OLI sensor and calculate the confusion matrix to validate the results of NDVI. Some soil morphological and Physico-chemical characteristics such as soil profile thickness (depth), soil particles distribution especially that related to clay content, electrical conductivity (EC), organic matter (O.M), gypsum and calcium carbonate content and exchangeable sodium percentage (ESP) were determined according to references which mentioned in materials and methods section. The geostatistical methods were used to study the correlation between the topographic attributes (slope position, slope, aspect) and geomorphologic units in and spatial distribution of soil in the study area. The results of the study revealed that the soil characteristics, whether physical or chemical were affected by geomorphologic feature and the topography factor, where the

proportion of clay content prevailed in the samples of the flood plain, while the proportion of sand increased in the samples of the rest of the terrain units. The results also indicated an increase in the soil characteristics such as (EC), (ESP), (O.M) and Gypsum and CaCO3 content where they increased from the flood plain towards the upper slopes unites. also, there is a clear effect of the degree of slope on the soil characteristics and vegetation cover density. with regard to effects of deposition Environment on soil characteristics, All the samples of the flood plain recorded very weak sorting, while the rest of the topographical units recorded a weak sorting, which reflects a clear difference in the strength of the precipitating factor for these sediments. As for the environment, the data indicate that the sedimentation of the floodplain was formed in an aeolian environment, while the sediments of the rest of the terrain units were formed in a marine coastal environment that was mainly associated with the tyranny of the Chess Sea on Egyptian lands.

Keywords: *Topographic factor, Soil Characteristics, Bahr Yousef*

INTRODUCTION:

The spatial variation of soil characteristics is significantly influenced by some environmental factors such as climate, topography, parent rock, vegetation, and disturbance due to human activity (Tsui, Chun-Chih et al., 2004). Major changes in soil type can occur over a very small difference in distance due to topography. Elevation, slope and aspect are the main elements of topography that can influence soil development. The existence of statistically significant differences between soil properties according to the geomorphological units and the physical and chemical properties of the soil and the available nutrients. Slope and aspect have an effect on spatial heterogeneity and soil characteristic distribution in the northwestern coast of Egypt (Taher, et al,2015) Remote Sensing and Geographical Information System have an important role in the linkage and analysis of the obtained data more specifically; remote sensing and/or GIS could be used: (1) to identify physiographic units; (2) to serve as a common physiographic base map; (3) to link spatial data with non-spatial ones but in more detailed attribute data; (4) to interpolate, for instance, upgrade experimental results from a few soil profiles to larger areas; (5) to illustrate data in the map and other graphic formats (Van Lynden and Mantel, 2001). The study area that their lands fall within the range of toe and the back slopes it suffers from high salinity and waterlogging of the soil, while the lands that are located at upper slope do not suffer from that land degradation types. The study area is suffering from waterlogging and salinity and sodicity as a result of slopes differences. The lands west of Bahr Youssef, especially in the desert region, are witnessing an expansion of agricultural reclamation processes, which are lands characterized by diversity in their topographical characteristics. Therefore, the present study aims to answer a basic question: What is the effect of the topographic factor and geomorphologic features on the soil characteristics western area of Bahr Youssef? The alternative

hypothesis that the soil characteristics are affected by the topographical factor and geomorphologic features, and this hypothesis formulated from the field observations, such as some manifestations of soil degradation which represented by the emergence of water pools that lagged behind agricultural drainage interspersed with agricultural lands, as well as complaints of many farmers during the field trip. These observations reflect a clear influence of soil characteristics by the topographical factor, which was confirmed by many previous studies (Birkeland,1999).

The main objectives of the study are:

1. **Recognizing the effect of geomorphologic characteristics on the western area of Bahr Yousef.**
2. **Recognizing the effect of topographic parameters on the study area.**
3. **Producing the thematic maps of the selected study area showing the distribution of soil characteristics.**
4. **Understanding the relationships between the soil variations of topographic position and deposition Environment in the Western area of Bahr Yousef, El-Minya.**

MATERIALS AND METHODS:

The materials and methods include:

1. **The description of geomorphologic and pedagogical features of the study area,**
2. **Data collection and**
3. **Methods used in this study. The three heading are discussed in detail as follows:**

1. Description of geomorphologic and pedagogical features of the study area

1.1. Location:

The study area is located at the western part of El-Minya district. It lies between longitude 30° 23' 30''and 30° 47' 30'' E and latitude 28° 35' 45'' and 28° 45' 30'' N. It is an expansive landmass of about 490.30 square kilometers in a large extent, and it is bounded by Bahr Yosef in the east and by 140 m elevation of contour line which represents the large extend of reclamation land in the west (Fig.1).

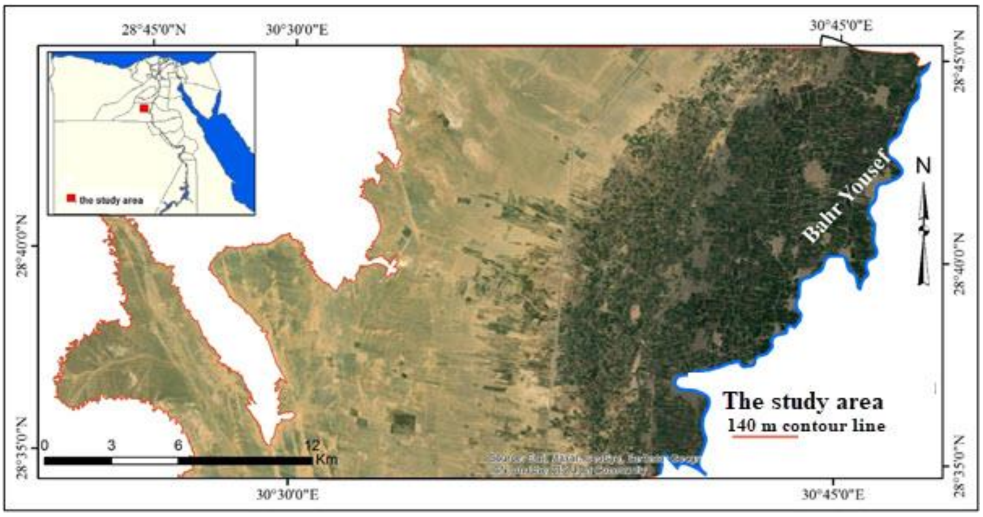

Figure 1. Location of the study area.

1.2.Geology:

El-Minya district and its surrounding area are essentially covered by sedimentary rocks which range in age from Middle to Recent Eocene. The study area consists of seven geologic formations; A. Samalut formation that consists of white limestone and chalky limestone with some marl and claystone interbeds. B. Wadi Rayan formation, which consists of sandy limestones and marls of Early Lutetian age and limestones, sandy limestones, dolomitic limestones. dolostones and marls of Late Lutetian -Bartonian age. C, The Protonile fluviatile deposits that belong to the third river system that occupied the present Nile basin are in the form of complex gravel, coarse sand, and loamy materials. D, Pronile deposits; the Prenile represented a vigorous and competent river with a copious supply of water and a wide flood plain. E. Nile silt Holocene deposits consist of a composite mixture of mineral materials, silt and organic fine sand grains from different sources. F. Wadis sediments: They are Holocene deposits derived from the sides of the valleys sloping towards the Nile Valley, and it consists of the remains of limestone, boulders, gravel and silt. G. Sand dunes: they are considered to be the most recent sediments and they are sand of various sizes. and the Rayyan Valley formations (Figure .2) after CONOCO (1987).

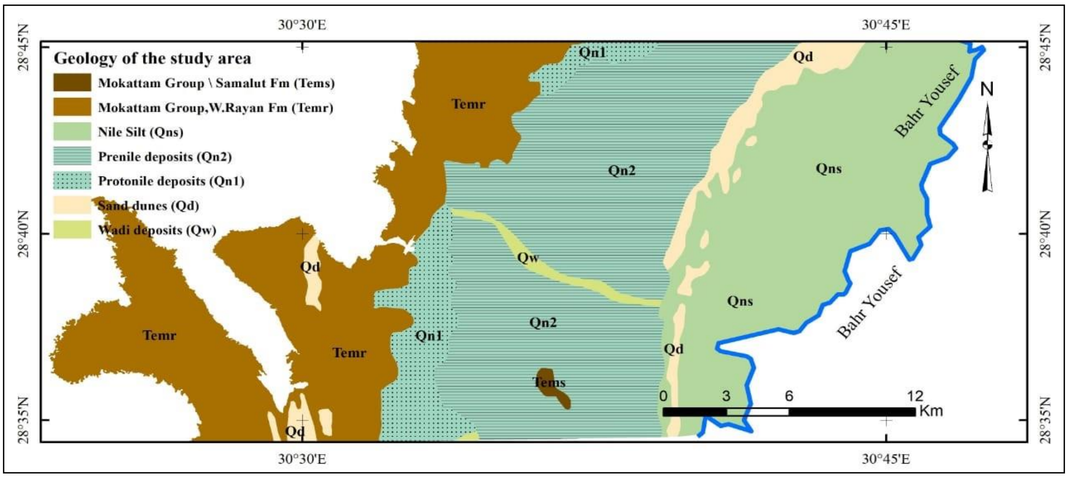

Figure 2. Geology of the study area.

1.3.Geomorphology:

The study area is consisting of four distinct geomorphologic units; floods plain, and toe, back and upper slopes, these units to form longitudinal extensions from the northern part to the southern part of the study area which is bounded by Bahr Yousef in the east and contour line 140 meter in the west as illustrated in Figure (3).

