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SOME PHYSICAL AND CHEMICAL PROPERTIES AND STATUS OF NUTRIENTS AS AFFECTED BY SLOPE POSITION IN MARSA-MATRUH

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ABSTRACT

The current study aims to study some soil physical and chemical properties and available nutrient content in relation to soil erosion. Five soil profiles were dug in Wadi-Madwar in Marsa Matruh. The name of soil profiles were represented (South Wadi-Madwar, Soil stone, Bir Haiyub,Elshiyab cemeter and El Qasr). Soil profiles along the main slope inside Wadi-Madwar reflect the effect of water erosion process on soil properties with slope 122-4mm. The results can be summarized as follows:- Particle size distribution and soil texture class for soil profiles revealed that silt and clay fractions were gradually increased down slope and soil texture of Wadi-Madwar were sand, sandy loam and loamy sand. Values of gravel percentage were decreased with down slope. The changes in pore size distribution due to soil erosion were identical and revealed that values of slowly drainable pores (SDP) in the soil profiles under investigation were very small. Water holding pores (WHP) and fine capillary pores (FCP) values were increased with increasing the slope length to the sea direction. Field capacity (FC) and wilting point (WP) values in the soil profiles under study increased with slope length toward the sea and Hydraulic conductivity (K) values decreased down slope toward the sea. Soil bulk density value in the deep layer was slightly higher than of the surface layer, at the same time, soil bulk density values were higher beside the mountain and decreased gradually with slope length towards the sea. Total porosity values decreased in all profiles beside the mountain and increased with down slope. Soil pH values of all soil profiles ranged between 8.1 and 8.9 and reflect the alkalinity of studied profiles. EC values were low and decreased with increasing soil depth and ranged between 3.1 and 6.9. Average content of calcium carbonate tends to increase with soil depth and at the down slope. Organic matter content tends to increase with soil depth and at the down slope. Cation exchange capacity (CEC) was mainly correlated with the soil fine fraction content and it was increased at down slope. The contents of available N, P, K, Fe, Mn, Zn and Cu increased towards the down slope area.

INTRODUCTION

Soil erosion by water is a serious problem in Marsa- Matruh. Dry land farming areas in North Africa extend about 3000 Km along the Mediterranean Sea and 35 Km in land with total areas of 105000 Km^2. The region lies within the boundary coordinates 30^0 35\ to 33^0 57\ N and 10^0 to 33^0 15\ E. Erosion effects on soil productivity mainly by modifying certain soil properties such as soil structure, soil texture, organic matter content. Arroug (1995) and Mohamed (1999) evaluated some erosion parameters on the north western coast soils of Egypt. Lu and Li (1992) studied the effect of soil moisture on soil loss. They found an inverse relationship between soil loss and moisture in the upper 30 cm. Recently there is a major focus on soil physical properties, geological and topographic conditions as key factors which control runoff response in tropical catchments under extreme rainfall patterns (Bruijzeel 2004 and Noguchi *et al*., 2005). El-Hassanin(1983) indicated that the slope length and slope gradient influenced particle size distribution .As slope length increased, sand markedly declined while silt and clay appreciably increased . However, the role of silt and clay removal to down-slope positions was more evident than sand. Gaber (1989) found that changes in organic matter with slope positions were similar to silt and clay. Organic matter percentage at the upper slope position was lower than at the lower slope position. Also, he found that total porosity showed higher values at the lower slope position due to the lower bulk density values and higher clay content and pH values in surface layers of the virgin tropical soils ranged from 4.56 to 5.16 at the top of slope and decreased at the down slope from 4.15 to 4.64. Hoa *et al*. (2002) found an insignificant difference in soil organic carbon between upper and lower slope position. Moges and Holden (2008) made a comparison at landscape level, and revealed that the sand fraction was significantly greater, whereas the silt fraction was significantly smaller, on the lower slope relative to the middle slopes. Moreover, the organic carbon and total nitrogen were significantly less on lower slopes than upper and middle slopes.

