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Rating Scaleof Pedological Development in Aridic Moisture Regime of Some Western Nile Delta Soils, Egypt

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The field morphology rating scale for evaluating pedological development according to Bilzi and Ciolkosz, (1977) was modified in the current study through suggestion of adding several important properties such as gravel contents for field morphology ratings and some chemical and physical properties such as salts, pH, calcium carbonate and gypsum for both Relative Horizon Distinctness (RHD) and Relative Profile Development (RPD). Adding a rating scale of diagnostic horizon for an average of relative profile development ratings (modified RPD) to compare between profiles development and evaluation of chrono sequence of soils developed in aridic moisture regime.Application of field morphology rating scale and suggested modification on some soils of Western Nile Delta- Egypt, achieved the chrono sequence, as well as, the diagnostic horizons of soils which belong to Aridisolsorderand have higher values of modified RPDthan soils which belong to Entisolsorders.So, these suggestions of rating scale with field morphological rating scale can be a useful tool for comparing pedological development of soils in arid climatic regime.

Keywords: Pedological development,Aridisols, Entisols, Western Nile Delta soils.

1. Introduction

Study of Barakat (1998) shows that application of a field morphology rating scale for evaluating pedological development on soils of WadiHawdayn, according to Bilzi and Ciolkosz, (1977) reveal to soils of TypicTorrisalids have values of Relative Profile Development (RPD) ratings lower than soils of TypicTorrifluvents i.e. soils of Aridisols are relatively development than soils of Entisols, in spite of he applied the modification of Salem et al.(1997). Such of these results are observed in study of Zayed, et al (2022) on soils of South El-Amiria, and concluded that the studies of pedological development need more attempts to include different features of the international soil development.

According to Bilzi and Ciolkosz (1977) the rating scale was developed to quantitively evaluate several important morphological properties of soils. The rating scale was used by two ways: the first, to determine the relative distinctness of horizons, and the second, to determine the relative development of soil profile. The determination of relative distinction of horizons was made by a comparison of adjacent horizons, while the determination of the relative profile development was made by a comparison of the C horizon to the horizons above it in the profile. The rating scale was effective in evaluating pedological- development of soils developed in a humid-temperate climate. They added that morphological factors may be needed to evaluate pedological development of soils developed in other climate regimes.

Meixner and Singer (1981) used a field morphology rating system of Bilzi and Ciolkosz (1977) to evaluate a chrono sequence of soils in the northeastern San Joaquin Valley, California. Generally, Relative Horizon Distinctness (RHD) ratings were less than 10. RHD ratings greater than 10 were obtained for observed and suspected parent material or soil formation discontinuities. Relative Profile Development (RPD) ratings increased with age. Maximum values were in the A horizons of younger soils and in the B horizons of older soils.

Soils of Western Delta, which are considered as a pilot area for applying the attempt of improve rating

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scale to evaluate the pedological development, lie between latitudes 29°29´30´´and 30° 30´05´´North and longitudes 29°47´55´´and 30° 30´05´´East. Different pedological features of area under consideration are studied by Zayed et al (2021) and shown in Map1.

Interpretation of soil morphology and development depends upon a correct evaluation of soil parent material (Arnolod, 1968).

Geology of this area according to UNDP/FAO (1963) an outstanding feature in the pre- Pleistocene geology of this area is of course beautifully folded and over folded cretaceous outcrop of Gebel El Ghigigah and Abu Roash, West- North- West of Cairo. This outcrop has definitely been the western gatepost of the Nile Valley, beyond which the open sea extended in Pliocene age and around which the delta formations of the different river terraces stages fanned out westward in Pleistocene age. According to Shata et al. (1962) and La Moreaux (1962) Quaternary lake deposits and old alluvial deposits are the main features which cover the studied area. The Quaternary deposits are underlain sedimentary rocks of Pleistocene and Pliocene ages which consist of sand and gravel interbedded with thin layers of clay. These, in turn are underlain by limestone of Miocene, Oligocene and Paleocene ages. Beds of chalk and limestone of Cretaceous and Eocene ages are brought to the surface in the north direction.

The study area includes two main physiographic units, the first is river terraces and the second is Wadi El-Natrun complex as shown in Map 1 according to Zayed et al. (2021).

The aim of the current study is an attempt to quantify some morphological, chemical and physical properties of soils, which are located in arid zone, so that these data can be easily compared and interpreted. In this context, all suggestions will be tested on the area under consideration.