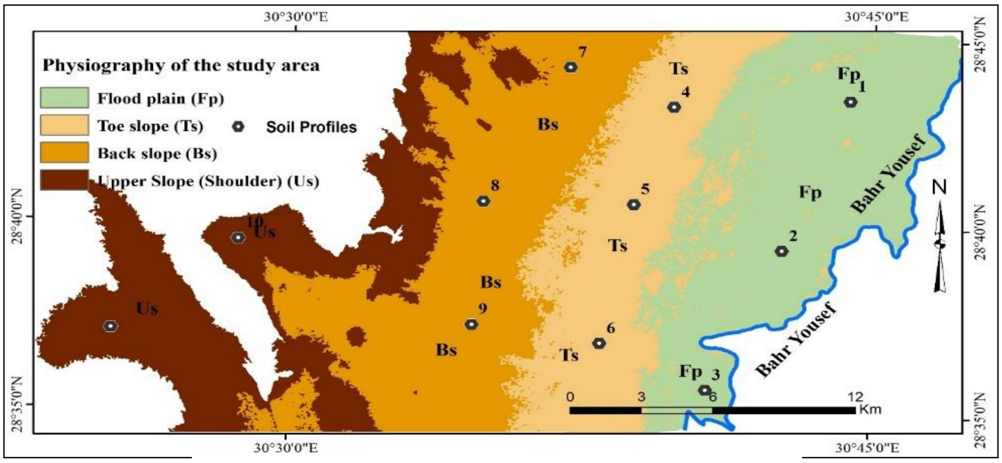

Figure 3. Physiography of the study area.

1.4.Soils:

The study area soils vary concerning their texture from clay and clay loam in the east to sandy in the west. The soils are mostly light in texture. the soils of the flood plain are predominantly clay of riverine origin and the soils of Toe, Back and Upper slopes are predominantly sandy which was formed as a result of parent materials origin and some external processes such as erosion. The classification of soils belongs to and Miscellaneous Land, Petrogypsic Gysicorthesis, Typic Quartzipsamments, Typic Torrierts, Typic Torrifluvents and Typic Torriorthents as depicted in Figure (4) after ASRT (1986).

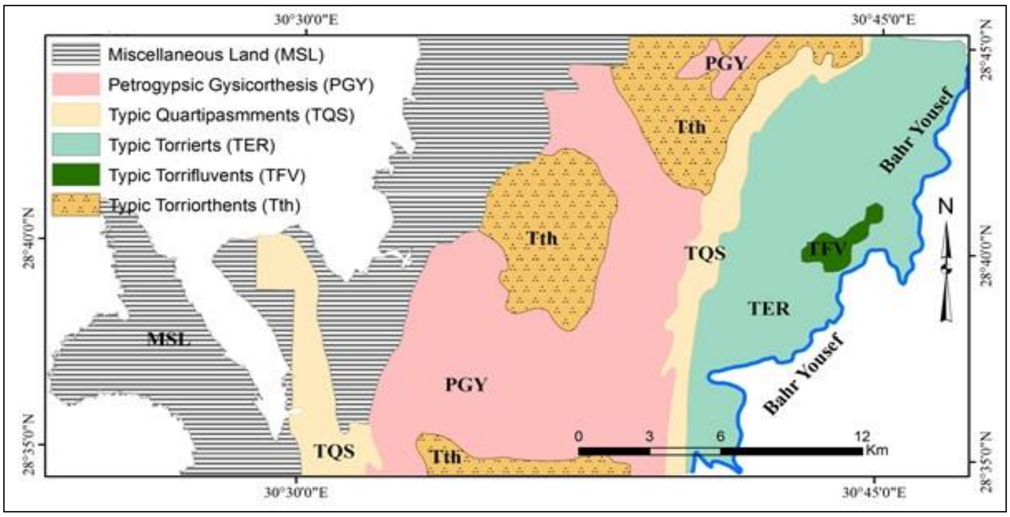

Figure 4. Soils types of the study area.

1.5.Vegetation:

There are differences in the type of crops planted according to the geomorphological units, as traditional crops are grown in the flood plain, such as wheat and corn, while non-traditional crops are grown on the toe slope and back slopes such as medicinal plants, vegetables and sugar, while the upper slopes are devoid of cultivation due to the prevalence of rocky soil.

1.6.Climate:

The study area is complying with the classification of Kabn climate within the hot desert climate region or subtropical. Climatologically, December and January are the coldest and wettest months, while July and August are the hottest and driest sessions as shown in Figure (5). As for the relative humidity, its rates are constant during the months of summer, winter and autumn, ranging between 45-59%, and it decreases slightly during the spring season to reach 42%.

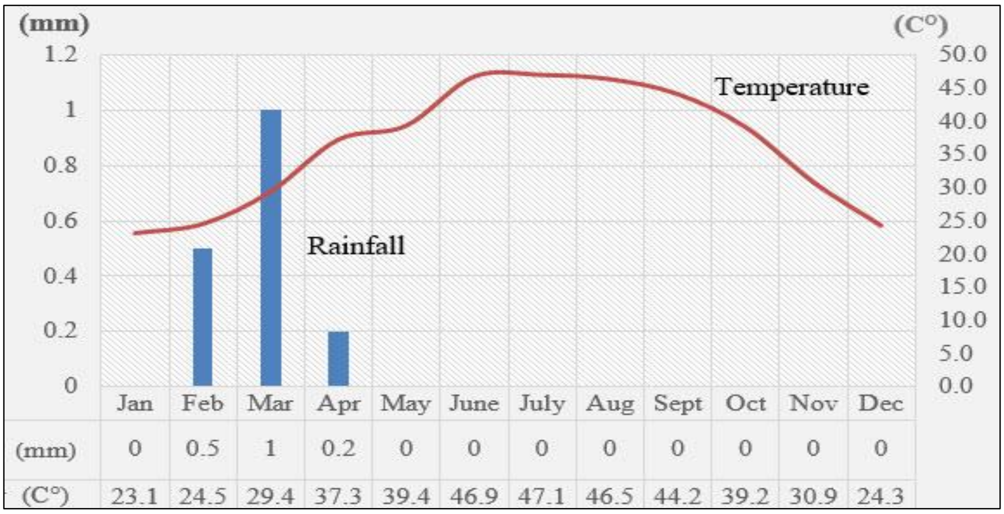

Figure 5. Average monthly climatic factors (1980 – 2020) of El-Minya station.

In addition to the description of the study area, the data collection and methods that used in the study are summarized in Figure 6 and are discussed in detail as follows:

2. Data Collection:

Remote sensing data: Landsat 8 image (Path 177. Row 40) with 16 days temporal resolution and a Level 1 Terrain Correction processing (geometric and terrain correction) and SRTM (Shuttle Radar Topographic Mission) with 30 m resolution were downloaded from the Global Land Cover Facility.

(http://www.glcf.umiacs.umd.edu/) , and (http://earthexplorer.usgs.gov/)as shown in Table 1.

Table 1. Attributes of Landsat data of the study area

Satellite	Sensor	Identifier
Landsat-8	Operational Land Imager OLI	LC08_L1TP_177040_20200914_20200920_01_T1_MTL
DEM	SRTM 1 Arc (30x30 meter)	N28E030.SRTMGL1.hgt

2.1. Geologic maps: Previous data of geologic maps were obtained to identify the lithology of the study area. The maps belonged to (CONCO Project, 1987). In addition, a soil map was obtained to verify the classification of soils of the study area according to Academic Scientific Research (1986).

2.2. Soil samples: Eleven soil profiles were dug to represent the various geomorphic units which include: Upper, Back, Toe slope and Flood plain. 27 Soil samples were collected and soil analyses were performed using the soil survey laboratory methods manual (USDA. 2011).

3. Methods:

3.1. Digital Images Processing: pre-processing image preprocessing includes layer stacking and resizing the image to equivalent the study area. Digital image post-processing was applied to extract the statistical feature's characteristics and information. The post-processing procedures involved data image enhancement (Red. green and blue (RGB) composite and false colour display) and linear enhancement as illustrated in Figure 6.

3.2. Vegetation index: vegetation index was used to identify the spatial distribution of vegetation and its density through the levels of chlorophyll detected in the leaves. the normalized difference vegetation index (NDVI) was calculated from the visible band (RED) and near-infrared band (NIR) light reflected by vegetation as clarified in the following equation:

$$\mathbf{NDVI} = ((\mathbf{NIR} - \mathbf{RED}))/((\mathbf{NIR} - \mathbf{RED}))$$

The final step of image processing is classification accuracy assessment, which is a confusion matrix that is used to show the accuracy of a classification result by comparing this result with ground truth information as shown in Table.2 (Jensen, 2005). All the aforementioned techniques were done for the Landsat image to characterize the study area using the specific model in ENVI version 5.3 and Arc G1S version 10.5 software.

Table 2. Confusion matrix of NDVI classification of the study area.

