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USING OF FIELD MORPHOLOGICAL RATING SYSTEM TO ESTIMATE THE DEVELOPMENT OF WADI QENA SOILS

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ABSTRACT

This study aims to estimate and evaluate the changes of some soils of wadi Qena using the morphology rating scale introduced by Bilzi and Ciokosz (1977). Twenty seven profiles were examined, seven out of them representing soils of wadi Qena.

Soil distinctness and development were assessed using the recent methods; Relative Horizon Distinctness (RHD) and Relative profile Development (RPD). Also, profile index values were calculated from horizon index values using quantitative profile index methods.

The average RHD ratings of the studies profiles are 7 to 17, 7 to 19, 9 to 14 and 9 to 14 whereas those of RPD ratings are 14 to 18, 5 to 20, 6 to 20 and 7 to 15 for the Typic Torrifluvents, Typic Haplocalcids, Typic calcigypsids and Typic Haplosalids, respectively.

The RHD values coincide with those of RPD ratings and profile index values. Data revealed that the clear differentiation between two soil orders, Entisols and Aridisols.

Key words: Estimate of RHD, RPD and Quantitative Index, Wadi Qena.

INTRODUCTION

The Wadi Qena hydrographic basin forms the only obsequent valley in the Eastern Desert. It discharges its water, during flash floods, directly into the Nile. It is one of the biggest basins where it runs opposite to the Nile from north of south for two degrees of latitude. It is bound by longitudes 32° 30ˉ to 33° 30ˉ E and latitudes 26° 00ˉ to 28° 00ˉ N and Covers a total area of about 18000 km^2. Map (1). Wadi Qena is located 700 km south of Cairo. The downstream part of the Wadi is accessible through the Cairo-Qena highway, while its upstream is accessible through Safaga- Qena and El-Sheikh Fadel-Ras Gharib roads.

The trunk channel of Wadi Qena exhibits a genral slope of about 3:100. It begins at the southern slopes of Gabal El-Galala El-Qiblia (about 1100 m above sea level), where the relief is rugged, and extends to its deltaic mouth at the town of Qena (about 100 m above sea level), where it issues into the Nile. It is clear from the topographic map that the trunk channel is rather flat course and the western part of the basin is more steeper than the eastern one.

Wadi Qena is sited under arid climatic conditions which are characterized by extremely low rainfall. However, there some occasional thunder storms which are severe and torrent crushing the desert rocks driving in front of them tons of mud materials and gravels through the Wadi toward the River Nile. The inhabitants suffer greatly from these floods which sweep their crops, lands and homes.

Fig1

The temperature and evaporation rates are very high in summer while are normal in winter. The relative humidity is generally high in wadi Qena region. The available Meterological climatic data from the Egyptian Authority of Meterology in wadi Qena are given in Table (1).

According to these data, the moisture regime is aridic and the temperature regime is hyperthermic in the study area (soil taxonomy, 1975).

The wind velocity ranges between 1.7 to 3.2 m/sec. with an annual mean of 2.3 m/sec. According to the FAO (1974) classification, wind velocity at the area under consideration is moderate.

The downstream area of Wadi Qena and its surroundings (escarpments and hills) are essentially covered by rocks and friable sediments that range in age from late Cretaceous to Holocene. However, the present study is mainly dealing with the friable soil sediments which are belonging to Pliocene- Quaternary succession. Such succession represents the old Nile sediments (Pliocene- Pleistocene; Said, 1981) in addition to the recent soil sediments of the Wadi Plains.

The Pre-Pliocene sediments are composed of mixed siliciclastic-carbonate phosphorite rocks of Upper Cretaceous, Paleocene and lowere Eocene sequences.

The Pliocene sequence of Wadi Qena downstream area could be subdivided into two informal units. The lower unit (Early Pliocene) seems to be deposited in marine (gulf) depositional environment while the upper unit (late Pliocene) was deposited by Fluviatile-estuarine processes.