MATERIALS AND METHODS

Location of soil profiles and field work:

The current work was conducted to study the changes of soil physical and chemical properties and available nutrient content in relation to soil erosion in Marsa Matruh, Wadi-Madwar. The studied soils were in semi arid zone. Rainfall is considered the most active erosion agent (150-200 mm/year) which falls in few storms causing surface flowing water with energy strong enough to erode the soil. Five soil profiles were dug in Wadi-Madwar in Marsa Matruh. Distance between soil profiles 5 Km. Soil profiles along the main slope inside the Wadi-Madwar reflect the effect of water erosion process on soil properties of slope with 122-4mm.The name of soil profiles were represented (South Wadi-Madwar, Soil stone, Bir Haiyub,Elshiyab cemeter and El Qasr) as shown in map(1). The upper slope was in profiles South Wadi-Madwar and Soil stone; middle slope was in profiles Bir Haiyub and Elshiyab cemeter and down slope was in profile El Qasr. The soil profiles were dug deep down to 120cm or to water table level .The collected soil samples were disturbed and undisturbed. The disturbed soil samples were air dried, crushed and passed through 2 mm sieve and used to determine some soil chemical properties and available nutrients, while the undisturbed soil samples were used to determine soil physical properties. Particle size distribution was carried out by the pipette method as described by Gee and Bauder (1986) using sodium hexameta- phosphate as a dispersing agent. Soil bulk density was determined by using the undisturbed soil column according to Richards (1954).

Map(1) : Location of Wadi – Madwar in Marsa Matruh

Total soil porosity was calculated as percentage from the obtained values of real and bulk densities (Richards, 1954). Wilting point was determined according to Stakman and Vanderhast (1962), while field capacity was determined as described by Richards (1954). The determination of soil moisture equilibrium values was carried out according to the methods described by Richards and Weaver (1944) and Richards (1947). The moisture retention values were determined by using the pressure cooker under 0.10, 0.33, 0.66 and 1.0 atmospheres and the pressure membrane for pressure 15 atmosphere. Pore size distribution was calculated according soluble salts (EC) was determined by using electrical conductivity meter at 25 ○ C in soil paste extract as dSm-1 and organic matter content using Walkely and Black's rapid titration method (Jackson, 1973). Total content of $CaCO_3$ was determined volumetrically using collin's calcimeter and soil pH was determined in (1:2.5) soil: water suspension using electrode pH meter according to Jackson (1973). Available micronutrients Fe, Zn and Cu were extracted by using DTPA extract as described by Soltanpour (1985) and determined by using atomic absorption spectrophotometer according to Cottenie *et al*. (1982). Available phosphorus was extracted by using sodium bicarbonate ($NaHCO_3$) 0.5 M at pH 8.5 according to Olsen (1965) and determined by using ascorbic acid method as described by Watanabe and Olsen (1965).Available potassium was extracted by using ammonium acetate (CH_3COONH_4) 1N at pH 7.0 and determined using flame-photometer according to Cottenie *et al*. (1982).Total available nitrogen was extracted by using potassium chloride 1N (KCl) and determined by the method of semimacrokjeldahl according to Jackson (1973).

RESULTS AND DISCUSSION

Soil physical properties:

Particle size distribution:

Particle size distribution and texture class for soil profiles of Wadi-Madwar in Marsa Matruh are shown in Table (1). The results revealed that silt and clay fractions were gradually increased with down slope. Soil texture of Wadi-Madwar is sand, loamy sand and sandy loam. The results also revealed that little changes in particle size distribution with soil profile depth while these changes were pronounced through the length of slope particularly at the surface layer.

Table (1): Some physical properties of the studied soil profiles

Location	Profile No.	Depth cm	Gravels %	Particle size distribution			Texture
				Sand %	Silt %	Clay %	
South Wadi-Madwar	1	0-25	59.8	87.3	10.4	2.3	Sand
		25-50	59.6	86.7	9.8	3.5	Sand
Soil stone	2	0-20	46.3	85.5	11.9	2.6	Sand
		20-40	51.4	83.9	13.0	3.1	L. Sand
		40-70	49.1	84.4	12.7	3.9	L. Sand
Bir Haiyub	3	0-30	41.0	82.3	12.6	5.1	L. Sand
		30-70	43.6	82.9	13.1	4.0	L. Sand
		70-100	39.3	84.2	12.9	2.9	L. Sand
Elshiyab cemeter	4	0-30	27.4	70.1	21.3	8.6	S. Loam
		30-65	29.1	74.5	17.6	7.9	S. Loam
		65-85	28.0	72.3	18.1	9.6	L. Sand
		85-120	29.2	73.1	20.1	6.8	L. Sand
El Qasr	5	0-30	17.6	67.1	18.3	14.6	S. Loam
		30-60	12.5	69.8	15.2	15.0	S. Loam
		60-80	13.9	68.4	17.7	13.9	S. Loam
		80-100	12.5	71.9	16.4	11.7	L. Sand

