J. Agric. Sci. Mansoura Univ., 32 (8): 6963 - 6975, 2007

STATISTICAL EVALUATION OF COPPER AND LEAD DISTRIBUTION IN SOME CONTAMINATED SOILS WITH INDUSTRIAL WASTE WATER IN EGYPT.

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ABSTRACT

Forty two surface soil samples (0-30cm depth) from four location, highly polluted with industrial wastes in Egypt, were analyzed for the total Pb and Cu, DTPA-extractable Pb and Cu. The values of total Pb ranged from 37 to 249 ug/g soil with mean value 136 ug/g soil. The values of total Cu ranged from 26 to 245 ug/g soil with mean value 119 ug/g soil. The minimum, maximum and mean values of DTPA-extractable were 2.4 and 34.6 and 14.91 ug/g soil for lead, respectively and 1.7 ,32.8 and 15.06 ug/g soil for copper, respectively.

Multiple regression equations were derived to find the relationships between: First total Pb and other variables, second between total Cu and other variables, third between DTPA-extractable Pb and other variables and forth between DTPA-extractable Cu and other variable, the more variables added to the equation, little improvement in R-sq was observed.

Factor analysis was used to combine variables Clay%; pH; EC; CaCO3%; OM%; Pb(T); Pb(av) ,Cu(T); Cu(av) as soil analysis parameters into homogeneous groups. For the first agglomeration, the final partition shows the lowest similarity of 49.2% between two associations cluster {Clay% }and cluster { pH; EC; OM%; Pb(T); Pb(av); CaCO3%}.While there is evident with the highest similarity of 96.3% when joining cluster. {Pb(T)} with cluster {Pb(av). For the second agglomeration, the highest similarity of 90.4% was found when joining cluster {Cu(T)}with cluster{ Cu(av) }; while the lowest similarity of 52.172% between two associations cluster {Clay% }and cluster { pH; EC; OM%; Cu(T); Cu(av); CaCO3%}.For the third agglomeration, there is evident with the highest similarity of 96.3% when joining cluster {Pb(T) ug/g}; and cluster{ Pb(av) ug/g}. While the lowest similarity of 52.17% was found between cluster{Clay} and cluster {pH, OM ,EC; Cu(T); Cu(av) , Pb(T) , Pb(av), CaCO3}.

Keywords: Contaminated soils-Lead-Copper- multiple regression-cluster variable analysis

INTRODUCTION

Urban and industrial soils are known to contain higher metal concentrations compared with agricultural soils. Elevated levels of Cu and Pb, have been observed in surface soils near various industrial facilities. Metal pollution of soils is assessed through measurements that include total and available concentrations in soils .Total metal concentrations are the most useful index to assess the degree of accumulation of metals in soils. Also, metal availability to plants is better reflected from soil solution composition. Shahin *et al.*,(1988) stated that soil- Pb beside an industrial complex were 16 times greater than that of those of normal soils. Rabie *et al.*, (1996) in El-Saff are mentioned that in soil nieghbouring to Iron and Steel Complex contains an average of 129 ppm, Pb. In industrial area of Shoubra El-Kheima, Matter

(1999) reported that the total Pb content is ranged from 21 to 64 mg / kg. El-Sanafawy (2002) reported that the total Pb elevated to 375.29 mg kg-1 in the surface soil of Talkha, and decreased with soil depth. In Wadi El-Waten , El-Ashir Min Ramadan ,Gendy (2004) reported that the total Pb content ranged from 68.1 to 112.4 mg / kg in the surface soils. El-Sokkary and Lag (1980) reported that the total Pb value in some polluted soil in Egypt is ranged from 4.8 to 29 with an average of 11.24 mg /kg. Similar results were also obtained by Abdel Shakour (1982) who mentioned that 14.9 mg / kg was the average of Pb content in soils of lower Egypt.

In Egyptian soils, the maximum value stated for Cu –background levels was 78.0 mg/ kg, as mentioned by (Rashad et al ., 1995; El-Toukhy ,1995). Abdel Shakour (1982) stated that the average soil-copper concentration was about 70 ppm .He also added that this value dependent mainly on geographical location, geological constituent and pollution sources. In the same connections, El-Leithi (1986) added that heavy metals contents in industrial area were vary largely from one site to another depending on the nature and composition of the industrial wastes.