The early Pleistoncene sequence in the Wadi Qena downstream area consists of fluviatile deposits that belong to the “Protonile” of Said (1981).

Table (1): Meteorological–climatic data of wadi Qena, average of the period 1960-1990.

Months	Rainfall	Temperature °C			Relative	Evaporation	Mean scale wind
	(mm)	Max.	Min.	Aver.	Humidity (%)	mm/day	Spread (m/sec)
January	0.2	22.7	6.7	14.7	66.0	3.4	1.75
February	1.0	25.3	7.6	16.4	59.0	4.3	1.95
March	0.1	30.3	11.1	20.7	47.0	6.6	2.25
April	0.1	35.4	15.9	25.6	35.0	9.3	2.65
May	0.3	39.0	20.7	29.8	31.0	11.6	2.60
June	0.1	40.9	22.9	31.9	35.0	12.6	2.95
July	0.0	40.8	23.7	32.2	38.0	11.6	3.20
August	0.0	40.8	24.1	32.4	39.0	11.8	2.20
September	0.0	38.1	22.2	30.1	52.0	9.0	2.60
October	0.6	35.1	18.9	27.0	57.0	8.1	2.10
November	2.2	29.8	13.6	21.7	61.0	4.5	1.85
December	0.9	24.3	8.9	16.6	66.0	3.3	1.70
Annual mean		33.5	16.4	25.0	49.0	8.0	2.30
Total	5.5						

- **Moisture regime is : Torric.**
- **Temperature regime is : Hyperthermic.**

They are in the form of loamy sandy gravel terraces standing over the Pliocene stratified calcareous fine grained sandstone in many scattered places on the Wadi floor.

The Middle Pleistocene sediments are mainly represented by a sequence of sandstone (the prenile “Qena Sands”) followed uncoformably by gravels (the Abbassia gravels; Said, 1981). This sequence is restricted around Qena Bend and near Qena town where it is termed Qena Hill by Sandford (1929); but here was called “mouth hills”.

The quaternary deposits (Late Pleistocene- Holocene) of the study dominated the Wadi plain. These deposits consists of late Pleistocene Neonile sediments, Pleistocene– Holocene wadi deposits and Holocene Nile alluvium. The Neonile sediments at Qena Bend near the Nile course consist mainly of fine sand and silt. The Pleistocene – Holcene wadi deposits include subercent (alluvial) cover which mainly represented by fanglomerates, channels and wind laid sediments. The holocene Nile alluvium is dominated by clays, sandy clay, clayey fine sands and silts.

Abd El-Ghaffar (1997) in their studies of soil classification and land suitability evaluation of an area in Wadi Qena found that the soils are classified according to the U.S. soil taxonomy system (Soil Survey Staff, 1994) into seven Mapping units as follows:

Mapping unit (1)	:	Typic Haolpcalcids, coarse loamy, mixed, Hyperthermic
Mapping unit (2)	:	Typic Torrifluvents, sand skeletal, mixed, Hyperthermic
Mapping unit (3)	:	Typic Calcigypsids, fine loamy, mixed, Hyperthermic
Mapping unit (4)	:	Typic Haplocalcids, fine lomay, mixed, Hyperthermic
Mapping unit (5)	:	Typic Haplo salids, fine loamy, mixed, Hyperthermic
Mapping unit (6)	:	Typic calcigypsids, snad skeletal, mixed, Hyperthermic
Mapping unit (7)	:	Typic calcigypsids, coarse loamy, mixed, Hyperthermic