		Referenced Data				
Classified Data	Class Value	No vegetation	Low	Moderate	Total	User's Accuracy
	No vegetation	63.00	5.00	1.00	69.00	0.91
	Low	1.00	14.00	4.00	19.00	0.74
	Moderate	1.00	0.00	10.00	11.00	0.91
	Total	65.00	19.00	15.00	99.00	0.00
	Producer's Accuracy	0.97	0.74	0.67	0.00	0.88
	Overall Accuracy	0.77				
	kappa coefficient	0.75				

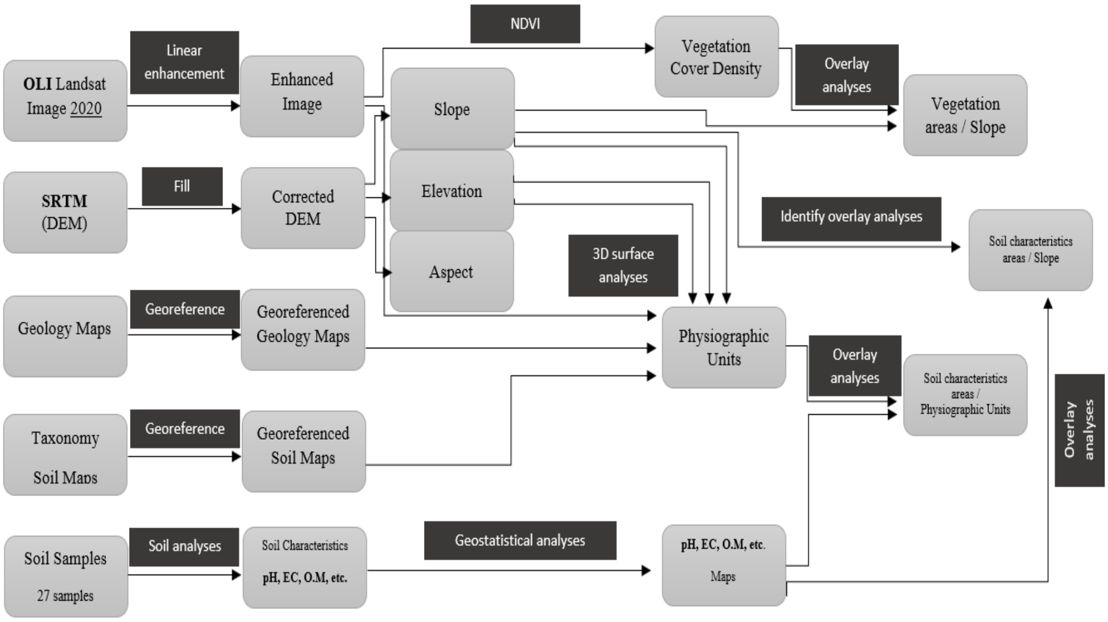

Figure 6. Flow chart of methods that used in the study area.

Topographical analysis: Slope maps derived from the DEM were classified according to FAO guidelines (2006). Aspect as a topographic feature was derived from a raster surface (DEM) to identify the downslope direction using ArcGIS 10.5 software as illustrated in (Figures 9 to 10). The digital slope gradient (Fig. 11) and aspect (Fig. 14) maps were derived from the generated DEM by using the spatial analyst function in Arc GIS software (ESRI, 2010) of the study area. In the slope gradient map. the slope gradient was divided into four classes of slope %; flat areas (0 - I %), low slope areas (1-3 %). medium slope areas (3-5 %) and high slope areas (5-10 %).

The differences between the means of soil characteristics were compared using the least significant differences (LSD) at $p \leq 0.05$. Linear regression analysis was used to show trends, if any, between soil characteristics across varying slope gradients for different aspects in the entire watershed (Table 2).

3.3. Physical and Chemical Analyses:

- **Mechanical analysis: Particle size distribution was determined by dry saving and pipette methods according to Page (1982)**
- **pH and Electrical Conductivity (EC) and soluble cations and anions of soil samples were measured in saturated soil paste as described by Jackson (1967).**
- **Exchangeable Sodium Percentage (ESP) was measured according to Richards (1954).**
- **Calcium carbonate was determined volumetrically method given by Piper (1950).**
- **Gypsum content was determined by precipitation with acetone according to the method described by Richards (1954).**
- **Organic matter content (O.M) was determined according to the method given**

by modified Walkley and black (Black, I965)

3.4. Geo-statistical analyses:

Inverse distance weighted (IDW) interpolation technique determines cell values using a linearly weighted combination of a set of sample points. The weight is a function of inverse distance. The surface being interpolated should be that of a locationally dependent variable. Interpolation by (IDW) was executed for the soil properties i.e., EC, ESP, (OM), calcium carbonate and Gypsum content. These soil properties were interpolated using the geostatistical analyst module in Arc GIS 10. x software.

3.5. Geo-statistical of Environment deposition:

The statistical analysis of the sediments depends on the grain size analysis outputs, where the so-called ascending aggregate weight is used, or the weight ratio of the sediments is calculated on the phi values according to Wentworth classification so that the analysis includes reliance on four indicators that are the mean through the following equation:

$$M = 1/3\ (Ø_{16} + Ø_{50} + Ø_{84})$$

This indicator refers to the average size of the sediment, while the second indicator is sorting, and it can be calculated through the following equation:

$$Sorting = (Ø_{84} - Ø_{16})/4 + (Ø_{95} - Ø_{5})/6.6$$

The results of this equation indicate the size of the smallest and largest grains within the sample, or in other words, the normality of the sediment spread and its distribution within the sample. It also reflects the strength of the precipitating factor or the differences in the strength of the precipitating factor during the sedimentation period, while the third indicator is the skewness, and it can be calculated by the following equation:

$$Skewness = Ø84 + Ø50 - 2(Ø50)/2(Ø84 - Ø16)$$

It reveals the nature of the distribution type for a given size from the average, the skewness values are always positive or negative depending on the smoothness or roughness of the sediments, and finally, the Kurtosis index, which indicates the degree of concentration of the volumes concerning the central volume and can be calculated through the following equation

$$Kurtosis = Ø95 - Ø5 / 2.4(Ø75 - Ø25)$$

It is also possible to know the sedimentation environment, the sedimentation basin, the type of sediment, and the deposition current of these sediments through a number of the following equations

Y1= 3.5688Mz+3.6016Б12-2.0766SK1+3.1135KG

Y2=15.6534Mz+65.7091 Б12+18.1071 SK1 +18.5043KG

Y3 =0.2852MZ-8.7604 Б12-4.8932SK1+0.0482KG

Y4 =0.7215Mz-0.403 Б12+5.2927KG

Where the calculation is based on the results of the statistical analysis of the sediment, which was previously discussed in the previous lines, so that it indicates:

Y1 **refers to the sedimentation environment, and if it is less than -2.74, it means that the sedimentation environment is aeolian, and greater than that indicates a coastal environment**

Y2 **refers to the sedimentation basin. If the value is less than 63.36, this indicates a**

beach sedimentation basin, while greater than that, the sedimentation basin is marine or a shallow lake.

Y3 refers to the type of sediment. If it is less than -7.41, the sediments are deltaic and greater than that, the sediments are deposited in a turbulent shallow.

Y4 **refers to the type of deposited current. If it is less than 9.84, then the deposited current is characterized by real estate, but if it exceeds that, the deposited current is a current in a deltaic environment (Macmanus, 1988).**

RESULTS AND DISCUSSION:

The results and discussion include the effects of geomorphologic features and topographic parameters such as slope, aspect, etc. on soil characteristics in the study area and analyses of deposits environment that are discussed in detail as follows:

1- Effects of geomorphologic features on soil characteristics

Eleven soil profiles were dug to represent the various geomorphic units which include: Upper, Back, Toe slopes and Flood plain. 27 Soil samples were collected and soil analyses were performed according to the soil survey laboratory methods manual (2011). The obtained results indicate to the clay-textured soil prevails in the floodplain while the rest of the samples recorded a sandy texture in the remaining geomorphological units. There are differences in average of cations and anions between geomorphological units, where it increases from the flood plain towards the upper slopes through the toe slopes and back slopes, except for HCO_3^-, which witnesses fluctuation between the geomorphological units and they increase according to the depth of the soil where are high in the surface layer and then decrease in the lower layer and then return to rising again in the deep layers (Table.3)

The mean pH values ranged between 8.09 - 8.34, the lowest value restricted to the flood plain, while the high mean pH value was in the upper slope, and also pH values varied according to the depth of soil profile samples where it increased from surface to dipping layer samples. There are differences between the geomorphological units in the EC values as they decrease in the flood plain and increase towards the upward slope. The value of ESP reflects the extent of the sodicity of the soil, and thus indicates poor permeability as one of the characteristics of poor soils, as the ESP exceeds 15% means that the soil is affected by strong sodicity degree, and the soil in the upper slope sector is the only soil that can be described as strong sodicity degree of soil where ESP has reached 19.5% (Table.3).

The average gypsum ranged between 0.92-5.71 % in the geomorphological units in the study area, and the gypsum values tend to rise from the flood plain towards the higher slopes, that is, towards the rocky soil. The Calcium carbonate content reduces away from the flood plain, where the flood plain has a low value which is reaching to 5.63, while the upper slopes have the highest values, reaching 9.85. The higher values of gypsum and calcium carbonate may be due to the impact of the geological formations in which limestone predominates (Table.3 and Figures 7, 8).

The average organic matter indicates that an increase in its value towards the upper slope where the organic matter decreases in the flood plain and increases towards the upper of the slopes. The higher percentage of organic matter in the upper slope than a lower slope of the study area may be due to that the existence of marine sedimentary materials which is reached in its salinity than the lower slope and salinity preserves the existing organic matter from decomposition even if its percentage is low, because the high salinity is considered not suitable for the work of decomposing microbes, and it may also be attributed to that when estimating the organic matter in saline lands, the chloride interferes with the carbon of the organic matter and interacts with the potassium dichromate, meaning that the chloride oxidizes part of the potassium dichromate as organic carbon, which leads to a high percentage of the organic matter in the analysis of high salinity rocky lands (Table.3 and Table .4 and Figures 7, 8).