In Talkha area, El-Sanafawy (2002) reported that the total Cu content in surface soil was 165.20 mg/ kg. Also, Gendy (2004) observed that the total contents of Cu in El-Ashir Min Ramadan City, varied from 48 to 79 mg/ kg, in the surface soil and is decreased in the subsurface soil. Surrounding Abu-Zaabal Fertilizer Company, Kafr El-Zayat Fertilizer Company and Talka Fertilizer Company, Salem (2002) reported that the available Cu in surface soils was; 10.83, 6.87 and 13.91 mg/ kg, respectively. Factor analysis attempts to simplify the complex and diverse relationships that exist among a set of observed variables by revealing common and unobservable factors that link together the seemingly unrelated variables (Usunoff and Guzman-Guzman,1989;Evans *et al.*, 1996). In hydrochemical studies, the results of ground water chemical analysis and field measurement data are the observable variables, and the underlying physicochemical and/or biological processes in the ground water system are the so-called unobservable factors.

Cluster analysis groups the whole ground water system into a finite number of clusters. Each cluster represents a specific and similar hydrogeochemical state of ground water. Usually, cluster analysis is applied to the raw data, the observable variables (Frapporti *et al.*, 1993; Ochsenkühn *et al.*, 1997).

The present work aims at investigate the distribution of Pb and Cu in both forms total and available in some soils contaminants by industrial wastes in Egypt, and to initiate the multiple regression equations for different relationships among the factors (i.e., pH, EC and OM %) that affect the total and available Pb and Cu and finally apply the Cluster variables analysis which is a part of multivariate analysis concerning with huge amount of data.

MATERIALS AND METHODS

Four locations characterized by industrial activities had been chosen for this study. They are located in the northern part of Cairo (Kaliobih governorate). These locations are (1) Shoubra El-Kheima,(2) Musturd , (3)Kalub and (4)Banha.

Forty two surface soil samples (0-30cm depth) were collected from the locations, air dried, ground and sieved through a 2 mm sieve,

Soil analysis :

Mechanical analysis was carried out by pipette method (Piper, 1950).Organic matter content was determined by Walkley and Black (Jackson, 1967).Calcium carbonate content was determined volumetrically (Piper, 1950). Soil pH was determined in soil paste using pH meter. Electrical conductivity was determined in the soil water extract 1:2.5 (Jackson, 1967).

The soil samples were analyzed for DTPA extractable Pb and Cu (Lindsay and Norvel,1978).The total Pb and Cu were determined after fusion with mixture of concentrated HNO3, HClO4 and H2SO4 (Hesse, 1971). The obtained data are presented in Table (1).

Statistical Analysis

Factor and cluster analyses have been employed to reveal the most important governing processes and the hydrogeochemical similarities between the observation points through data reduction and classification (Suk and Lee, 1999). Several researchers (Ritzi *et al.*, 1993; Ochsenkühn *et al.*, 1997) have applied factor and/or cluster analyses to ground water chemical data in order to understand ground water systems correlations, cluster analyses and multiple regressions and frequency distribution were calculated using Mini Tab**.**

RESULTS AND DISCUSSION

The data presented in Table (1) shows that, clay content % ranges from 29.63 % to 49.11% and the mean value is 40.857% (with standard deviation, STD ,5.14) and the median value is 41.11. pH values ranged from 7.54 to 7.90 and the median value is 7.72. The soil salinity measured in soil water extract (1:2.5) and expressed as EC dS/m ranged between 2.05 to 39.7 with mean value 14.67 dS/m with STD 8.39 .

Calcium carbonate % ranged from 0.75 to 6.33, mean value 3.07% with STD 1.28 and the median value is 3.11 . While organic matter % in soil has a minimum value of 0.36 and the maximum value is 1.73 whereas the mean value was 1.01% with STD 0.38 and the median value is 1 % .

The minimum value of total Pb is 37 ug/g soil and the maximum value is 249 ug/g soil with mean value of 136 ug/g soil and the median value is 139 ug/g soil .

The minimum value of total Cu is 26 ug/g soil and the maximum value is 245 ug/g soil with mean value 119 ug/g soil and the median value is 122 ug/g soil. The DTPA-extractable lead range from 2.4 ug/g soil 34.6 ug/g soil with mean value of 14.91 ug/g soil and the median value is 14.3 ug/g soil. The DTPA-extractable Copper ranged between 1.7 ug/g soil to 32.8 ug/g soil with mean value of 15.06 ug/g soil and the median value is 14.8 ug/g soil .

Histogram of data with normal curve

Histogram of the data distribution was overlaid with a normal curve and can be used to assess the normality of the given data. A normal distribution is symmetric and bell-shaped, as indicated by the curve.

A histogram displays data that have been summarized into intervals. It can be used to assess the symmetry or skewness of the data.

Fig 1(a,b,c,d) represent the histograms of the frequency distribution for total Cu ,DTPA-extractable Copper, total Pb, DTPA-extractable lead data respectively, notice the single extreme values in the interval if not for this outlier, the distribution would be perfectly symmetric and fairly normal.