Characterization of the soil parent material is necessary for ameaningaful interoperation of soil morphology and pedology (Arnold, 1968). Bilzi and Ciolkosz (1977) presented an easy, field morphology rating system, to evaluate quantitatively the degree of soil development. The system includes two soil rating scales namely; the relative horizon distinctness (RHD) and the relative profile development (RPD). In the first scale, morphological features of two adjacent horizons, in a pedon, are compared to identify depositional or parent material discontinuities. While in the second scale, a comparison of the features of discrete horizons with the C horizon within a pedon. Meixner and Singer (1981) applied this system to a chronosequence in San Joaquin Valley in California. They reported that the rating values were generally less than 10 and were proportional to the degree of horizon differentiation. Values exceeding 10, however, allocated soils were observed and suspected discontinuous parent materials. They added that although RPD increased with age yet, A- horizons of younger soils and B- horizons of older soils acquired the highest RPD values. Harden (1982) suggested a modification to this index, based on filed description, to improve the quantitative assessment of the degree of soil profile development.

The aim of this study is to estimate and evaluate the soil horizons distinctness of Wadi Qena by applying different rating scales. Also, a new modification for the rating scales, to account for secondary soil formation, was implicated in the study.

MATERIALS AND METHODS

Variation in soil morphological properties of seven mapping units were studied to estimate their developments, using the field morphology rating scale methods described by Bilizi and Ciolkosz (1977). Twenty seven profiles were studied and seven out of them were chosen to representing different soil mapping units of the studied area of Wadi Qena. Their locations are illustrated in map (2). The profiles were examined and morphologically described according to the system outlined by FAO (1990). The most important morphological properties are texture, structure, consistence, sticky, plasticity, soil color (using the Munsell color) in both dry and moist states, and the boundaries between soil horizons. Each horizon (layer) of each representative profile was sampled and kept for laboratory analyses. Samples representing of horizons were subjected to laboratory determinations e.g. ECe, pH, $CaCO_3$ and gypsum ($CaSO_4$ - $2H_2O$) content, Table (2) (Richards, 1954).

The rating points needed to quantify relative horizons distinctness (RHD) and relative profile development (RPD) were calculated according to the methods suggested by Bilzi and Ciolkosz (1977) and Meixner & Singer (1981), respectively. Profile index values, were also calculated according to Harden (1982). In addition the soil contents of secondary formations (carbonate, gypsum and salts) were determined, according to Richards (1954).

RESULTS AND DISCUSSION

Soil classification of the studied profiles has been classified up to the family level depending on the soil taxonomy system; using USDA keys of Soil Taxonomy (1994). The soils were classified as two orders; Entisols and Aridisols. The order Entisols having one suborder; namely fluvents (profile 8). While the order Aridisols having three suborders; namely, salids (profile 14), calcids (profiles 2 and 13) and Gypsids (profiles 11, 15 and 16). This classification is justified by morphological description and some chemical analyses data (Table 2). Climatological data indicate that the soil temperature regime of these area is hyperthermic. Table (3) shows the soil taxonomy classification up to the family level according to USDA (1994).

The soil description in Table (2) shows there exist no diagnostic horizons in profile 8 where profiles (14), (2 and 13), (11, 15 and 16) have salic, calcic and gypsic horizons respectively.

They are else characterized by wide range of soluble salts (1.76 - 176.50 dSm^{-1}) having a slightly acid to moderately alkaline pH (6.3- 7.9) and high calcium carbonate content (5.0- 55.0 %). However gypsum was range between (0.10- 8.10%).

Table (2) shows the morphological description of seven profiles covering different soils of Wadi Qena and their banks. The soils were evaluated and prospective points were assigned as descried by Meixne and Singer (1981) and the soil rating scale as applied. In addition, rating points of

Table2

Table2cont

Table3

Table4

secondary components (carbonate, gypsum and salt) along with the pH values of the soil paste were recorded in Table (4).

Relative Horizon Distinctness (RHD):

The values of the RHD rating are listed in Table (5). Values are plotted at the boundary between horizons to give relative distinctness of graphical representation (Fig. 1).