Gravel:

Generally, values of gravel percentage for the studied soil profiles tended to decrease down slope toward the sea in the Wadi-Madwar. This is due to the selectivity process during water erosion where fine particles are carried away, while gravel rest upper slope.

Moisture retention curves:

The shape of soil moisture curves depends mainly on some properties of the soil as texture, structure, soluble salts content, and exchangeable cations .The moisture retention curves in the upper slope position, which contain high amount of coarse sand, show a sharp decrease in the moisture content at low suctions. There was gradual decrease in moisture with increasing the slope length toward the sea which may be due to the increase of fine particles (silt, clay) down slope, Table (2) and Fig (1).

Table (2): Moisture contents (volumes %) of the studied soil profiles under different tensions (atm)

Location	Profile No.	Depth cm	Different tensions (atm)					
			0.001	0.1	0.33	0.66	1.0	15.0
South Wadi-Madwar	1	0-25	21.1	17.5	16.3	14.7	10.6	5.1
		25-50	22.0	17.9	16.7	15.1	10.0	5.2
Soil stone	2	0-20	23.5	20.3	18.6	16.2	11.3	5.3
		20-40	23.9	20.6	19.0	16.5	11.7	5.5
		40-70	23.5	20.5	18.7	16.3	11.6	5.3
Bir Haiyub	3	0-30	24.2	21.6	19.9	17.8	13.1	6.1
		30-70	24.5	21.9	20.3	17.9	13.5	7.3
		70-100	23.4	21.1	19.4	17.3	17.1	6.0
Elshiyab cemeter	4	0-30	25.9	23.2	21.9	19.1	14.5	8.1
		30-65	25.9	23.3	22.0	18.6	15.1	8.3
		65-85	24.6	22.3	21.1	18.0	14.9	8.0
		85-120	24.0	21.9	20.6	17.3	14.0	7.9
El Qasr	5	0-30	26.8	24.0	22.8	19.9	15.3	8.7
		30-60	27.3	24.9	23.0	20.0	16.1	8.9
		60-80	26.6	23.8	22.7	17.5	15.9	8.5
		80-100	26.7	24.3	22.9	17.9	16.0	8.7

Fig. (1): Moisture retention curves for the studied soil profiles.

Soil moisture constants:

Results in Table (3) revealed that field capacity and wilting point values in the soil profiles under study were increased with slope length toward the sea. Available water value was increased down slope with distance due to the increase of fine particles and organic matter. The results of Darwich (2000) are confirmed with our results.

Soil bulk density and total porosity:

Soil bulk density and total porosity are the most important soil factors that represent a function of soil structure (Lawrence, 1977). Data in Table (4) reveals that there were pronounced differences in their values at either along the different slope positions or soil depths. Soil bulk density value in the depth was slightly lower than of the surface layer, at the same time soil bulk density values were higher beside the mountain and decreased gradually with slope length towards the sea .This behavior is mainly rendered to erosion process and transport of fine particles down slope towards the sea. Total porosity values were decreased in all the profiles beside the mountain and increased down slope. This is mainly attributed to the dominance of coarse sand beside the mountain and the fine particles (silt, clay) at down slope.