Test for Overall Multiple Regression

The first question that we need to ask in any multiple regression is whether there could be a regression relationship. If there's no possibility at all of a linear relationship between the dependent variable and *any* of the independent variables, then, of course, there's no multiple regression. For a simple linear regression, we answered the question by conducting a test of the slope parameter **:**

H_0: $\beta_{\square} = 0$

Where: H_0 hypothesis of no relationship

$\beta_{\square}$ slope of the regression

By extending this test to include p slope parameters

H_0: $\beta_1 = \beta_2 = \beta_3 = ... = \beta_p = 0$

H_0: no multiple regression relationship

Rejecting the null hypothesis means that at least one of the slope parameters is not zero; that is, there could be a linear relationship between Y and at least one of the p independent variables.

R-Sq and R-Sq (adj) values

The R and adjusted R values represent the proportion of variation in the response data explained by the predictors.

(R-Sq) describes the amount of variation in the observed response values that is explained by the predictor(s). Adjusted R-sq is a modified R-sq that has been adjusted for the number of terms in the model. If unnecessary terms were included, R-sq can be artificially high. Unlike R-sq, adjusted R may get smaller when you add terms to the model. Table 2 shows the results of Multiple Regression analysis, R-sq and adjusted R-sq and the F test value where p-Value=0.0.

The amount of variability explained by the linear regression (MSR) is greater than the amount due to residual error (MSE). The difference is large enough (the p-value is, in fact, close to 0) to strongly reject the null hypothesis,

A linear relationship, then, could exist between at least one of the productivity variables .

For the Cu (T) data, the predictors {Cu(av) and OM%} explain 65.8 % of variation in the Cu(T) observations. While adjusted R-sq is 64.1 % .

For the Cu (T) data, the predictors {Cu(av) and OM% and EC} explain 68.1 % of variation in the Cu(T) observations. While adjusted R-sq is 65.5 % .

For the Cu (T) data, the predictors {Cu(av) and OM% and EC and pH} explain 68.2 % of variation in the Cu(T) observations. While adjusted R-sq is 64.7 %.

Regarding the Cu (av) data, the predictors {Cu(T) and OM%} explain 66.5 % of variation in the Cu(av) observations. While adjusted R-sq is 64.8 %.

Regarding the Cu (av) data, the predictors {Cu(T) and OM% and EC} explain 66.5 % of variation in the Cu(av) observations. While adjusted R-sq is 63.9 %.

Regarding the Cu (av) data, the predictors {Cu(T) and OM% and EC and pH} explain 66.8 % of variation in the Cu(av) observations. While adjusted R-sq is 63.2 %.

On the other hand , for the Pb (T) data, the predictors {Pb(av) and OM% } explain 88 % of variation in the Cu(T) observations. While adjusted R-sq is 87.4 %.

For the Pb (T) data, the predictors {Pb(av) and OM% and EC} explain 88.7 % of variation in the Cu(T) observations. While adjusted R-sq is 87.9 %**.**

For the Pb (T) data, the predictors {Pb(av) and OM% and EC and pH} explain 88.8 % of variation in the Cu(T) observations. While adjusted R-sq is 87.6 %.

While the reversing the above relationships it noticed that for the Pb (av) data, the predictors {Pb(T) and OM% } explain 78.1 % of variation in the Pb(av) observations. While adjusted R-sq is 86.4 %**.**

For the Pb (av) data, the predictors {Pb(T) and OM% and EC } explain 78.1 % of variation in the Pb(av) observations. While adjusted R-sq is 86 %**.**

For the Pb (av) data, the predictors {Pb(T) and OM% and EC and pH } explain 78.1 % of variation in the Pb(av) observations. While adjusted R-sq is 85.7 %**.**

The above results revealed that adding more predictors to the equation gives little improvement in the value of R-sq .

where values of R-sq for equations (2,3and 48)were 65.8,68.1 and 68.2 respectively

where values of R-sq for equations (6,7and 8)were 66.5,66.5 and 66.8 respectively

where values of R-sq for equations (10,11and 12)were 88,88.7 and 88.8 respectively

where values of R-sq for equations (14,15and 16)were 78.1,78.1and 78.1 respectively

Table (2): Regression analysis

No.	Regression equation	R-sq	R-sq adj.	F
1	Cu(T) = 30.5 + 5.84 Cu(av)	65.3	64.4	75.3