It appears that, the Torrifluvents soils (profile No. 8) have RHD ratings between 7 and 17 (Table 5) indicating a strong distinctness. As many properties are contributed to the ratings horizons subdivisions C1, C2, C3, C4 and C5 which are suggested to point to big differences. The RHD ratings, are more than 10 densting no depositional or parent material discontinuities is detected, (Meixner and singer, 1981).

As for profiles No. 2 and 13 representing Aridisols soils (Typic Haplocalcids) having RHD ratings between 7 and 19 (Table 5) indicating that a very clear distinctness. Thus, the surface horizon has a clear distinctness in comparison to other horizons. All soil properties have contributed to the RHD ratings. The previous results suggested that, the soils of Typic calcigypsids profiles 11, 15 and 16 have moderate or slight distinctness, may be due to the gypsic horizon (profiles 11, 15 and 16), which due to the natural of parent material. Also, the moderate distinctness, was found in the salids soils (profile 14) have RHD ratings between 9 and 14.

Relative Profile Development (RPD):

Value of RPD ratings of the studied profiles are listed in Table (6). The same values at midpoint of the horizon are plotted to give graphical representation of the relative profile development of the soils, Fig. (2).

It appears that the soils of Torrifluvents representing by profile No. 8 have high RPD ratings and vary between 14-18, Table (7) indicating a well development which disturbed in all horizons of profiles studied. The salids soils, represented by profile No. (14), have RPD ratings between 7-15. These soils are relatively lower developed than the Typic Torrifluvents.

As for the soil of Typic calcigysids which are represented by profiles 11, 15 and 16, RPD ratings ranged between (10-20), (13-19) and (6-9) respectively. The relative profile development was clear in profile 11 more than the profiles 15 and 16 respectively.

In respecting soils of Typic Haplocalcids which represented by profiles 2 and 13, RPD was clear in lower Wadi (profile 2) more than the profile No. (13). Whereas RPD rating ranged between (5-20). The rating clearly reflected a good development in the Haplocalcids.

Data in Table (6) indicate that, the variations of the RPD rating of the surface and substratum layers are 6, 4, 10, 7, 7, 3 and 3 for the profiles No. 2, 8, 11, 13, 14, 15 and 16, respectively.

Quantitative index Methods:

Profile Development Index (PDI) which described by Harden (1982) was applied for seven profiles representing the different soil mapping units of Wadi Qena. At the request of such an evaluation the following consideration were taken into account:

Table5

Table5 cont

(1) The area under study is geographically a very small one, extending only few square kilometers. All deposits were considered as belonging to the same parent material and the same geomeorphic units.
(2) As no geological stratification was evidenced through the morphological description or the analyses of the previously discussed RHD ratings of the morphological rating scale methods.
(3) The parent material of all soils under study was scoped to be sandy loam, massive or singly grains structure, slightly hard and friable when moist, non-sticky, non-plastic on wet consistence. The colour notations of “10 YR 7/4 dry” and “10 YR 6/3 moist” are used as basic colours of the parent material. pH value is 7.1 in addition to secondary formation (salts, carbonate and gypsum) were assigned nil.

The field properties of the studied profiles, as accumulated and abbreviated from the morphological descriptions, which are described in Table (2) are quantified (step1), and normalized (step2). All the normalized properties are summed up for each horizon (step3). And divided by n; whereas (n): the number of investigated properties (step4).

This number resembles other normalized property ranges from 0 to 1 and is called the Horizon Index. It is of interest to note that missing data would not affect the range of this index. Each horizon index is multiplied by horizon thickness to yield index- cm of development. Summation of the index- cm of all horizons in the profile represents the final step No. (5). The resultant is the profile development index.

The field properties of the soils under study quantified and combined into the development index are given in Tables 7 and 8.

It appears from Table (8) that the horizon index values of the Entisols (Typic Torrifluvents, sand skeletal, mixed, thermic) representing by profile No. 8 are moderate: 0.05, 0.06, 0.07, 0.08 and 0.14 for the C1, C2, C3, C4 and C5 horizon respectively. The values in the substratum (C4) are higher than the others horizons.