Table (3): Moisture contents (%) at soil moisture constants of the studied soil profiles

Location	Profile No.	Depth Cm	Soil moisture constants %		
			F.C.	W.P.	A.W.
South Wadi-Madwar	1	0-25	16.3	5.1	11.2
		25-50	16.7	5.2	11.5
Soil stone	2	0-20	18.6	5.3	13.3
		20-40	19.0	5.5	13.5
		40-70	18.7	5.3	13.4
Bir Haiyub	3	0-30	19.9	6.1	13.8
		30-70	20.3	6.3	14.0
		70-100	19.4	6.0	13.4
Elshiyab cemeter	4	0-30	21.9	8.1	13.8
		30-65	22.0	8.3	13.7
		65-85	21.1	8.0	13.1
		85-120	20.6	7.9	12.7
El Qasr	5	0-30	22.8	8.7	14.1
		30-60	23.0	8.9	14.1
		60-80	20.7	8.5	12.2
		80-100	21.0	8.7	12.3

Soil hydraulic conductivity (K):

Hydraulic conductivity (K) is an important factor for planning and design projects of land reclamation especially for irrigation. Data in Table (4) show that, hydraulic conductivity (cm^3/hour) values were decrease with down slope toward the sea. Values of hydraulic conductivity (K) were ranged between 8.6 and 5.2 cm^3/hour. The low values of hydraulic conductivity were attributed to increase the fine particles transported by water erosion process with down slope direction.

Table (4): Soil bulk density, total porosity (%), soil hydraulic conductivity (cm^3/h) and Pore size distribution in the studied soil profiles

Location	Profile No.	Depth cm	BD (ton/m^3)	T.P %	K (cm^3/h)	Pore size distribution %				
						Q.D.P	S.D.P	D.P	W.H.P	F.C.P
South Wadi-Madwar	1	0-25	1.77	33.2	8.6	3.6	1.2	4.8	11.2	5.1
		25-50	1.73	34.7	8.8	4.1	1.2	5.3	11.5	5.2
Soil stone	2	0-20	1.73	34.7	8.3	3.2	1.7	4.9	13.3	5.3
		20-40	1.72	35.1	8.0	3.3	1.6	4.9	13.5	5.5
		40-70	1.70	35.8	7.9	3.0	1.8	4.8	13.4	5.3
Bir Haiyub	3	0-30	1.75	33.9	7.7	2.6	1.7	4.3	13.8	6.1
		30-70	1.73	34.7	7.7	2.6	1.6	4.2	13.0	7.3
		70-100	1.70	35.8	7.2	2.3	1.7	4.0	13.4	6.0
Elshiyab cemeter	4	0-30	1.64	38.1	7.1	2.7	1.3	4.0	13.8	8.1
		30-65	1.63	38.5	7.1	2.6	1.3	3.9	13.7	8.3
		65-85	1.61	39.2	6.8	2.3	1.2	3.5	13.1	8.0
		85-120	1.60	39.6	6.4	2.1	1.3	3.4	12.7	7.9
El Qasr	5	0-30	1.63	38.5	6.1	2.8	1.2	4.0	14.1	8.7
		30-60	1.62	38.9	5.8	2.4	1.9	4.3	14.1	8.9
		60-80	1.60	39.6	5.5	2.8	3.1	5.9	14.2	8.5
		80-100	1.59	40.0	5.2	2.4	3.3	5.7	14.2	8.7

Q.D.P (>28.84) Quickly Drainable Pores. **K = Hydraulic Conductivity.**
S.D.P (28.8-8.62u) Slow Drainable Pores. **D.P (8.62u) Drainable Pores.**
W.H.P (8.62-.019) Water Holding Pores. **F.C.P (<0.19u) Fine Capillary Pores.**
BC= Bulk density **Averge of real density (ton/m^3) = 2.65** **T.P. =Total porosity**

Pore size distribution:

The changes in pore size distribution due to soil erosion are identical on the studied soil. From the data in Table (4) value of quickly drainable pores (QDP) was high as a result of the dominance of coarse sand, and decreased with slope length toward the sea where fine particles increased. Values of slowly drainable pores (SDP) in the soil profiles under investigation were very small. Variations of water holding pores (WHP) were increased with increasing the slope length to the sea direction. Fine capillary pores values (FCP) were increased with increasing the slope length to the sea direction.