2	Cu(T) = 41.1 + 5.92 Cu(av) - 11.7 OM%	65.8	64.1	37.6
3	Cu(T) = 29.8 + 5.57 Cu(av) - 10.7 OM% + 1.06 EC	68.1	65.5	26.9
4	Cu(T) = - 173 + 5.51 Cu(av) - 12.4 OM% + 1.20 EC+26.3 pH	68.2	64.7	19.8
5	Cu(av) = 1.85 + 0.112 Cu(T)	65.3	64.4	75.3
6	Cu(av) = - 0.51 + 0.111 Cu(T) + 2.42 OM%	66.5	64.8	38.7
7	Cu(av) = - 0.41 + 0.112 Cu(T) + 2.41 OM% - 0.0110 EC	66.5	63.9	25.1
8	Cu(av) = - 46.9 + 0.110 Cu(T) + 1.99 OM% + 0.022 EC+6.0 pH	66.8	63.2	18.6
9	Pb(T) = 21.0 + 7.73 Pb(av)	86.0	85.6	245.4
10	Pb(T) = 47.9 + 7.47 Pb(av) - 22.9 OM%	88.0	87.4	142.6
11	Pb(T) = 46.3 + 7.02 Pb(av) - 24.7 OM% + 0.689 EC	88.7	87.9	99.8
12	Pb(T) = - 90 + 7.01 Pb(av) - 26.1 OM% + 0.776 EC + 17.7 pH	88.8	87.6	73.3
13	Pb(av) = - 0.24 + 0.111 Pb(T)	68.0	85.6	245.0
14	Pb(av) = - 2.97 + 0.116 Pb(T) + 2.10 OM%	78.1	86.4	131.4
15	Pb(av) = - 2.98 + 0.116 Pb(T) + 2.13 OM% - 0.0055 EC	78.1	86.0	85.2
16	Pb(av) = 6.6 + 0.116 Pb(T) + 2.23 OM% - 0.0119 EC - 1.25 pH	78.1	85.7	26.3

Cluster

Distinct group of variables that are more similar to each other than to variables outside of the group. Use the cluster variables procedure to classify variables into groups when the groups are initially not known. The primary reason to cluster variables is to reduce the number of variables. Cluster variables uses a hierarchical clustering procedure.

Similarity. *Distance* measures how far apart two observations are. Cases which are alike share a low distance. *Similarity* measures how alike two cases are**:**

The first step in cluster analysis is establishment of the similarity or distance matrix**.** This matrix is a table in which both the rows and columns are the units of analysis and the cell entries are a measure of similarity or distance for any pair of cases.

There are a variety of different measures of inter-observation distances and inter-cluster distances to use as criteria when merging nearest clusters into broader groups or when considering the relation of a point to a cluster. Mini Tab supports these interval distance measures.

Dendrogram

The dendrogram displays the groups formed by clustering of variables, and their similarity levels.The final grouping of clusters (also called the final partition) is the grouping of clusters that should identify groups whose observations share common characteristics. The decision about final grouping is also called cutting the dendrogram. The complete dendrogram (tree diagram) is a graphical depiction of the amalgamation of observations into one cluster. Cutting the dendrogram is akin to drawing a line across the dendrogram to specify the final grouping**.**

Factor analysis was used to combine Variables: Clay%; pH; EC; CaCO3%; OM%; Pb(T); Pb(av) as soil analysis parameters into homogeneous groups;. Figure2 presents the results of cluster analysis for such parameters monitoring data from the four locations. The final partition shows the lowest similarity of 49.2% between two associations cluster {Clay%} and cluster{ pH; EC; OM%; Pb(T); Pb(av); CaCO3%}.

While there is evident with the highest similarity of 96.3% when joining cluster. {Pb(T)} with cluster {Pb(av)}.

In addition to the above , The association between cluster{ EC }and cluster{ Pb(T); Pb(av) } gave the 76.19 % similarity.

Agglomeration of cluster {CaCO3%} with cluster {EC; Pb(T); Pb(av)} has a weak association of 65.1% similarity.