2. Materials and Methods

Both physical and chemical analyses methods are illustrated by Zayed et al. (2021) manuscript.The field morphology rating system of Bilzi and Ciolkosz (1977) was used to determine both Relative Horizon Distinctness (RHD) by comparing to adjacent horizons and Relative Profile Development (RPD) by comparing each horizon with the C horizon within each pedon. On the other hand, these criteria used are found in study of Meixner and Singer (1981) are added whenever it is preceded, as described below:

Color (dry and moist): One point is assigned for any class change in hue and for any unit change in value and chroma. One unit difference in hue is defined as the number subdivisions in the Munsell Soil ColorCharts, e.g., 5YR vs. 7.5 YR, while a two-unit change would be 5YR vs. 10YR. One unit change in value and chroma is equal to one of their units, e.g. 5/6 vs. 6/6 equals one unit change in value and 5/6 vs. 5/8 equals two unit changes in chroma.

Texture: One unit change in textural class equals a change to an adjacent class on the textural triangle e.g., loam v.s. clay loam, while a two-unit change requires the crossing of an intermediate class, e.g., loam vs. clay. In addition, a change from non-gravelly to gravelly or very gravelly is assigned one or two points, respectively.

In the relative distinctness of horizons only:

Structure: One unit change in grade of structure equals a change of one class, e.g., structure less to weak equal’s one unit change, while weak to strong equals two units. If the type of structure is the same its size is compared, e.g., fine sub-angular blocky vs. medium sub-angular blocky equals one unit, while fine subangular blocky vs. coarse subangular blocky equals two units. If the type of structure is different, one unit change is assessed for type; while no assessment is made for size and grade.

Consistence: One point is assigned for any class change in dry (lo, so, sh, h, vh, eh) and moist (lo, vfr, fr, fi, vfi, efi) consistence.

The clay films: the amount (few, common, and many), and the thickness (thin, moderately thick, and thick) of clay films is utilized. If the clay films are located in a different place, e.g., in pores vs. on ped faces, one unit change is assessed.

Boundaries: One point is assessed for a gradual boundary, two points for a clear boundary, and three points for abrupt boundary.

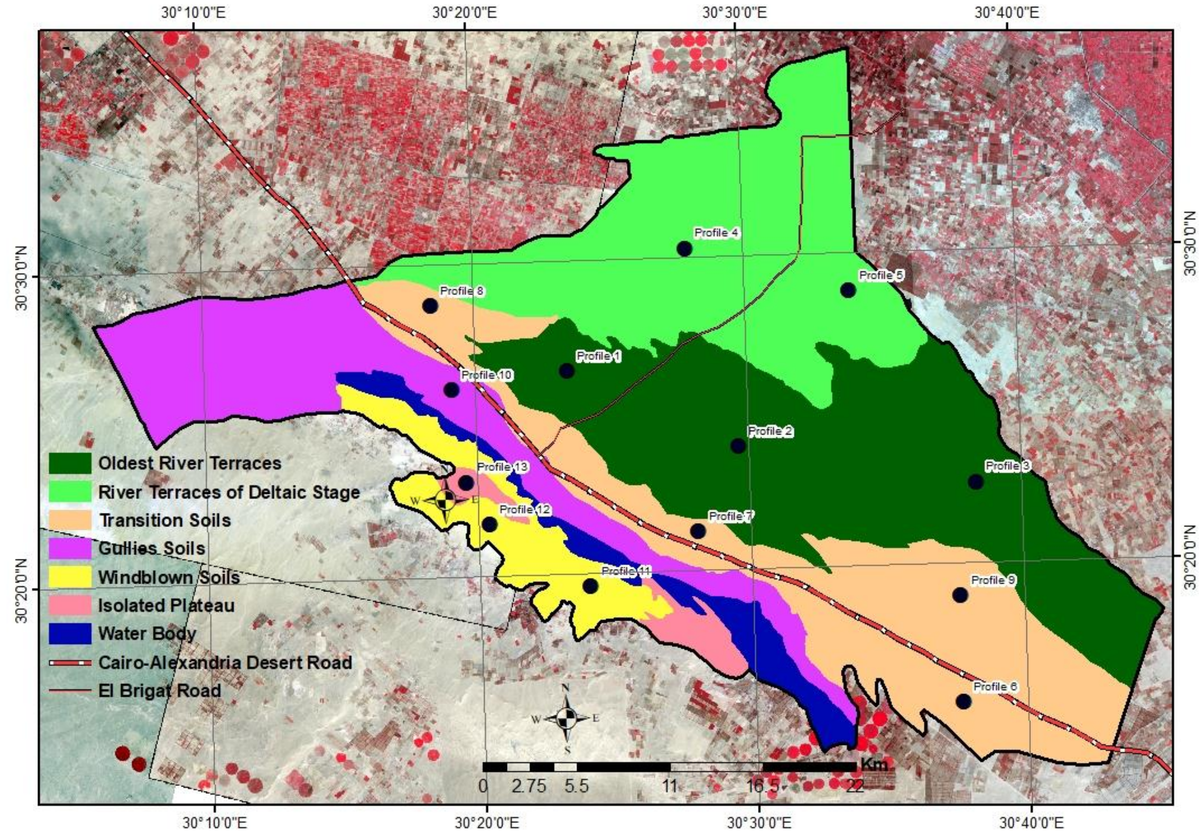
Finally, the points are summed and the greater the difference in morphology between horizons the larger of the total value. These values can be plotted at the boundary between the horizons to give a graphical representation of the relative distinctness of horizons in the soil profile.