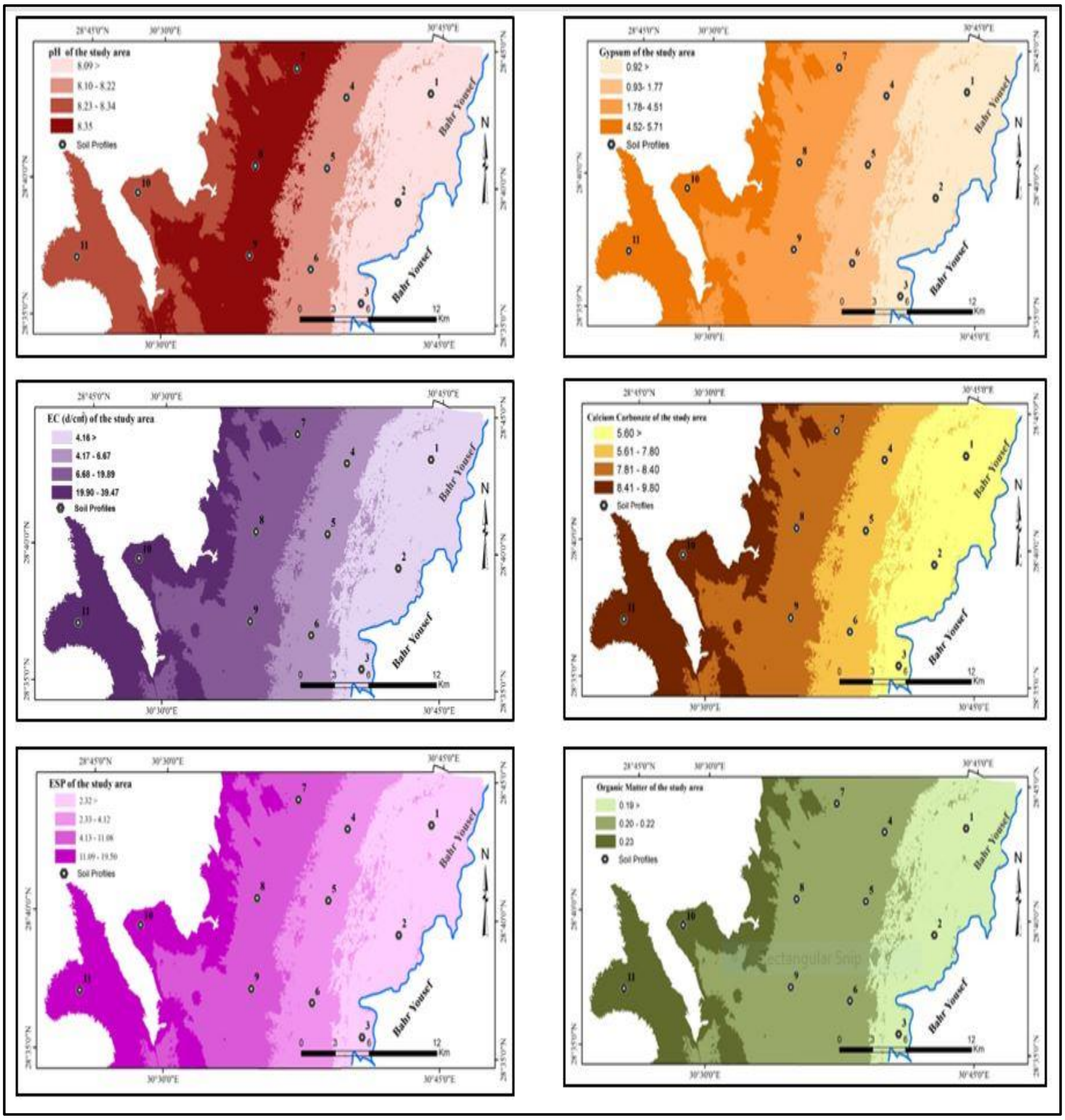

Figure 7. Distribution of the chemical soil characteristics according to the geomorphologic unit.

Table (3) Chemical and physical analyses of soil samples in the study area.

Geomorphologic unit	soil Profile No	Depth (cm)	SP	pH	EC ds/m	Cations meq./L.				Anions meq./L.				O.M	gypsum	$CaCO_3$	ESP	Texture
						Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}					
Flood plain	1	0-40	50	7.73	1.30	10.81	4.67	5.13	0.23	0.0	3.4	16	1.44	0.14	0.32	4.01	1.47	Clay Loam
		40-80	45	7.77	1.85	8.64	9.43	4.96	0.1	0.0	3.6	10	9.53	0.26	0.43	2.67	1.19	Clay
		80-120	75	7.98	0.73	5.4	4.92	3.04	0.06	0.0	4.8	5.0	3.62	0.14	0.36	6.69	0.72	Clay
	2	0-40	60	7.95	0.50	8.1	2.22	1.64	0.03	0.0	3.4	4.0	4.59	0.26	0.27	3.12	0.07	Clay
		40-80	75	8.40	3.06	5.4	4.92	16.42	0.1	0.0	3.0	20	3.84	0.14	0.50	3.12	9.50	Clay
		80-120	75	7.98	0.73	8.1	1.19	3.07	0.06	0.0	1.8	2.0	8.62	0.14	0.33	3.12	0.85	Clay Loam
	3	0-35	70	7.08	1.04	3.24	5.02	6.84	0.16	0.0	3.4	3.0	8.86	0.12	0.52	3.12	3.11	Clay
		35-75	62	8.11	1.45	10.81	0.49	7.18	0.23	0.0	2.4	6.0	9.33	0.26	0.37	5.25	3.44	Sandy
		75-120	20	9.16	2.23	4.32	9.1	8.55	0.26	0.0	2.6	6.0	13.63	0.16	0.53	3.00	4.26	Clay
Toe slope	4	0-40	20	8.77	2.18	8.1	8.42	9.57	0.4	0.0	3.2	8.0	15.29	0.15	0.23	11.89	4.02	Sandy
		40-75	23	7.76	1.49	5.94	4.38	8.37	0.33	0.0	2.4	7.0	9.62	0.13	0.25	9.99	3.85	Sandy
	5	0-40	16	8.29	0.82	8.64	3.75	2.22	0.16	0.0	4.4	3.0	7.37	0.42	0.28	10.48	0.12	Sandy
		40-85	23	9.48	1.35	10.81	4.67	2.42	0.33	0.0	3.8	3.0	11.43	0.31	0.55	13.36	0.25	Sandy
		85-115	23	8.10	1.05	16.21	12.18	2.18	0.26	0.0	4.2	3.0	23.63	0.11	0.26	13.45	0.04	Sandy
	6	0-35	23	7.31	6.14	32.21	13.22	25.99	0.8	0.0	2.4	28.0	41.82	0.25	1.20	4.27	6.50	Sandy
		35-70	26	7.47	4.40	30.27	5.87	15.39	0.4	0.0	3.2	11.0	37.73	0.25	3.66	3.62	3.89	Sandy
		70-110	25	8.59	5.08	37.83	12.76	14.36	0.5	0.0	2.4	17.0	46.05	0.28	1.40	2.44	3.38	Sandy
Back slop	7	0-40	22	7.50	165.40	324.3	217.83	1245	2.69	0.0	2.2	1100	687.52	0.26	8.00	8.17	111.37	Sandy
	8	0-40	22	8.10	4.13	38.37	15.32	11.28	0.74	0.0	4.4	12	49.31	0.40	4.59	14.71	1.97	Sandy
		40-85	24	9.45	3.48	41.62	6.21	23.94	1.71	0.0	2.2	6.0	65.28	0.16	1.37	19.56	6.93	Sandy
		85-120	23	7.58	2.98	34.05	17.58	5.13	1.07	0.0	2.2	6.0	49.63	0.12	3.58	11.31	0.04	Sandy
	9	0-30	23	6.65	2.49	27.02	2.92	2.63	1.17	0.0	2.2	3.0	28.54	0.11	3.91	4.75	0.05	Sandy
		30-70	22	8.83	2.82	36.75	3.33	0.85	0.37	0.0	2.8	2.0	36.5	0.28	10.24	2.92	0.02	Sandy
		70-110	22	8.95	2.95	38.57	5.31	0.99	0.5	0.0	2.6	2.0	40.77	0.15	2.86	0.97	0.20	Sandy
Upper slope	10	0-40	30	8.31	47.68	302.27	188.22	126.5	6.52	0.0	2.4	250	371.15	0.28	8.58	8.09	11.57	Sandy
		40-75	30	8.20	54.70	189.18	213.09	301	5.36	0.0	1.41	600	107.18	0.13	7.32	12.07	28.23	Sandy
	11	0-40	25	8.40	66.39	270.27	217.13	314.6	4.04	0.0	3.2	700	102.88	0.26	6.62	11.15	28.75	Sandy

Table 4. The mean and standard deviation (**SD**) of the chemical soil characteristics according to the geomorphologic unit.