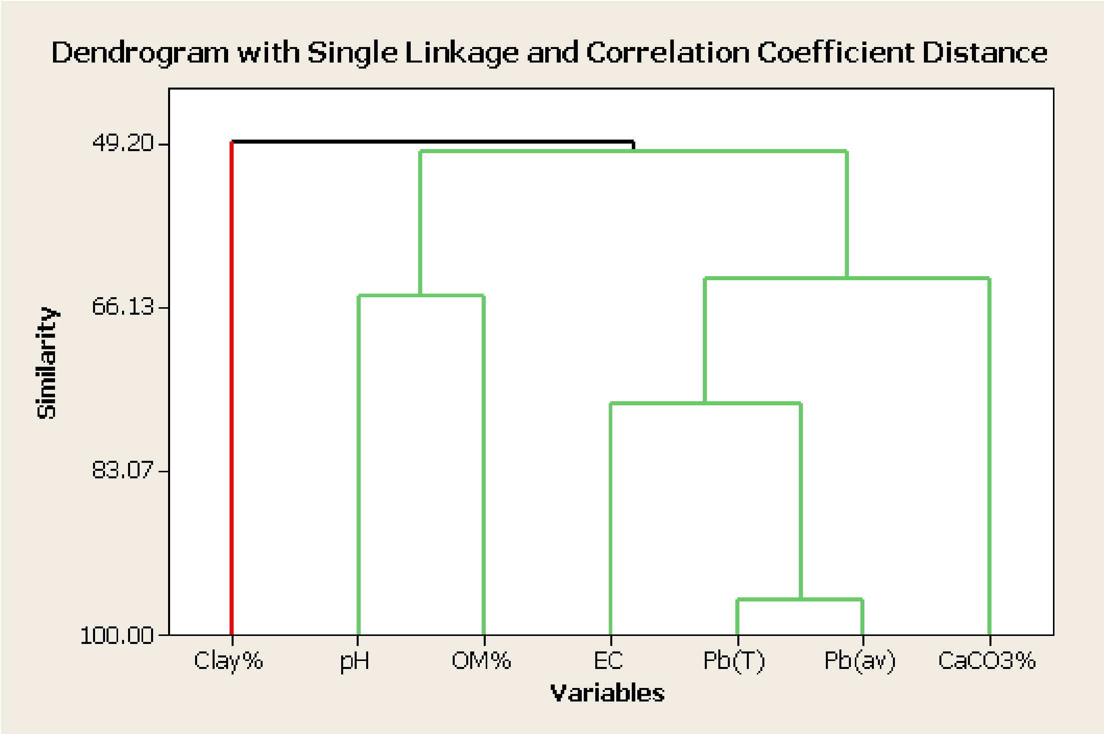

Fig. 2: Similarity dendrogram among soil parameters from cluster analysis. Seven soil parameters groupings shown: (1) Clay content% ;(2) pH values; (3) Organic matter % OM; (4) Soil Salinity EC 1:1 dS/m ;(5)Pb(T) ug/g ;(6) Pb(av) ug/g and (7) Calcium Carbonate CaCO3 %.

Factor analysis was used to combine variables: Clay%; pH; EC; CaCO3%; OM%; Cu(T); Cub(av) as soil analysis parameters into homogeneous groups. Figure3 presents the results of cluster analysis for such parameters monitoring data from the four locations.

While there is evident with the highest similarity of 90.4% when joining cluster. { Cu(T))} with cluster {Cub(av) }.

In addition to the above , The association between cluster{ EC }and cluster { Cu(T); Cu(av) } gave the 69 % similarity.

Grouping cluster {pH} and cluster {OM} gives similarity of 65 %.

Agglomeration of cluster {pH,OM} with cluster { EC; Cu(T); Cu(av) } has a weak association of 57.3% similarity.

The same declined similarity trend was obtained when grouping cluster{ CaCO3%} with cluster{{ pH; EC; OM%; Cu(T); Cub(av) } it gives 54.1% of similarity.

The final partition shows the lowest similarity of 52.172% between two associations cluster {Clay%} and cluster {pH; EC; OM%; Cu(T); Cub(av) ; CaCO3%}.