In the Relative Profile Development (RPD):

Structure, clay films and boundary conditions are assumed to be minimal or non-existent in the C horizon, so values are assessed to the horizons above the C evaluating the amount of development of these three morphological properties.

Structure: Assuming the grade of structure increases with profile development, no points are assessed for a structure less horizon, one point for a weak, two points for a moderate, and three points for a strong grade of structure. The size of structural units generally decreases with profile development, therefore one-half point is assessed for very coarse or coarse, and one point for medium and one and one-half points for fine and very fine size of structure.

Map 1.Physiographic units and locations of representative profiles of the studied area.



Adapted from Zayed et al. (2021).

Clay films: The greater the amount of clay films present the greater the amount of clay-translocation and the greater the amount of profile development, thus, one point is assessed for few, two points for common, and three points for many clay films.

Boundary: Boundary conditions are assumed to develop through pedogenesis, therefore no points are assessed for diffuse boundary, one point for a gradual boundary, two points for a clear boundary and three points for an abrupt boundary.

Finally, the points for each horizon are summed and total value plotted at the midpoint of the horizon being evaluated to give in graphical representation of the relative profile development of the soil.

Some suggested modifications according to the environmental conditions:

The suggestions in Table 1 follow ratings observed in Soil Survey Manual (USDA, 1993) and guidance of FAO (2015). Application of these ratings depends on the same idea of Bilzi and Ciolkosz (1977), where, in the relative distinctness of horizon: by calculating the difference between two adjacent horizons, while relative profile development by comparing each horizon with C horizon within each pedon.

Illuvial concentration of carbonates or gypsum are dominant by obliteration of all or much of the original rock structure, included as B horizons where contiguous to another genetic horizon that are the result of pedogenic processes (USDA,1993). So, when calculating the relative profile development, the soils were evaluated and points according to the environmental condition as described below:

1-The points of each horizon are summed.

2-Calculate the average of each pedonof representative profile.

3-One point is assessed for presence a calcic or petrocalcic horizon, two points for gypsic or petrogypsic horizon and three points for a salic horizon. Presence of any of diagnostic horizons and their points are summed for the average of the relative profile development.The modification of the rating scale was effective in evaluating pedological development of soils developed in aridic moisture regime.

3. Results and Discussion

To illustrate the use of this modification method some soils of Western Delta which are studied by Zayed, et al (2021) from the pedological point of view which used as applied example. The climatological data of the study area reveal to the soil moisture regime is Torric or Aridic and the soil temperature regime is Thermic, according to USDA (2014). Different morphological and some chemical and physical properties are given in Table 2.

Relative Horizon Distinctness (RHD)

The values of Relative Profile Development (RHD) ratings are listed in Table 3 and plotted in Fig. 1. Soils of river terraces are distinguished to oldest river terraces which are represented by soil profiles 1, 2 and 3 and river terraces of deltaic stage and are represented by profiles 4 and 5. Values of RHD in soils of oldest river terraces are less than 10 except RHD value of C2/C3 of profile 1, which is 13. The distinctness of this horizon dry and moist color and gravel contributed most to the ratings. Soils of river terraces of deltaic stage have RHD rating, between 6 and 14. Value of 14 is recorded in C3/C4 boundary of profile 4, this distinctness due to dry and moist color and salinity, with the exception of a rating 4 at profile 3 which has similarity and almost uniform in color, texture, consistence, gypsum and pH, soils of oldest river terraces consider an older soils of river terraces of deltaic stage.

Generally, the average of RHD in river terraces less than 10 according to Meixner and Singer (1981), the value of RHD ratings above 10 indicate differences that may well be due to geologic, rather than pedologic, processes. Data of RHD in Table 3 show that soils of river terraces higher than 10 due to distinctness in dry and moist color and gypsum and may be due to presence of salts. The distinctness in gypsum contents considered the main factor effecting on color in both dry and moist conditions. So, high values of RHD are due to the soil development.