Geomorphologic unit	Area	pH		EC (ds/m)		ESP		Gypsum%		$CaCO_3$%		O.M%	
	Km^2	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Floodplain	135.01	8.09	0.11	4.16	1.49	2.32	1.01	0.92	0.28	5.63	1.41	0.19	0.01
Toe slope	102.80	8.22	0.21	6.67	3.58	4.12	3.39	1.77	0.78	7.85	2.71	0.22	0.03
Back slope	144.87	8.35	0.20	19.89	16.23	11.08	12.11	4.51	1.13	8.38	2.80	0.22	0.02
Upper slope	107.76	8.34	0.09	39.47	16.91	19.50	9.44	5.71	1.13	9.85	1.13	0.23	0.02

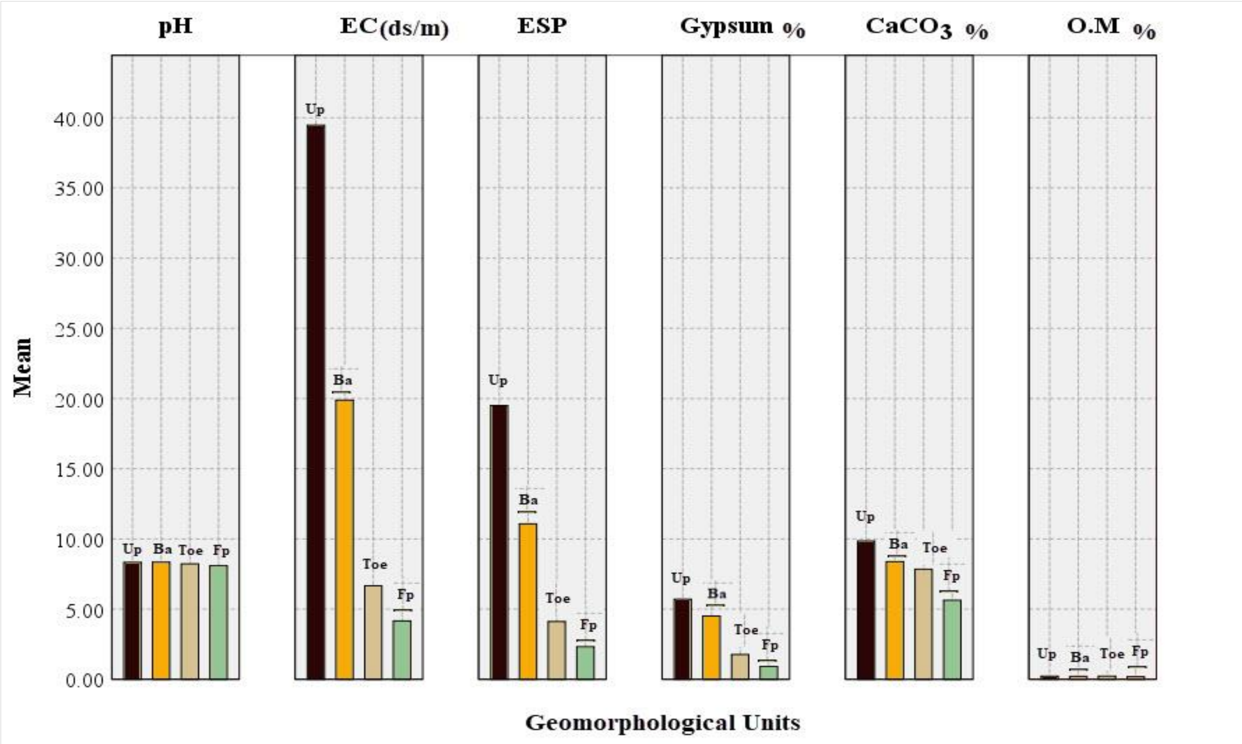

Figure 8. The mean of the chemical soil characteristics according to geomorphologic units.

2- Effects of Topographic parameters on soil characteristics:

- **The elevation and soil characteristics:**

The elevation of the study area was classified from the corrected digital elevation model into four classes. The land levels range from less than 40 meters to 190 meters, and the lands located on levels less than 50 meters came to form the largest proportion of the area by 28.88%, while the lands were distributed over the remaining levels in close proportions ranging from 5.34 to 8.81 up to the level of 75 meters. While the lands occupying levels higher than 120 meters, they constituted a small percentage of the studied area, reaching 0.07%. as illustrated in Figure .9. Differences in elevation can cause wide variations in soils profile depth and distinguishing the soil profile into horizons. In higher elevation, the soil profile has low depth and one or two horizons while in the lower elevation, the soil profile has three layers or more and has a large depth (Thickness) as depicted in Figure 10. This came as a result of water movement to low elevation areas, making more water available for soil genesis than the normal precipitation, in addition to, the elevation decreases, there is greater water runoff and soil erosion occurred.

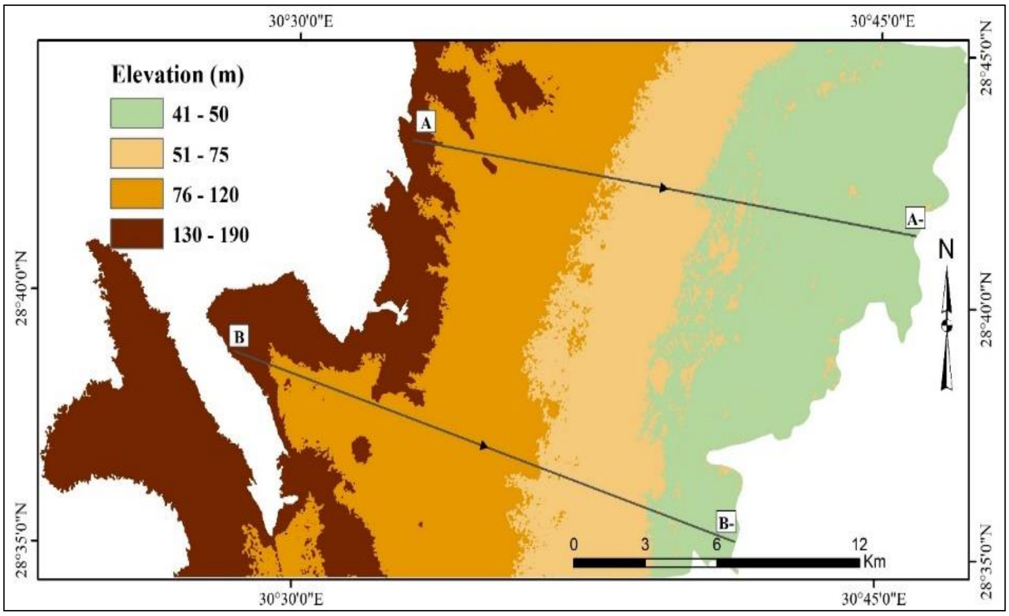

Figure 9. Elevation of the study area.

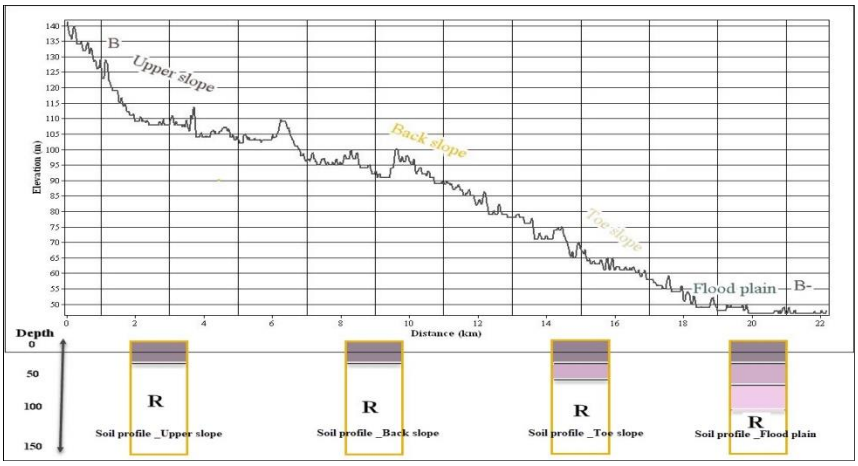

Figure 10. The cross sections of the study area.

• **Slope gradient and soil characteristics:** **The slope layer was derived from the SRTM data using Arc info GRID Module and it was divided into nine classes based on guidelines for soil description (FAO, 2006). The lands with slopes located between 0.0 - 0.5 and 2-5 form the largest percentage of the study area, at 34.1% for each of them, while sloping lands more than 10% came to constitute 3.7% of the study area. All aspects were represented in the study area, flat lands represented 34.1%, while lands were distributed in different aspects with close rates ranging between 6- 10.9% as illustrated in Table (5). The results revealed that an increase in the chemical properties of the soil with the increase in the degree of slope, and this may be due to the effect of the degree of slope on the moisture content of the soil, and then its dryness, as the low-slope lands tend to retain moisture while the soil moisture decreases with the increase in the slope and the soil here tends to dryness, which affects the chemical properties of the soil, as the degree of salinity increases with the prevalence of drought, which is always associated with the steepness of the gradient, and therefore the increase in salinity affects the pH concentrations, the increase in electrical conductivity, as well as the increase in the value of ESP. Table 5 and Figure 11.**

Table (5) Distribution of the chemical characteristics of the soil according to the degree of slope.