Soil chemical properties:

Data in Table (5) show that, soil pH values of all soil profiles were ranged from 8.1 to 8.9 and reflect to the alkalinity of studied profiles. EC values were low and decreased with increasing soil depth and ranged from 3.1 to 6.9**.** The reduction in the EC values with depth may be attributed to evaporation process responsible to the deposition of salts which occurs on the surface due to high temperature. Average content of $CaCO_3$ tends to increase with depth and at the down slope and they varied from 26.3 to 34.5% of the studied soil profiles. Organic matter content was increased with increasing slope position and soil depth of studied profiles and organic matter content ranged from 0.09 to 0.15%. The soil profiles fertile were increased by increasing the down slope due to the accumulation of transported organic matter and fine materials. The cation exchange capacity (CEC) was mainly correlated with the fine fraction content. Values of (CEC) were decreased in all profiles beside the mountain and increased at down slope. This is mainly attributed to the dominance of coarse sand beside the mountain and the fine particles (silt, clay) and organic matter with down slope, which transported by water erosion process.

Table (5): Some soil chemical properties of the studied soil profiles

Location	Profile No.	Depth cm	pH 1:2.5	EC ds/m	CEC c mol/kg	$CaCO_3$ %	OM %
South Wadi-Madwar	1	0-25	8.2	4.5	2.2	26.3	0.07
		25-50	8.3	35	3.3	27.0	0.06
Soil stone	2	0-20	8.2	4.6	2.4	27.0	0.09
		20-40	8.5	3.3	3.0	28.3	0.1
		40-70	8.3	3.1	3.7	28.5	0.08
Bir Haiyub	3	0-30	8.2	5.3	4.9	27.4	0.11
		30-70	8.5	5.0	3.8	28.9	0.09
		70-100	8.1	4.9	2.4	29.0	0.09
Elshiyab cemeter	4	0-30	8.7	6.8	7.4	30.7	0.13
		30-65	8.5	6.5	7.2	32.0	0.15
		65-85	8.3	5.7	9.1	33.4	0.11
		85-120	8.9	5.3	6.4	33.5	0.1
El Qasr	5	0-30	8.9	6.9	13.1	32.9	0.15
		30-60	8.8	6.7	14.2	33.8	0.14
		60-80	8.6	6.6	14.0	34.5	0.12
		80-100	8.6	6.5	13.1	34.1	0.11

Available nutrients content:

As for the effect of slope position on nutrients status, data in Table (6) show that, the upper slope area had relatively low nutrient concentration than down slope as a result of erosion of topsoil and subsequent deposition on down slope positions. This emphasized a close relationship exists between both organic matter and the released nutrients, however, there was a relatively high organic matter content in surface layer as compared to the subsoil one, such condition is probably due to the adding of organic manure to the surface soil. Such trend is greatly related to soil organic matter and clay contents, taking into consideration the noticeable slope gradients. Generally, the soil of down slope have a relatively high content of the available nutrients under study as compared to the upper slope.

Table (6): Available nutrients content (macro and micronutrients) in the studied soil profiles

Location	Profile No.	Depth cm	Available nutrients (mg /kg^{-1} soil)						
			N	P	K	Fe	Zn	Mn	Cu
South Wadi-Madwar	1	0-25	21.3	73	136.5	1.9	0.7	1.3	0.2
		25-50	20.0	5.5	130.8	1.5	0.6	0.9	0.2
Soil stone	2	0-20	22.7	8.9	189.5	1.9	0.9	1.5	0.3
		20-40	20.6	7.1	156.9	1.6	0.8	1.3	0.2
		40-70	18.3	6.8	159.3	1.5	0.6	1.2	0.2
Bir Haiyub	3	0-30	35.9	9.9	191.9	1.8	0.9	1.8	0.4
		30-70	37.8	9.1	190.5	1.7	0.8	1.6	0.3
		70-100	29.4	7.8	158.4	1.6	0.8	1.3	0.2
Elshiyab cemeter	4	0-30	41.7	11.4	200.7	1.9	1.1	1.9	0.5
		30-65	43.9	10.2	200.0	1.7	0.9	1.8	0.4
		65-85	35.3	9.1	186.5	1.6	0.9	1.5	0.3
		85-120	30.0	7.5	175.3	1.5	0.8	1.4	0.3
El Qasr	5	0-30	49.4	13.9	219.7	1.9	1.2	1.9	0.7
		30-60	51.3	12.5	210.5	1.9	1.1	1.9	0.6
		60-80	39.0	11.0	191.3	1.8	1.0	1.7	0.5
		80-100	32.0	8.1	183.4	1.7	0.9	1.6	0.5

CONCLUSION

Soil erosion (Rainfall-Runoff) processes by water are a serious problem in Marsa Matruh soil. Which effect on soil physical, chemical properties, available nutrients content and vegetation types at the same time relation to slope gradients.