Transition soils of Wadi El-Natrun which represented by soil profiles 6, 7, 8 and 9 have RHD rating values between 3 and 17. Soils of profile 8 have RHD rating of 3, which reveal to homogeneous materials that differ in salinity properties only, while other representative profiles which record RHD rating values 10 or more. The distinctness of the horizon boundaries and variations in dry and moist color, gravel contents, may be salinity, alkalinity and texture contributed most to the ratings, and they confirmed the nomenclature of this unit transition soils and indicate differences that may well be due to geological rather than pedological processes according to Meixner and Singer (1981).

Guillies soils which represented by soil profile 10 have RHD rating less than 10. These soils are affected by erosion and the distinctness of the horizon boundaries and variations in pH and salinity contributed most to the ratings. These data confirmed the nomenclature of the unit, too.

TABLE 1. The Suggested rating points for some physical and chemical soil properties

Lime or Gypsum		Salinity		pH values		
Quantity %	**Rating points**	**EC (dS m^{-1})**	**Rating points**	**Terminology**	**pH range**	**Rating points**
< 5	0	< 2	0	Ultra acid	< 3.5	0
5 - < 15	1	2 - < 4	1	Extremely acid	3.5 - 4.4	1
15 - < 25	2	4 - < 8	2	Very strongly acid	4.5 - 5.0	2
25 - < 50	3	8 - < 15	3	Strongly acid	5.1 - 5.5	3
50 - > 50	4	15 - < 30	4	Moderately acid	5.6 - 6.0	4
* By guidance of FAO (2015)		30 - > 30	5	Slightly acid	6.1 - 6.5	5
		- In soil paste extract * By guidance of FAO (2015),		Natural	6.6 - 7.3	6
				Slightly alkaline	7.4 - 7.8	7
		Except the first category which cited from USDA (1993)		Moderately alkaline	7.9 - 8.4	8
				Strongly alkaline	8.5 - 9.0	9
				Very strongly alkaline	> 9.0	10
				- In soil paste *C.F. USDA (1993)		

TABLE 2. Morphological and some chemical and physical properties of studied area

Profile No.	Horizon	Lower depth Cm.	Colour		Texture	Gravel %	Structure	Consistence		Clay films	Lower boundaries	$CaCO_3$ %	Gypsum %	pH	EC dS/m	Diagnostic horizons
			Dry	Moist				Dry	Moist							
								1- Physiographic unit : River Terraces								
	1.1- Oldest river terraces															
1	C_1	0 - 25	10 YR 7/6	10 YR 6/6	SL†	40	M	So	VFr	N	Gradual	6.76	4.82	7.29	4.95	---------
	C2	25 - 60	7.5 YR 6/8	7.5 YR 5/8	SL	35	M	So	VFr	N	Gradual	8.82	4.82	7.32	4.73	Calcic
	C3	60-120	7.5 YR 5/6	7.5 YR 4/6	LS††	10	M	So	VFr	N	----------	9.30	7.74	7.36	5.00	Calic&Gypsic
2	C1	0 - 50	7.5 YR 6/8	7.5 YR 5/8	LS	40	SG	Lo	Lo	N	Gradual	6.34	9.80	7.38	7.02	Gypsic
	C2	50-110	7.5 YR 7/8	7.5 YR 6/8	S†††	20	SG	Lo	Lo	N	----------	4.65	6.88	7.51	8.62	---------
3	C1	0 - 50	10 YR 7/6	10 YR 6/6	S	30	M	Sh	VFr	N	Gradual	4.23	11.18	7.80	20.24	---------
	C2	50-100	10 YR 7/6	10 YR 6/6	S	55	M	Sh	VFr	N	----------	5.07	12.90	7.70	45.08	Gypsic
	1.2- River terraces of deltic stage -															
4	C_1	0 - 20	10 YR 6/8	10 YR 5/8	S	40	M	So	VFr	N	Gradual	5.07	5.16	7.79	30.36	---------
	C_2	20 - 40	10 YR 6/6	10 YR 5/6	S	35	M	So	VFr	N	Clear	3.38	2.41	7.82	13.95	---------
	C_3	40 - 60	10 YR 6/8	10 YR 5/8	S	5	M	So	VFr	N	Gradual	5.07	2.41	7.86	8.51	---------
	C_4	60-100	10 YR 7/4	10 YR 6/4	S	5	M	So	VFr	N	----------	5.92	6.88	8.10	2.30	Gypsic
5	C_1	0 - 20	10 YR 7/4	10 YR 6/4	S	35	SG	Lo	Lo	N	Gradual	2.53	2.58	7.52	3.82	---------
	C_2	20 - 55	10 YR 7/3	10 YR 6/3	S	40	M	Sh	VFr	N	Clear	2.11	1.72	7.20	2.01	---------
	C_3	55-120	10 YR 7/4	10 YR 6/4	S	10	M	Sh	VFr		----------	2.53	0.86	7.10	3.61	---------
								2- Physiographic unit : Wadi EL-Natrun								
	2.1- Transition soils															
6	C_1	0 - 45	10 YR 6/6	10 YR 5/6	S	40	SG	Lo	Lo	N	Gradual	5.92	4.82	7.45	15.20	---------
	C_2	45-100	10 YR 7/8	10 YR 6/8	*S*	40	SG	Lo	Lo	N	----------	3.38	1.38	7.25	2.30	---------
7	C_1	0 - 20	10 YR 5/4	10 YR 4/4	S	10	M	So	VFr	N	Clear	7.61	3.44	7.15	15.07	---------
	C_2	20 - 70	10 YR 6/8	10 YR 5/8	S	35	M	So	VFr	N	Clear	7.61	4.13	7.87	11.06	---------
	C_3	70-120	10 YR 6/6	10 YR 5/6	S	5	M	Sh	VFr	N	----------	5.92	2.41	7.97	14.15	---------