Slope Classes	AREA (Km^2)	pH		EC(ds/m)		ESP		Gypsum		$CaCO_3$		O.M	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
0.0-0.5 Flat	167.00	8.22	0.19	13.77	16.71	7.33	9.39	2.65	2.08	7.35	2.64	0.21	0.02
0.5-2.0 Level	43.80	8.25	0.20	16.79	18.64	8.85	10.53	3.11	2.16	7.78	2.68	0.21	0.02
2.0-5.0 Gently sloping	167.10	8.25	0.20	17.10	18.38	9.04	10.57	3.22	2.13	7.88	2.70	0.21	0.02
5.0-10 Sloping	94.30	8.29	0.19	21.39	18.47	11.25	11.07	3.97	1.96	8.41	2.47	0.22	0.02
> 10.0 Strongly Sloping	18.10	8.32	0.16	25.78	14.80	14.26	10.22	4.62	1.55	8.95	1.91	0.22	0.01

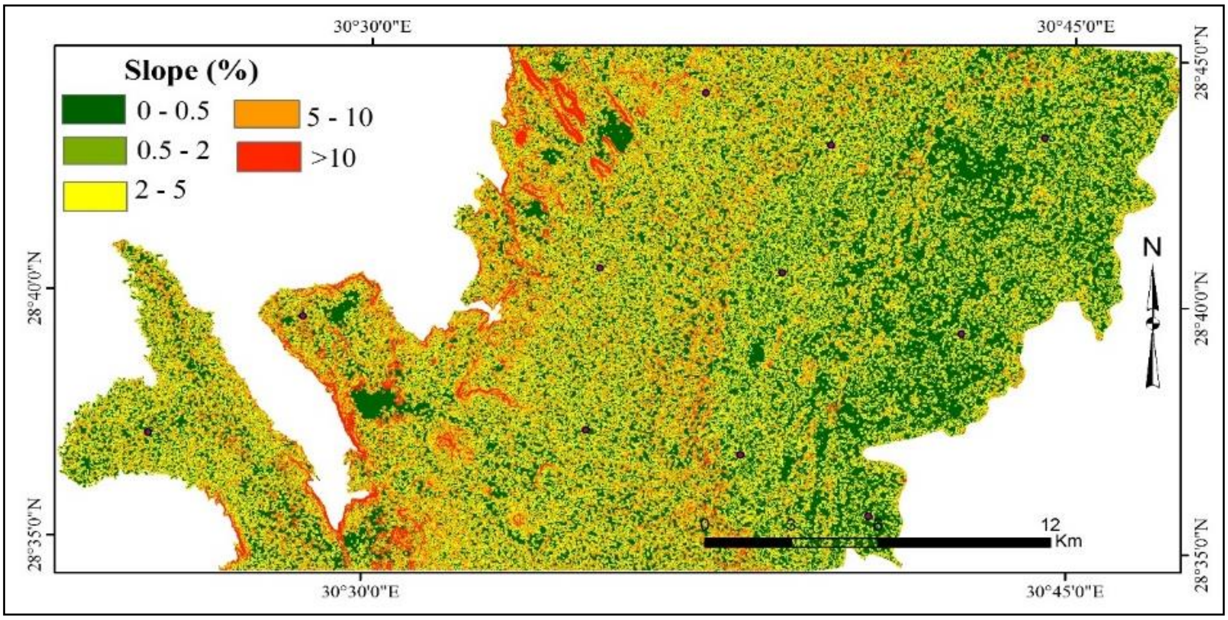

Figure 11. Slope of the study area.

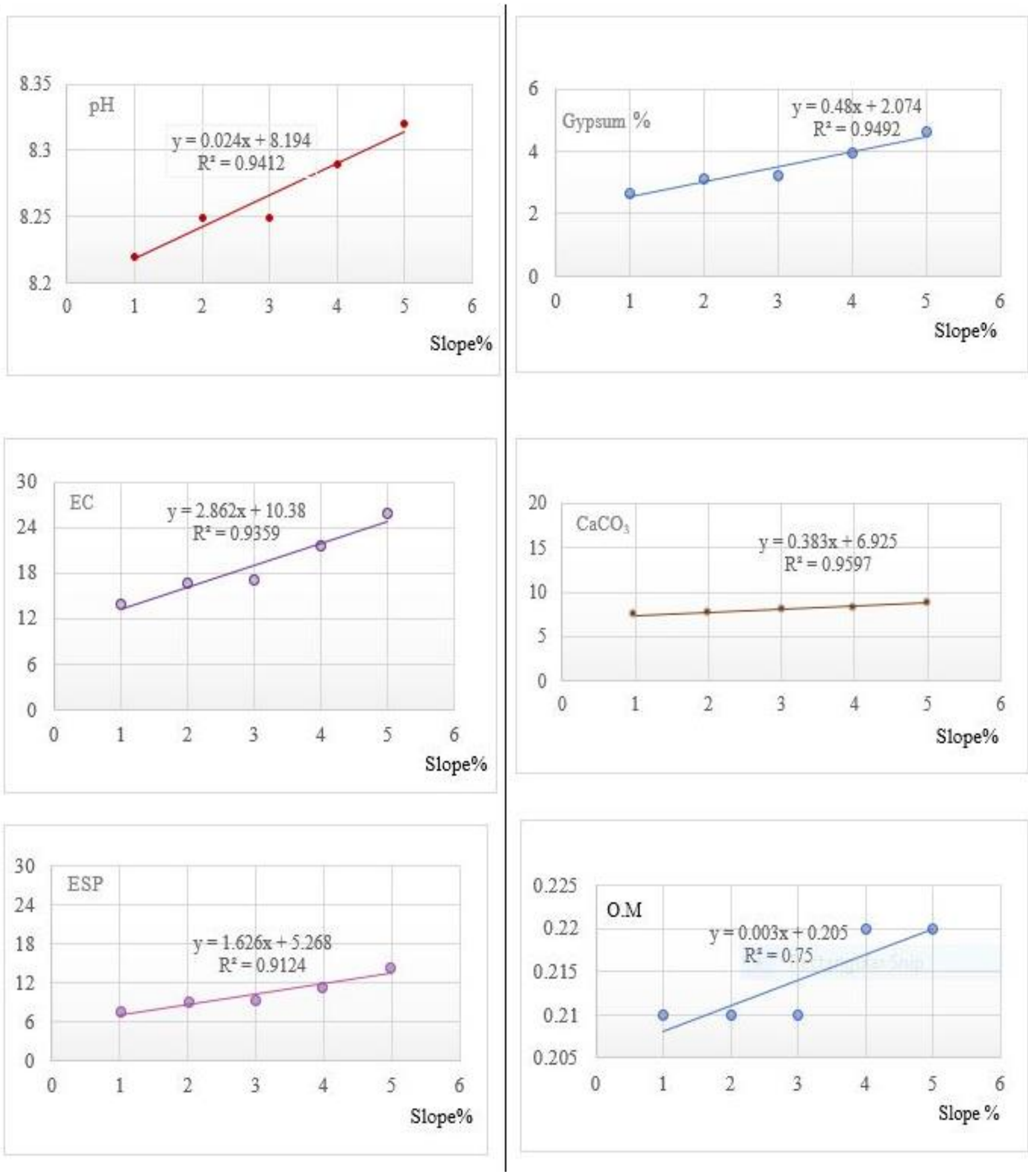

Figure 12. The correlation and regression best-fitted line between slope and soil characteristics.

The five slope classes are coded as 1.2.3.4.5 to establish the correlation between slope and soil characteristics. The results showed that there is a strong correlation and high effect whereas the coefficient of determination (R2) is more than 0.9 except for O.M equals 0.75 as shown in (Figure. 12).

- **Slope gradient and soil vegetation cover:**

The slope plays a critical role in influencing vegetation pattern and density in a semiarid area. The obtained results indicated that an area of None vegetation cover density category constitute more than 70.10 % of the total studied area, with an area of 343.34 Km^2 which is ranged between 101.0 km^2 that belonged to slope degree (0.0-0.5) and 17.10 km^2 which belonged to slope degree (10>.0). Also, the results revealed that the low vegetation density class covers more than 88.25 km^2 of the total area and varied between 36.0 that belonged to slope degree (0.0-0.5) and 0.79 km^2 which

restricted to slope degree (>10.0) while the Moderate vegetation cover density class represented by 11.88 %, with an area of 58.71 km^2 of which 30.0 km^2 belonged to slope degree (0.0-0.5) and 0.21 involved into slope degree (> 10.0) as depicted in Table 6. and Figure 13.

Table (6) The slope and the area of vegetation cover density.

Slope Classes	Area (km^2)	%	Area of vegetation cover density (km^2)		
			None	Low	Moderate
0.0 – 0.5	167.00	34.10	101.0	36.0	30.0
0.5 -2.0	43.80	8.90	28.40	9.50	5.90
2.0 -5.0	167.10	34.10	116.40	32.20	18.50
5.0-10.0	94.30	19.20	80.44	9.76	4.10
>10.0	18.10	3.70	17.10	0.79	0.21
Total	490.30	100.00	343.34	88.25	58.71