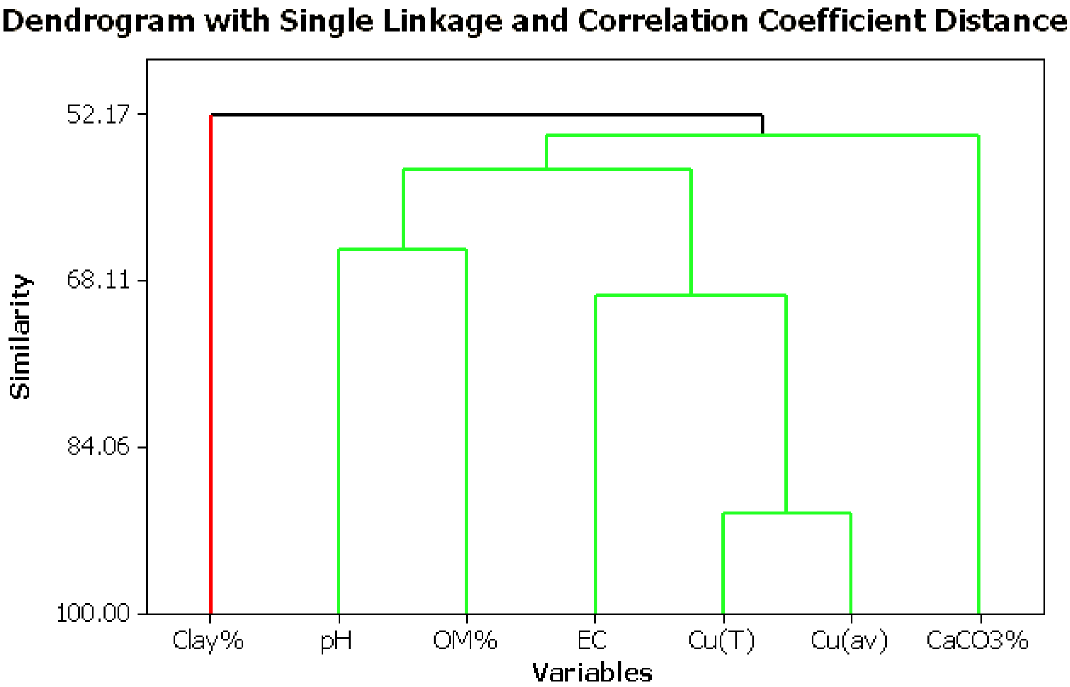

Fig. 3: Similarity dendrogram among soil parameters from cluster analysis. Seven soil parameters groupings shown: (1) Clay content% ;(2) pH values; (3) Organic matter % OM; (4) Soil Salinity EC 1:1 dS/m ;(5) Cu(T) ug/g ;(6) Cu(av) ug/g and; (7) Calcium Carbonate $CaCO_3$ %.

Factor analysis was used to combine variables: clay%; pH; EC; $CaCO_3$%; OM%; Cu(T) ug/g ; Cu(av) ug/g ;Pb(T) ug/g ; and Pb(av) ug/g as soil analysis parameters into homogeneous groups. Figure 4 presents the results of cluster analysis for such parameters monitoring data from the four locations.

There is evident with the highest similarity of 96.3% when joining cluster. { Pb(T) ug/g} ; and cluster{ Pb(av) ug/g}

There is high similarity of 90.3% when joining cluster. { Cu(T) ug/g} and cluster{Cu(av) ug/g.

In addition to the above , The association between cluster{{ Pb(T) , Pb(av)}and { Cu(T),Cu(av) } gave 80% similarity.

{EC}and cluster { Cu(T); Cu(av) } gave the 69 % similarity.

Grouping Cluster {pH} and Cluster {OM} gives similarity of 65 %.

Agglomeration of cluster {pH,OM} with cluster { EC; Cu(T); Cu(av) } has a weak association of 57.3% similarity. While the lowest similarity of 52.17% was found between cluster{Clay} and cluster {pH,OM ,EC; Cu(T); Cu(av) , Pb(T) , Pb(av),
{CaCO3}.