TABLE 2. Cont.

Profile No.	Horizon	Layer depth Cm.	Colour Dry	Colour Moist	Texture	Gravel %	Structure	Consistence Dry	Consistence Moist	Clay films	Lower boundaries	$CaCO_3$ %	Gypsum %	pH	EC dS/m	Diagnostic horizons
8	C_1	0 - 20	10 YR 7/4	10 YR 6/4	S[†††]	5	M	So	VFr	N	Gradual	3.80	0.86	8.37	4.52	---------
	C_2	20-100	10 YR 7/4	10 YR 6/4	S	5	M	So	VFr	N	----------	3.38	0.86	8.00	1.99	---------
9	C_1	0 - 12	7.5 YR 6/4	7.5 YR 5/4	SL[†]	40	M	Sh	Fr	N	Clear	6.76	6.19	7.90	10.87	---------
	C_2	12 -35	10 YR 8/4	10 YR 7/4	SL	10	M	Sh	Fr	N	Clear	1.69	1.72	7.89	3.80	---------
	C_3	35-95	10 YR 8/2	10 YR 7/2	S	10	SG	Lo	Lo	N	Gradual	2.11	1.55	7.64	1.50	---------
	C_4	95-150	7.5 YR 7/4	7.5 YR 6/4	S	10	SG	Lo	Lo	N	----------	2.53	0.86	7.68	2.65	---------
2.2- Gullies soils																
10	C_2	0 - 30	10 YR 6/4	10 YR 5/4	LS[††]	0.0	M	So	VFr	N	Clear	4.23	1.72	7.26	23.46	---------
	C_1	30-100	10 YR 7/4	10 YR 6/4	S	0.0	SG	Lo	Lo	N	----------	3.38	1.72	7.59	13.71	---------
2.3- Windblown soils																
11	C_1	0 - 40	10 YR 8/4	10 YR 7/4	S	0.0	SG	Lo	Lo	N	Gradual	3.38	3.27	7.70	8.05	---------
	C_2	40-120	10 YR 8/8	10 YR 7/8	S	0.0	SG	Lo	Lo	N	----------	2.53	1.72	7.81	4.59	---------
12	C_1	0 - 50	10 YR 7/3	10 YR 6/3	S	0.0	SG	Lo	Lo	N	Gradual	3.38	1.72	7.58	5.57	---------
	C_2	50-120	10 YR 8/4	10 YR 7/4	S	0.0	SG	Lo	Lo	N	----------	2.96	4.30	7.68	3.86	---------
2.4- Isolated plateau																
13	C_1	0 - 40	2.5 Y 7/2	2.5 Y 6/2	S	0.0	SG	Lo	Lo	N	Abrupt	8.46	1.38	7.62	14.39	---------
	C_2	40- 55	2.5 Y 6/2	2.5 Y 5/2	SL	0.0	M	Sh	Fr	N	Gradual	48.64	0.52	7.74	32.43	Salic & Calcic
	C_3	55-100	2.5 Y 6/4	2.5 Y 5/4	SCL[‡]	0.0	M	H	Fi	N	----------	32.15	0.69	7.63	136.28	Salic & Calcic

SL[†] : Sandy Loam **LS**[††] : Loamy Sand **S**[†††] **: Sand** **SCL**[‡] : Sand Clay Loam **M** : Massive **SG** : Single Grains So : Soft **Lo** : Loose **Sh** : Slightly hard **H** : Hard **VFr** : Very friable **Lo** : Loose **Fr** : Friable **Fi** : Firm **N** : Not observed