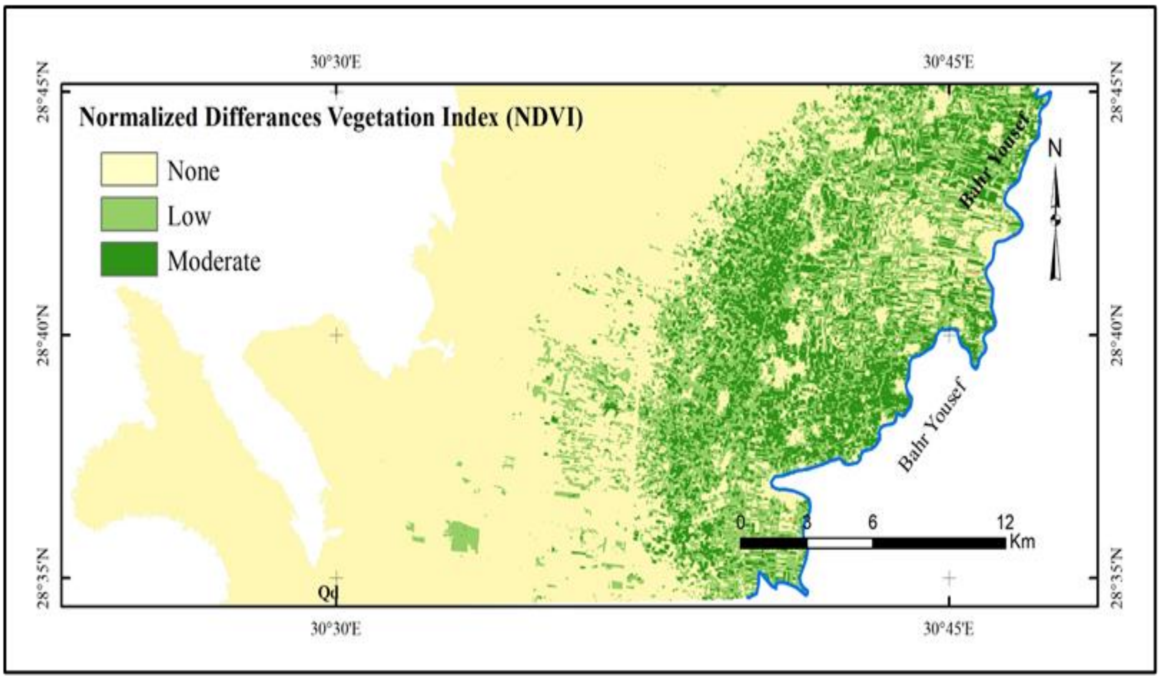

Figure 13. Vegetation cover density of the study area.

- **Slope aspect and soil characteristics:**

The topography is determined by slope gradient and elevation attributes in addition to slope aspect (orientation). The aspect influences, for example, the precipitation input, the temperature regime and the character of humus in higher latitudes. The results showed significant effects of slope aspect on some soil chemical characteristics of soil samples as shown in (Table 7).

In general, the dominant aspects in the study area are East and Southeast as illustrated in Figure .5 in the materials and methods section. The result indicated that no significant differences could be obtained in soil pH for all slope aspects where it has a mean around 8.2. the significantly highest value of EC was found on a flat area with an average value of 13.77 ds/m while the highest values were obtained on other aspects with an average of around 18.50 ds/m. The ESP ranged between 7.33 for the flat area and 10.52 10.10 for the East and Southeast aspects, respectively. The average of gypsum and CaCO3 percentage was lowest in a flat area

with 2.65 % and 7.35 %, respectively and none significantly differed from the other aspects. Also, there are differences among all aspects regarding the content of organic matter. This result might reflect the influence of water runoff on eroded clay particles toward down slopes. On the other hand, many other factors affect the amount of clay percentage within the same area as the amount, types and percentage of vegetation cover. Finally, the area that is occupied by each class of aspect.

Table (7) Distribution of the chemical characteristics of the soil according to the aspect.

Slope Aspect	pH		EC (ds/m)		ESP		Gypsum%		$CaCO_3$%		O.M%	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
Flat	8.22	0.19	13.77	16.71	7.33	9.39	2.65	2.08	7.35	2.64	0.21	0.02
North	8.25	0.20	17.81	18.64	9.31	10.76	3.37	2.11	7.91	2.68	0.21	0.02
East-north	8.27	0.19	18.93	18.58	10.20	10.95	3.54	2.07	8.16	2.67	0.22	0.02
East	8.28	0.19	18.88	18.31	10.08	10.84	3.53	2.06	8.23	2.60	0.22	0.02
Southeast	8.28	0.19	18.66	18.39	9.91	10.75	3.52	2.08	8.23	2.62	0.22	0.02
South	8.27	0.19	18.73	18.24	9.97	10.73	3.53	2.10	8.09	2.63	0.21	0.02
Southwest	8.27	0.19	19.55	18.20	10.52	10.85	3.57	2.11	8.11	2.54	0.22	0.02
West	8.25	0.19	19.32	18.66	10.07	10.76	3.50	2.17	7.89	2.53	0.21	0.02
Northwest	8.25	0.19	18.24	18.62	9.40	10.65	3.36	2.15	7.84	2.59	0.21	0.02
North	8.25	0.19	18.60	18.38	9.72	10.49	3.49	2.12	7.97	2.63	0.21	0.02

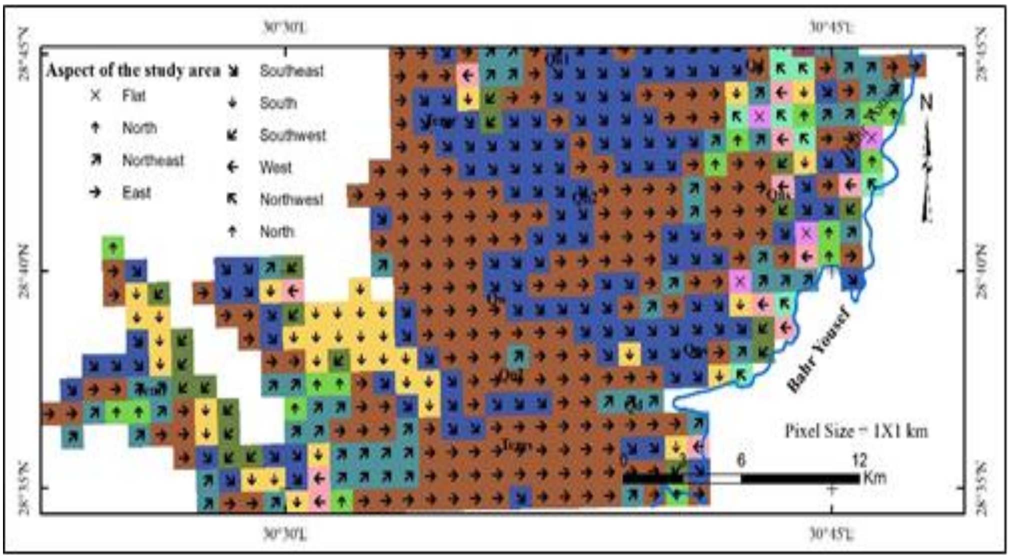

Figure 14. Aspect of the study area.

3- Effects of deposition Environment on soil characteristics:

The average sizes of the sediment in the study area ranged between 0.42-5.3 on phi values, meaning that the sediments ranged between very coarse silt and very coarse sand. The sediment sizes vary according to the geomorphological units. The flood plain ranged between very coarse silt and coarse silt (4.35-5.3), with a clear increase for the very coarse silt samples at the expense of the coarse silt samples. Calculation of the rest of the sizes, as for the back and upper slopes, the sand sediment

samples of medium size predominated (-0.42-1.67). The sorting values in the study area ranged between (1.13-2.96), that's means it lies between weak and very weak sorting. All the samples of the flood plain recorded very weak sorting, while the rest of the topographical units recorded a weak sorting, which reflects clear differences in the strength of the precipitating factor for these sediments. The predominance of the very weak sorting in the floodplain sediments is due to the periods of high floods that carried coarser sediments and mixed with fine sediments. Most of the sediment samples came with a positive Skewness in the study area. One sample was recorded in the floodplain with a very positive Skewness, while the Kurtosis values ranged between (0.57-1.56) which means Kurtosis in the study area ranged between very flat, flat, medium, tapered and very tapered. The relationship between the values of Kurtosis and Skewness indicates the presence of fine sediments of silt that was not removed by erosion factors. As for the environment, the sedimentation basin, the type of sediment, and the sedimentary current, the data indicate that the sedimentation of the floodplain was formed in an aeolian environment, while the sediments of the rest of the terrain units were formed in a marine coastal environment that was mainly associated with the tyranny of the Chess Sea on Egyptian lands. As for the sedimentation basin, the data indicate that the sediments were formed in the Basin It is shallow in most of the sediment samples indicating that it is of deltaic type, while the sedimentary stream varied between a turbid stream and another deltoid as shown in Table (8) and Table (9).

Table (8) Estimated phi value for each geomorphological unit based on the texture of soil samples.