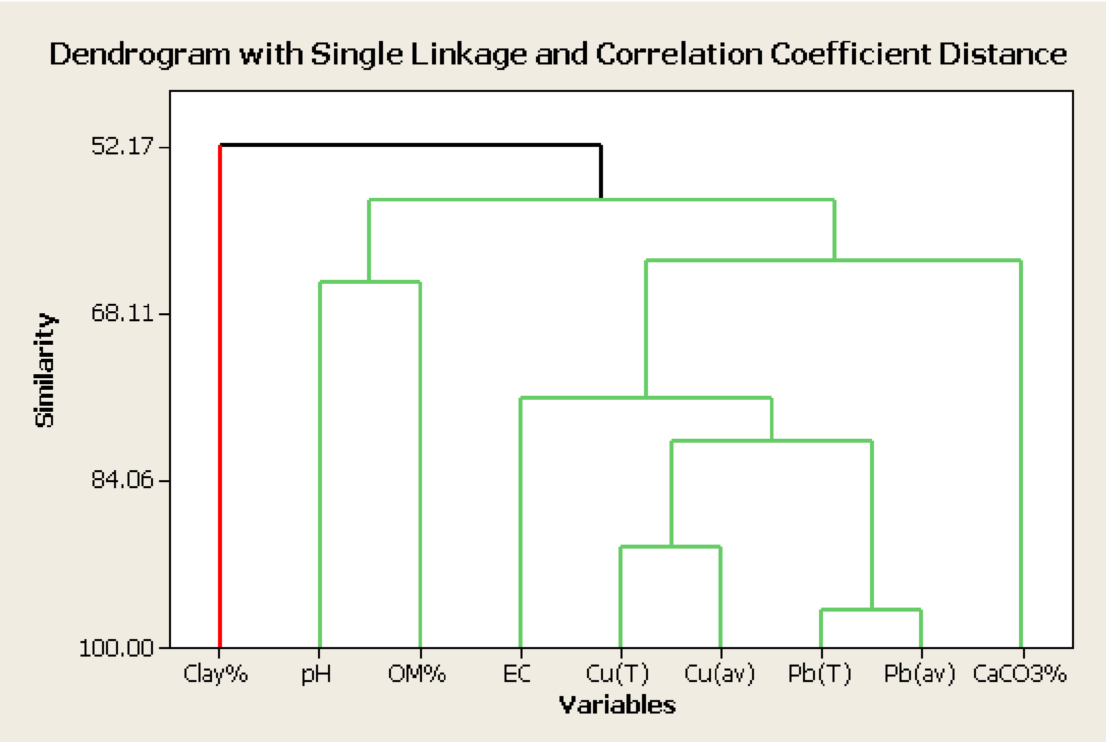

Fig. 4 : Similarity dendrogram among soil parameters from cluster analysis. Seven soil parameters groupings shown: (1) Clay content% ;(2) pH values; (3) Organic matter % OM; (4) Soil Salinity EC 1:1 dS/m ;(5) Cu(T) ug/g ;(6) Cu(av) ug/g ;(7)Pb(T) ug/g ;(6) Pb(av) ug/g and (8) Calcium Carbonate CaCO3 %.

CONCLUSION

The amount of variability explained by the multiple regression was expressed as coefficient of determination (R-sq).The results revealed that adding more predictors to the equations give little improvement in the value of R-sq . The association between clusters gave highest similarity when agglomeration cluster. { Pb(T) ug/g} ; and cluster{ Pb(av) ug/g} while, the association between clusters{Clay} and cluster {pH,OM ,EC; Cu(T); Cu(av) , Pb(T) , Pb(av), CaCO3}gave lowest similarity 52.17% .

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التقييم الإحصائى لتوزيــع النحاس والرصاص فــى بعض الأراضى الملوثة بمياه الصرف الصناعى فى مصر

على محمد أحمد النجار – محمد محمد كامل

قسم الأراضى – كلية الزراعة – جامعة القاهرة

تم تجميع عدد إثنين وأربعون عينة تربة سطحية (صفر – 30 سم) من أربعة مواقع ملوثة بمياه الصرف الصناعى فى مصر وتم تحليل هذه العينات وتقدير كل من الرصاص والنحاس الكلى و الكميات الصالحة لامتصاص النبات باستخدام مستخلص DTPA للرصاص والنحاس وكذلك محتوى العينات من الطين وكربونات الكالسيوم و المادة العضوية بالإضافة إلى تقدير ملوحة التربة (EC) ورقم الحموضة (pH).

كانت قيم الرصاص الكلى تتراوح من 37 إلى 249 ميكروجرام/جرام تربة بينما المتوسط العام 136 ميكروجرام/جرام تربة وكانت قيم النحاس الكلى تتراوح من 26 إلى 245 ميكروجرام/جرام تربة بينما المتوسط العام 119 ميكروجرام/جرام تربة.

ومن ناحية أخرى كانت القيم الأدنى ، والأقصى والمتوسط للرصاص المستخلص بواسطة DTPA هى 2.4 ، 34.6 ، 14.91 ميكروجرام/جرام تربة على الترتيب. بينما كانت نفس القيم للنحاس للمستخلص بواسطة DTPA هى 1.7 ، 32.8 ، 15.06 ميكروجرام/جرام تربة على الترتيب.

تم استنباط معادلات الإنحدار المتعدد لإيجاد العلاقة بين **أولاً**: الرصاص الكلى وباقى المتغيرات ، **ثانياً**: النحاس الكلى وباقى المتغيرات ، **ثالثاً**: الرصاص المستخلص بواسطة DTPA وباقى المتغيرات ، **ورابعاً**: النحاس المستخلص بواسطة DTPA وباقى المتغيرات. وقد وجد أنه بزيادة عدد المتغيرات فى معادلة الإنحدار المتعدد يؤدى ذلك إلى تحسن طفيف فى قيمة R-sq للمعادلات.

استخدم أسلوب تحليل المتغيرات العنقودى وذلك لتجميع المتغيرات الآتية فى عناقيد clay %, pH, EC CaCO$_3$ %, OM %, Pb(T), Pb(av), Cu(T), Cu(av).