TABLE 3.Relative Horizon Distinctness (RHD) ratings of the studied profiles

Profile No.	Horizon	Color		Texture	Gravel	Structure	Consistence		Clay films	Lower Bound-aries	$CaCO_3$ %	Gypsum %	pH	EC dS/m	RHD	Average of RHD profile	Average of RHD unit
		Dry	Moist				Dry	Moist									
								1- Physiographic unit : River Terraces									
	1.1- Oldest river terraces																
1	C_1/C_2	4	4	0	0	0	0	0	0	1	0	0	0	0	9		
	C_2/C_3	4	4	1	2	0	0	0	0	1	0	1	0	0	13	11.130	
2	C_1/C_2	1	1	1	1	0	0	0	0	1	1	0	1	1	8	8.000	
3	C_1/C_2	0	0	0	1	0	0	0	0	1	1	0	0	1	4	4.000	7.710
	1.2- River terraces of deltic stage																
4	C_1/C_2	2	2	0	0	0	0	0	0	1	1	1	0	2	9		
	C_2/C_3	2	2	0	2	0	0	0	0	2	1	0	1	0	10		
	C_3/C_4	5	5	0	0	0	0	0	0	1	0	1	0	2	14	11.750	
5	C_1/C_2	1	1	0	0	0	2	1	0	1	0	0	1	0	7		
	C_2/C_3	1	1	0	2	0	0	0	0	2	0	0	0	0	6	6.350	9.050
								2- Physiographic unit : Wadi EL-Natrun									
	2.1- Transition soils																
6	C_1/C_2	3	3	0	0	0	0	0	0	1	1	0	1	3	12	12.000	
7	C_1/C_2	5	5	0	2	0	0	0	0	2	0	0	2	1	17		
	C_2/C_3	2	2	0	2	0	1	0	0	2	0	0	1	0	10	13.500	
8	C_1/C_2	0	0	0	0	0	0	0	0	1	0	0	0	2	3	3.000	
9	C_1/C_2	3	3	0	2	0	0	0	0	2	1	1	0	2	14		
	C_2/C_3	2	2	2	0	0	2	2	0	2	0	0	1	1	14		
	C_3/C_4	4	4	0	0	0	0	0	0	1	0	0	0	1	10	12.406	10.226
	2.2- Gullies soils																
10	C_1/C_2	1	1	1	0	0	1	1	0	2	0	0	1	1	9	9.000	9.000
	2.3- Windblown soils																
11	C_1/C_2	4	4	0	0	0	0	0	0	1	0	0	0	1	10	10.000	
12	C_1/C_2	2	2	0	0	0	0	0	0	1	0	0	0	1	6	6.000	8.000
	2.4- Isolated plateau																
13	C_1/C_2	1	1	2	0	0	2	2	0	3	2	0	0	2	15		
	C_2/C_3	2	2	1	0	0	1	1	0	1	0	0	0	0	8	10.000	9.750

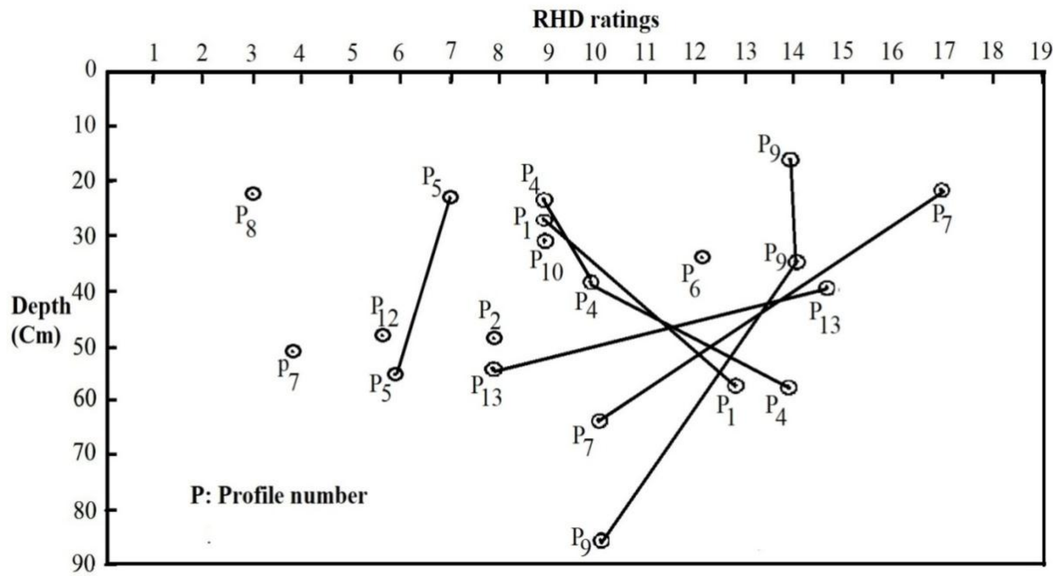


Fig 1.Relative Horizon Distinctness (RHD) ratings

Data points are pointed at boundary between the horizons

Soils of windblown sand, which represented by soil profiles 11 and 12 have RHD rating values 10 and 6, respectively. Dry and moist color and salinity are most properties which are affective in these ratings, on the other hand the RHD rating does not exceed than 10, which reveal to homogeneity of parent material and the differences that may will be due to pedological rather than geological processes.