Geomorphological unit	Soil Profile No	Depth (cm)	phi value							
			phi_5	phi_14	phi_16	phi_25	phi_50	phi_75	phi_84	phi_95
Flood plain	1	0-40	1.0	1.15	1.25	1.5	4.7	7.0	8.0	8.5
		40-80	1.0	1.1	1.25	2.25	6.25	7.6	8.4	8.75
		80-120	1.0	1.25	1.5	2.0	4.5	7.25	7.75	8.75
	2	0-40	1.0	1.30	1.5	2.0	4.5	7.25	8.0	8.6
		40-80	1.0	1.15	1.4	2.0	5.2	7.4	8.0	8.75
		80-120	1.2	1.6	1.75	2.3	4	6.7	7.5	8.7
	3	0-35	1.0	1.4	1.6	2.0	4.5	7.4	8.0	8.7
		35-75	1.0	1.25	1.45	1.8	3.8	7.0	7.8	8.7
		75-120	1.0	1.4	1.6	2.4	5.7	7.8	8.0	8.7
Toe slope	4	0-40	-2.0	-1.65	-1.4	-0.7	0.35	1.35	1.8	2.85
		40-75	-1.85	-1.5	-1.35	-1.0	-0.35	0.6	1.2	3
	5	0-40	-1.85	-1.35	-1.25	-0.5	1.15	2.15	2.75	3.75
		40-85	-2.0	-1.35	-1.2	-0.25	1.25	2.35	2.75	3.9
		85-115	-2.0	-1.75	-1.65	-1.0	0.5	1.6	2.0	3.25

	6	0-35	-1.25	0.4	0.6	1.2	1.85	2.6	2.8	4.0
		35-70	-2.0	0.2	0.35	0.9	1.7	2.4	2.7	3.5
		70-110	-2.0	-0.25	0.0	0.45	1.35	2.0	2.45	3.0
Back slop	7	0-40	-1.8	-0.85	-0.75	-0.25	0.75	1.7	2.0	3.35
	8	0-40	-2.0	-0.7	-0.5	0.25	1.25	2.5	3.0	4.4
		40-85	-1.65	-0.5	-0.25	0.25	1.1	2.0	2.5	3.8
		85-120	-2.0	-0.9	-0.5	0.35	1.85	2.8	3.5	4.5
	9	0-30	-2.0	-1.75	-1.7	-1.35	-0.5	0.75	1.3	2.5
		30-70	-2.0	-1.9	-1.7	-1.0	0.5	1.75	2.4	3.6
		70-110	-2.0	-1.7	-1.5	-1.25	-0.5	0.3	0.75	1.75
Upper slope	10	0-40	-1.65	-0.5	-0.25	0.3	1.4	2.45	2.8	3.75
		40-75	-2.0	-0.6	-0.4	0.3	1.55	2.6	2.9	4.25
	11	0-40	-1.7	-0.25	0.0	0.5	1.75	2.75	3.25	4.0

Table (9) Statistical analysis of phi values according to geomorphological units**.**

Geomorphological unit	Soil Profile No	Depth (cm)	Mean	Sorting	Skewness	Kurtosis	y1	y2	y3	y4
Flood plain	1	0-40	4.65	2.82	0.24	0.57	-4.84	273.24	-24.61	9.13
		40-80	5.30	2.96	0.15	0.60	-6.34	291.42	-25.17	9.21
		80-120	4.58	2.74	0.26	0.62	-4.81	267.62	-23.94	9.40
	2	0-40	4.67	2.78	0.27	0.60	-5.02	271.49	-24.32	9.48
		40-80	4.87	2.82	0.21	0.60	-5.43	276.72	-24.40	9.25
		80-120	4.42	2.57	0.30	0.71	-4.62	256.87	-22.77	10.01
	3	0-35	4.70	2.77	0.27	0.59	-5.21	271.27	-24.23	9.47
		35-75	4.35	2.75	0.31	0.62	-4.03	266.11	-24.42	9.61
		75-120	5.10	2.77	0.18	0.59	-6.44	275.83	-23.66	9.13
Toe slope	4	0-40	0.25	1.53	0.23	0.99	7.39	127.09	-14.44	7.53
		40-75	-0.17	1.37	0.30	1.26	8.97	116.43	-13.51	9.16
	5	0-40	0.88	1.85	0.20	0.88	6.02	155.18	-16.89	7.38
		40-85	0.93	1.88	0.19	0.95	6.19	159.15	-17.11	7.70
		85-115	0.28	1.71	0.21	0.84	7.50	135.93	-15.85	6.72
	6	0-35	1.75	1.35	0.22	1.56	3.16	148.60	-12.29	11.52
		35-70	1.58	1.42	0.21	1.53	3.93	150.24	-12.98	11.22
		70-110	1.27	1.37	0.22	1.34	4.30	60.60	-12.65	10.02
Back slop	7	0-40	0.67	1.47	0.23	1.10	6.01	131.33	-13.74	8.41
	8	0-40	1.25	1.89	0.25	1.24	5.89	171.22	-17.38	9.90
		40-85	1.12	1.51	0.25	1.30	5.14	145.43	-14.11	9.96
		85-120	1.62	2.06	0.21	1.19	5.14	186.55	-18.58	9.71
	9	0-30	-0.30	1.43	0.30	0.89	8.51	111.40	-14.08	7.13

		30-70	0.40	1.87	0.23	0.85	7.68	149.15	-17.37	7.05
		70-110	-0.42	1.13	0.28	1.01	8.23	91.44	-11.34	7.35
Upper slope	10	0-40	1.32	1.58	0.23	1.05	3.95	147.92	-14.54	8.64
		40-75	1.35	1.81	0.20	1.18	5.14	165.44	-16.41	9.27
	11	0-40	1.67	1.68	0.23	1.06	3.08	159.83	-15.28	8.98

CONCLUSION:

In this research, there are differences in average of cations and anions between geomorphological units, where it increases from the flood plain towards the upper slopes through the toe slopes and back slopes, except for HCO_3^-. The calcium carbonate, gypsum and organic matter content and EC, ESP values reduces away from the flood plain, where the flood plain has a low value and upper slope has a high value. The higher values of aforementioned characteristics may be due to the impact of the geological formations in which limestone predominates. The topography especially aspect and slope gradient affected some soil characteristics. For instance, an increasing slope gradient influenced almost all soil Physico-chemical characteristics. In addition, existing of parent materials at the upper slopes of physiographic units resulted in organic matter increasing and consequently more organic matter and total nitrogen accumulation in soil. Therefore, it is essential to recognize the effects of the most important component of slope on soil characteristics and in turn their effects on soil development in a study area. The results of the study revealed that the soil characteristics, whether physical or chemical were affected by the topography factor, where the proportion of clay content prevailed in the samples of the flood plain, while the proportion of sand increased in the samples of the rest of the terrain units. The results also indicated an increase in the soil characteristics such as (EC), (ESP), (O.M) and gypsum and CaCO3 content where they increased from the flood plain towards the upper slopes unites. also, there is a clear effect of the degree of slope on the soil characteristics and vegetation cover density, with regard to effects of deposition Environment on soil characteristics, All the samples of the flood plain recorded very weak sorting, while the rest of the topographical units recorded a weak sorting, which reflects a clear difference in the strength of the precipitating factor for these sediments. As for the environment, the data indicate that the sedimentation of the floodplain was formed in an aeolian environment, while the sediments of the rest of the terrain units were formed in a marine coastal environment that was mainly associated with the tyranny of the Chess Sea on Egyptian lands.

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تأثير العامل الطبوغرافي والمظاهر الجيومورفولوجية على خصائص التربة غرب بحر يوسف ، المنيا ، مصر

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الملخص :

تم استخدام التكامل بين الجيومورفولوجيا والتضاريس على نطاق واسع في علوم التربة، حيث يتم اشتقاق المعلومات الطبوغرافية من نماذج الارتفاع الرقمية (DEMs) المستمدة من القياس التصويري وصور الأقمار الصناعية لحساب السمات الطبوغرافية مثل الارتفاع الرقمي وتدرج المنحدر والجانب الذي تم إنتاجه يدويًا وتطبيقه للتحقيق في التباين المكاني في خصائص التربة وإنتاج خرائط التربة. يعد الارتفاع والانحدار والجانب من السمات الرئيسية للتضاريس التي يمكن أن تؤثر على تطور التربة وتطورها. تهدف الدراسة الحالية إلى الكشف عن تأثير عامل الطبوغرافيا والظاهرات الجيومورفولوجية على خصائص التربة غرب منطقة بحر يوسف بمحافظة المنيا. استندت الدراسة إلى أخذ ١١ قطاعا تربة (٢٧ عينة) موزعة على أربع وحدات تضاريس: منحدرات علوية ، وخلفية ، وأصابع القدم ، والسهل الفيضي. تم استخلاص وتحديد الوحدات الفيزيوجرافية الأربع بناءً على الصفات الطبوغرافية ومعالجة صور القمر الصناعي لاندسات ٨ ، بالإضافة إلى تحديد كثافة الغطاء النباتي بواسطة مؤشر الغطاء النباتي (NDVI) الذي تم حسابه باستخدام مستشعر OLI. تم تحديد بعض الخصائص المورفولوجية والفيزيائية والكيميائية للتربة مثل سماكة التربة (العمق) وتوزيع حبيبات التربة خاصة تلك المتعلقة بمحتوى الطين و (EC) و (O.M) ومحتوى الجبس والكربونات ونسبة الصوديوم القابلة للتبديل. أظهرت نتائج الدراسة أن خصائص التربة سواء الفيزيائية أو الكيميائية تأثرت بعامل التضاريس ، حيث سادت نسبة محتوى الطين في عينات السهل الفيضي ، بينما زادت نسبة الرمل في عينات باقي المناطق.

أشارت النتائج أيضاً إلى زيادة في خصائص التربة مثل (EC) و (ESP) و (O.M) ومحتوى الجبس و $CaCO_3$ حيث ازدادت من السهل الفيضي نحو المنحدرات العلوية، أيضا هناك تأثير واضح لدرجة الانحدار على خصائص التربة وكثافة الغطاء النباتي. أما فيما يتعلق بآثار بيئةالترسب على خصائص التربة، سجلت جميع عينات السهل الفيضي فرزاً ضعيفا جدا، بينما سجلت باقي الوحدات الطبوغرافية فرزاً ضعيفاً مما يعكس بوضوح الاختلاف في قوة عامل الترسيب لهذه الرواسب. أما بالنسبة لبيئة الترسيب ، تشير البيانات إلى أن رواسب السهول الفيضية قد تشكل في بيئة ريحية، بينما تشكلت رواسب باقي وحدات التضاريس في بيئة ساحلية بحرية .

الكلمات المفتاحية: العوامل الطبوغرافية ، خصائص التربة ، بحر يوسف