وهى المتغيرات الناتجة من تحليل التربة وتم تجميعها فى عناقيد متجانسة فكانت النتائج كالآتى:

التجميع الأول للعناقيد: حيث وجد أن أقل تشابه مقداره 49.25% ينتج من تجميع عنقود (clay %) مع عنقود (pH, EC, OM%, Pb(T), Pb(av), CaCO$_3$%) بينما يوجد دليل واضح على وجود أكبر تشابه ومقداره 96.3 % عند تجميع عنقود Pb(T) مع عنقود Pb(av).

التجميع الثانى للعناقيد: فقد وجد أن أكبر تشابه ومقداره 90.4 % يكون بين عنقود Cu(T) وعنقود Cu(av) بينما أقل تشابه ومقداره 52.172% بين عنقود (clay %) والعنقود المكون من {pH, EC, OM%, Cu(T), Cu(av), $CaCO_3$%}.

التجميع الثالث للعناقيد: يوجد دليل واضح على وجود أعلى تشابه و مقداره 96.3 % عند تجميع عنقود Pb(T) مع عنقود Pb(av) بينما أقل تشابه و مقداره 52.172% و بين عنقود (clay %) والعنقود المكون من {pH, EC, OM%, Cu(T), Cu(av), Pb(T), Pb(av), $CaCO_3$%}.

Table 1: Some soil physical and chemical analysis and Total and DTPA - extractable Pb and Cu in the studied locations

No.	location		Particl size distribution				Soil	pH
			Coars S%	Fine S%	Silt%	Clay%	Texture	(1:2.
1	Soubra ELKhema	1	3.70	30.71	29.45	36.14	C.L.	
2		2	2.97	27.11	28.61	41.31	C.	
3		3	6.66	27.38	29.19	36.77	C.L.	
4		4	1.86	28.19	25.89	44.06	C.	
5		5	2.03	23.09	27.86	47.02	C.	
6		6	4.51	23.53	26.94	45.02	C.	
7		7	3.19	22.86	26.64	47.31	C.	
8		8	4.21	21.89	28.87	45.03	C.	
9		9	4.37	20.85	34.02	40.76	C.	
10	Kaliobih	1	6.52	29.13	24.23	40.12	C.	
11		2	4.93	27.56	23.76	43.75	C.	
12		3	13.05	25.11	24.73	37.11	C.L.	
13		4	6.02	24.97	25.34	43.67	C.	
14		5	6.18	26.63	27.93	39.26	C.L.	
15		6	5.83	25.45	26.61	42.11	C.	
16		7	4.02	27.61	22.18	46.19	C.	
17		8	15.02	25.89	25.08	34.01	C.L.	
18		9	4.89	22.26	24.22	48.63	C.	
19		10	5.10	26.17	27.09	41.64	C.	
20		11	5.22	22.31	24.08	48.39	C.	
21		12	6.07	21.25	23.57	49.11	C.	

Table 1: cont.

No.	location		Particl size distribution				Soil	pH
			Coars S%	Fine S%	Silt%	Clay%	Texture	(1:2.5
22	Banha	1	6.09	33.45	22.25	38.21	C.L.	7.82
23		2	8.19	22.81	28.15	40.85	C.	7.85
24		3	5.11	25.13	29.09	40.67	C.	7.71
25		4	6.09	22.81	26.45	44.65	C.	7.69
26		5	2.03	28.75	25.73	43.49	C.	7.81
27		6	2.45	28.17	28.16	41.22	C.	7.79
28		7	3.93	23.67	26.03	46.37	C.	7.80
29		8	5.73	33.21	28.97	32.09	C.L.	7.83
30		9	4.87	24.81	26.95	43.37	C.	7.65
31	Moustured	1	6.21	32.39	26.11	35.29	C.L.	7.65
32		2	4.16	24.43	29.26	42.15	C.	7.72
33		3	9.33	34.78	25.14	30.75	C.L.	7.58
34		4	4.24	24.11	27.30	44.35	C.	7.64
35		5	7.21	32.80	28.73	31.26	C.L.	7.85
36		6	3.55	28.45	26.75	41.25	C.	7.66
37		7	6.36	35.78	28.23	29.63	C.L.	7.81
38		8	5.03	31.15	27.32	36.50	C.L.	7.61
39		9	5.44	27.93	27.96	38.67	C.L.	7.79
40		10	5.21	31.45	29.75	33.59	C.L.	7.54
41		11	4.11	22.93	26.84	46.12	C.	7.72
42		12	2.65	22.28	27.26	47.81	C.	7.76

H_0: $\beta_{\square} = 0$

Where: H_0 hypothesis of no relationship

$\beta_{\square}$ slope of the regression

By extending this test to include p slope parameters

H_0: $\beta_1 = \beta_2 = \beta_3 = ... = \beta_p = 0$