Soils of isolated plateau, which represented by soil profile 13 are recorded two clusters of RHD ratings. The first ratings of 15 are at the C1/C2 boundary. The distinctness of horizon boundaries and variations in dry and moisture consistence, texture, lower boundaries, total carbonate and salinity, which indicate differences that may well be due to geological, rather than pedological processes. The second cluster at the C2/C3 boundary, where it less than 10, which reveal to homogeneity of parent materials and the differences that will may be due to pedological rather than geological processes.

Relative Profile Development (RPD)

The relative profile development ratings of the studied profiles are recorded in Table 4 and the same ratings are plotted in Fig. 2. Data in Table 4 show that soils which have more than one comparison between different layers with deepest layer or profiles which have more than 2 layers are observed in soil profiles 1, 4, 5, 7, 9 and 13. The larger rating scale values of RPD are found near the surface and they decrease gradually except in soils of profile 1. The larger the rating scale value for a particular horizon is, the greater its pedological development is. These observations agree with Bilzi and Ciolkosz (1977).

Adding diagnostic horizon ratings for an average of Relative Profile Development (RPD) ratings (modified RPD) in Table 4 give an importance for presence of secondary formations, which is considered as a guidance for soil development Soils of isolated plateau (profile 13) which considered as the oldest in chrono sequence of soils achieved highest value 19.0 which has salic and calcic horizons, follows by profile 4 which has gypsic and salic horizons then profile 1, which has calcic and gypsic horizons.

In spite of, soils of profile 9 have modified RPD ratings 13.33 due to distinctness dry and moist of both color and consistence, texture and salinity. Gravel and gypsum contents qualify this profile to be a skeletal and have a gypsic horizon in surface layer but its thickness is considered as impediment.

Soils of profile 9 belong to Entisols order and recent. In the same context, soils of profile 6 in transition soils of Wadi El-Natrun have modified RPD 12. This profile belongs to Entisols order in USDA (2014), while in FAO (2015), it has a salichorizons and belong to Solonchaks Reference SoilGroup and it considers as moredevelopment.

Thesedataindicate that the field morphology rating scale and another ratings which are suggested in the current study can be a useful tool for comparing the pedological development of soils of aridic moisture regime e.g. the soils of Western Nile Delta, Egypt.

TABLE 4 .Relative Profile Development (RPD) ratings of the studied profiles

Profile No.	Horizon	Color		Texture	Gravel	Structure	Consistence		Clay films	Lower Boundaries	$CaCO_3$ %	Gypsum %	pH	EC dS/m	RPD	Average of RPD profile	Modified RPD
		Dry	Moist				Dry	Moist									
							1- Physiographic unit : River terraces										
	1.1- Oldest river terraces																
1	C_1/C_3	3	3	1	2	0	0	0	0	1	0	1	0	0	11		
	C_2/C_3	3	3	1	2	0	0	0	0	1	0	1	1	0	12	11.50	14.50
2	C_1/C_2	1	1	1	1	0	0	0	0	1	1	0	0	1	7	7.00	9.00
3	C_1/C_2	0	0	0	1	0	0	0	0	1	1	0	0	1	4	4.00	6.00
	1.2- River terraces of deltic stage																
4	C_1/C_4	5	5	0	2	0	0	0	0	1	0	0	1	4	18		
	C_2/C_4	3	3	0	2	0	0	0	0	2	1	1	1	2	15		
	C_3/C_4	5	5	0	0	0	0	0	0	1	0	1	0	2	14	15.67	17.67
5	C_1/C_3	0	0	0	2	0	2	1	0	1	0	0	1	0	7		
	C_2/C_3	1	1	0	2	0	0	0	0	2	0	0	0	0	6	6.50	6.50
							2- Physiographic unit : Wadi EL-Natrun										
	2.1- Transition soils																
6	C_1/C_2	3	3	0	0	0	0	0	0	1	1	0	1	3	12	12.00	12.00
7	C_1/C_3	3	3	0	0	0	1	0	0	2	0	0	2	1	12		
	C_2/C_3	2	2	0	2	0	1	0	0	2	0	0	0	0	9	10.50	10.50
8	C_1/C_2	0	0	0	0	0	0	0	0	1	0	0	0	2	3	3.00	3.00
9	C_1/C_4	1	1	2	2	0	2	2	0	2	1	1	1	2	17		
	C_2/C_4	2	2	2	0	0	2	2	0	2	0	0	1	0	13		
	C_3/C_4	4	4	0	0	0	0	0	0	1	0	0	0	1	10	13.33	13.33
	2.2- Gullies soils																
10	C_1/C_2	1	1	1	0	0	1	1	0	2	0	0	1	1	9	9.00	9.00
	2.3- Windblown soils																
11	C_1/C_2	4	4	0	0	0	0	0	0	1	0	0	0	1	10	10.00	10.00
12	C_1/C_2	2	2	0	0	0	0	0	0	1	0	0	0	1	6	6.00	6.00
	2.4- Isolated plateau																
13	C_1/C_3	3	3	3	0	0	3	3	0	3	2	0	0	2	22		
	C_2/C_3	2	2	1	0	0	1	1	0	1	0	0	0	0	8	15.00	19.00