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دراسة تأثير الانحدار على بعض الخصائص الطبيعية و الكيميائية والمغذيات في أراضى مرسى مطروح

انشراح ابراهيم محمد المعاز و مصطفى عبدالعدل درويش و هدى محمد رجائى محمود أحمد
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الهدف من إجراء هذة الدراسة هو بيان تأثير الميل الأرضى على الخصائص الطبيعية والكيميائية وحالة العناصر الكبرى و الصغرى فى أراضى مرسى مطروح (وادى المدور) ولهذا تم اختيار خمس قطاعات ارضية تمثل وادي المدور احد وديان مرسى مطروح (South Wadi-Madwar, Soil stone, Bir Haiyub,Elshiyab cemeter and El Qasr). حيث تم حفر القطاعات الأرضية لعمق 120 سم أو إلى مستوى الماء الارضى وأخذت عينات أرضية مثارة لإجراء التحليلات الكيميائية (كربونات الكالسيوم الكلية و المادة العضوية ودرجة الحموضة و درجة الملوحة و السعة التبادلية الكاتيونية) وعينات أرضية غير مثارة لإجراء التحليلات الطبيعية (نسبة الحصى و التحليل الميكانيكى و منحنيات الشد الرطوبى والثوابت الرطوبية و التوزيع النسبى للمسام والكثافة الظاهرية و المسامية الكلية والتوصيل الهيدروليكى) وكذلك دراسة حالة العناصر الكبرى الميسرة والمتمثلة فى(النيتروجين والفوسفور والبوتاسيوم) والعناصر الصغرى الميسرة والمتمثلة فى(الحديد و الزنك و المنجنيز و النحاس).

أظهرت النتائج بصفة عامة أن الأرض رملية طميية و طميية رملية بطول عمق القطاع كما أن نسب كل من السلت والطين تزيد عند نهاية الانحدار و المسامية قد كانت أعلى قيم لها عند نهاية الانحداروأيضا أرتبط التوزيع الحجمى للمسام بدرجة نعومة التربة و كذلك المحتوى الرطوبى فى التربة عند السعة الحقلية ونقطة الذبول والماء الميسر قد كانت أعلى قيم لها عند نهاية الانحدار بسبب زيادة نسب كل من السلت و الطين وكانت قيم التوصيل الهيدروليكى عالية فى قمة الانحدار بالمقارنة عند نهاية الانحدار بسبب زيادة نسبة الرمل الخشن و الناعم عند قمة الانحدار بالمقارنة بنهاية الانحدار. الكثافة الظاهرية لمعظم قطاعات التربة مرتفعة نسبيا وتقل مع العمق وقد كانت أعلى قيم لها عند موقع الانحدار العلوى. تشير قيم (pH) الى ان هناك انخفاض بسيط فى اتجاة المنسوب الأدنى وكذلك أوضحت النتائج أن الأرض المدروسة غير ملحية وذات تأثير قلوي و الكربونات الكلية فى صورة كربونات الكالسيوم $CaCO_3$ تقل مع انخفاض الميل و كذلك كان محتوى المادة العضوية فى زيادة واضحة فى اتجاة المنسوب الأدنى والسعة التبادلية الكاتيونية تتوقف على محتوى الارض من الحبيبات الدقيقة (الطين و السلت) وبالتالى فهى فى زيادة واضحة فى اتجاة المنسوب الأدنى. تشير قيم المحتوى الميسر من المغذيات الكبرى و الصغرى (N, P, K, Mn, Zn, Fe and Cu) الى زيادة واضحة فى اتجاة المنسوب الأدنى ومثل هذا الاتجاة متأثرا لحد كبير بتوزيع المادة العضوية والطين في اتجاة المنسوب الأدنى.

قام بتحكيم البحث

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