The horizon Index of profile 2 representing Aridisols (Typic Haplocalcids, coarse loamy, mixed Hyperthermic) are 0.21, 14, 0.08, 0.12, 0.07, 0.12, 0.05 and 0.13 for C1, C2, C3, C4, C5, C6, C7 and C8 horizons respec. The values in the surface (C1) are higher than the other horizons. This profile has relatively higher horizon index values than those obtained for the same Aridisols (Typic Haplocalcids, fine loamy, mixed, Hyperthermic) are 0.04, 0.06, 0.08, 0.08 and 0.08 for C1, C2, C3, C4 and C5 horizons, respectively, profile No. 13.

However, profile (14), representing Aridisols (Typic Haplosalids, fine loamy, mixed, Hyperthermic) has low horizon index values in horizons (0.05, 0.08, 0.20 and 0.06) for the C1, C2, C3 and C4 respectively.

Data reveal that the profile No. 16 representing the Aridisols (Typic calcigypside, coarse loamy, mixed, Hyperthermic) are 0.24, 0.06 and 0.13 for C1, C2 and C3 horizons, respectively. The values in the surface (C1) are higher than the other horizons. This profile has relatively higher horizon index values than those obtained from the same Aridisols (Typic calcigypsids), profiles Nos. 11 and 15.

Table6

Table6cont

Table7

Table8

Fig2

From the discussion presented here it may be concluded that the Aridisols has an impace on the development of soil profiles, prevailing aridic conditions.

CONCLUSION

Soil development is assessed using the recent morphology rating scale approach, and the quantitative index methods. Both methods revealed that differentiation between profiles of different soil orders (Aridisols and Entisols) was mainly related to the presence and distinctness of the formation processes and the developed horizon.

The relative Horizon distinctness (RHD) ratings is increased by increasing the soil development, since the recent soils Entisols have low distinctness more than the Aridisols.

The relative profile development (RPD) ratings is else increased by the increasing the soil development. The RPD rating averages for the Aridisols are 14.3, 13.7, 8, 10, 16.75 and 7.5. While it was 15.8 in the Entisols.

The horizon index values of the quantitative method varied with the soil formation processes and soil development; these are 27.50, 23.85, 22.00 , 15.75, 14.25 and 10.96 for soil Aridisols (prof. 15, 2, 11, 14, 16 and 13). While it was 11.14 in the recent soil Entisols (profile 8).

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استخدام نظام معدلات الوصف المورفولوجى فى تقييم تطور أراضى وادى قنا

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- تهدف هذه الدراسة الى تقدير وتقييم التغيرات فى بعض أراضى وادى قنا باستخدام معدل التغير فى الخواص المورفولوجية والمقترح بواسطة Bilzi and Ciolkosz (1977) وقد فحصت سبعة وعشرون قطاعاً سبعة منها تمثل أراضى وادى قنا.
- وقد قدرت درجة الوضوح النسبى للآفاق (RHD) وتطور القطاع الأرضى (RPD) كما تم حساب قيم Profile index من قيم Horizon index وذلك بطريقة المعامل الكمى للقطاع Quantitative profile
- أوضحت النتائج ان الوضوح النسبى للآفاق (RHD) فى الطبقات تراوحت ما بين 7-17و 7-19و 9-14و 9-14 أما التطور النسبى للقطاع (RPD) فكان 14-18و 5-20و 6-20و 7-15 فى أراضى Typic Torrifluvents وأراضى Typic Haplocalcids وأراضى Typic calcigypsids وأراضى Typic Haplosalids على الترتيب.
- وقد وجد أن قيم RHD تتوافق مع قيم RPD و قيمة profile index التى أظهرت الاختلاف الواضح بين أراضى رتبتى Entisols and Aridisol