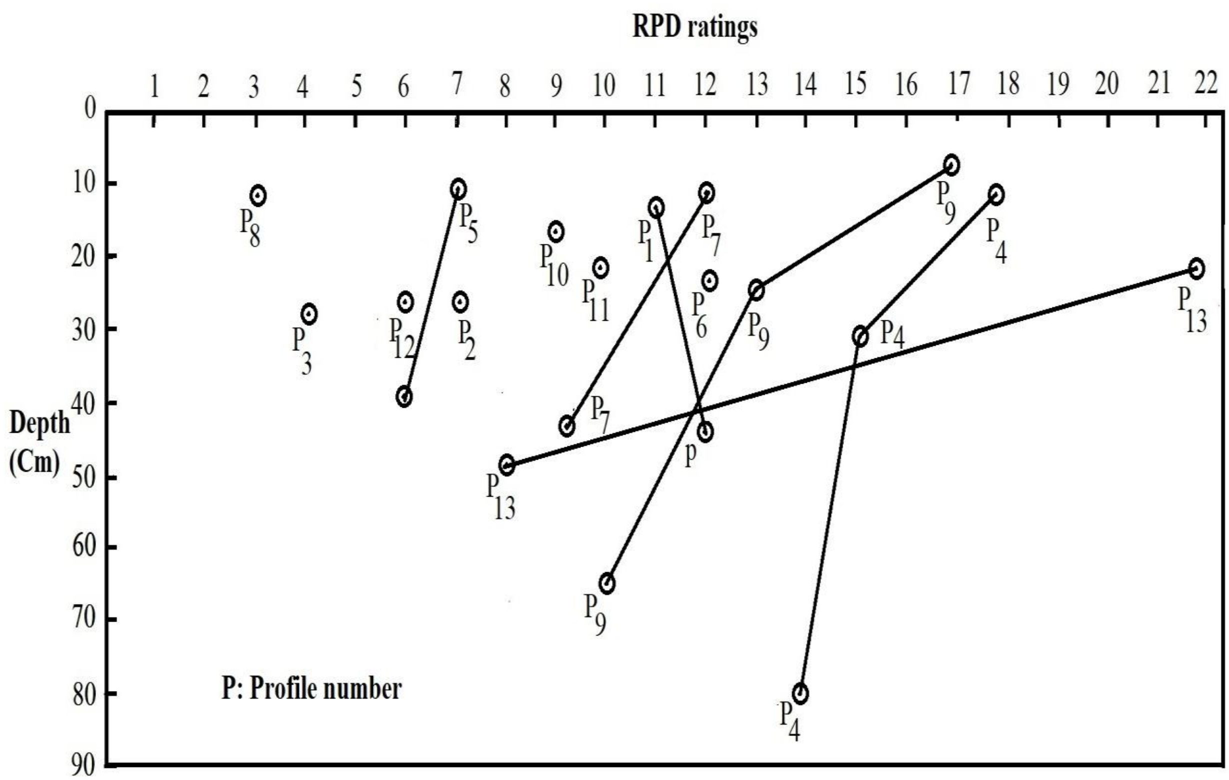


Fig 2. Relative Profile Development (RPD) ratings.

Data points are plotted at the midpoint of the horizons.

4. Conclusion

The proposed modifications of the morphological, physical and chemicalof soil properties showed the correlation between development research and what was mentioned in the Soil Taxonomy of USDA (2014).

The values of Relative Horizon Distinctness (RHD) and Relative Profile Development (RPD) for the Aridisols were higher than those for the Entisols.However,The current study is an attempt to adapt land development research under the conditions of arid zone areas, since these soils may be are characterized by A, B and C horizons, this attempt must be repeated in other regions of Egypt to confirm its suitability to express the degree of land development. Also, must be applied under the international level to include all climates and land environments.

Conflicts of interest

The authors declare no conflicts of interest.

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