JOURNAL OF TECHNIQUES

Journal homepage: http://journal.mtu.edu.iq

RESEARCH ARTICLE - ENGINEERING

Prediction of Heavy Metals Values for South-East of Baghdad Study Area

Eman Abdul Rahman[1*], Muthaina Abdullah Mustafa[2]

[1] Engineering Technical College - Baghdad, Middle Technical University, Baghdad, Iraq.

[2] University of Mousel, College of Environment and Technologies Mousel, Iraq.

[*] Corresponding author E-mail: iman_engineer@mtu.edu.iq

Article Info.

Article history:

Received
09 September 2021

Accepted
07 February 2022

Publishing
31 March 2022

Abstract

Soil, water and air are the main components of the environment. The presence of old and modern factories that emit pollutant materials such as steam and smoke polluting the air and soil, as well as dumping solid and liquid wastes for these industries on the lands and in the adjacent water channels, and all these pollutants will negatively affect the environment surrounding the industrial sites. The factories are located south-east of the capital, Baghdad. This study aims to estimate the damage and seriousness of heavy metals pollution in the soil surrounding these factories. Soil samples are taken at three depths (0-10) (10-30) (30-50) cm with nine different sites. The necessary tests are carried out to find the concentrations of heavy metals such as copper (Cu), iron (Fe), cadmium (Cd), nickel (Ni), zinc (Zn), and lead (Pb), as well as phosphate (PO_4) and PH. These tests values can be used in statistical program to obtain the analysis of variance tables for a significant level less than 0.05 in f-test. The least square difference method is used to find the significant difference among tests in one layer. The results show that, the second layer of soil is the worst where Mean square error is 24.432 with Mean Absolut error is 1.164 and Mean Absolut percentage error is 96.21. Using Minitab program to predict heavy metal values for the second layer and these values are not exceeding the permissible limits. In this study, the concentrations of heavy metals for the second layer of soil and for the nine sites starting from the first site are as follows Pb (3.05-11) mg/kg prediction values to Pb (3.15-17.35) mg/kg. Concentration of Cd (0.05-0.2) mg/kg while prediction values of Cd (0.09-0.31) mg/kg. Concentrations of Ni in second layer of soil (3-35) mg/kg; Prediction values Ni (4.41-37.08) mg/kg. Zn concentrations (0.6-22.5) mg/kg; Prediction concentration Zn (0.9-24.1) mg/kg. Concentrations Cu (0.35-8.55) mg/kg while predictions Cu (0.62-10.21) mg/kg. Concentrations of Fe (2.8-7.1) mg/kg. Prediction concentrations Fe (3.61-9.22) mg/kg. The benefits of prediction concentration of heavy metals in soil is crucial to finding solutions to contaminated soil in simple ways with primary treatment and acceptable measures for recycle waste factories. Loss of food security in the event of aggravated soil contamination with heavy metals.

Keywords: Heavy Metals; Brick Factories; Prediction; South Baghdad.

1. Introduction

The levels of heavy metals increase as a result of harmful substances in the atmosphere being deposited and the soil acts as a buffer for heavy metals, working to fix them in the soil [1]. The study [2] showed the sampling surface area industrial age 100 years to the smelter of copper was found that the contaminants to several sites around the smelter, residential location and the agricultural; the results of tests of heavy elements for each of lead, nickel, mercury, copper, manganese, and cadmium are respectively(230,260, 0.3, 0.2540, 1300, 53) mg/kg of soil and found that the contaminated area and a large area around the smelter diameter of 20 km and that the impact of this pollution on human health through the food chain. The study of [3] revealed the sites in Poland and secured from the results of tests of soil surrounding the sites of industrial and residential to that city on the proportions of contaminants relative to the background of the basic in that city where the study included both the pollutants cadmium, lead, copper and zinc (Cd, Pb, Cu, Zn) where ratios were respectively (61%,47%,49%,61%), and these ratios were high in the industrial areas and the city center and on the sides of highways.

Nomenclature & Symbols

Pb	Lead	Cd	Cadmium
Ni	Nickel	Cu	Copper
Fe	Iron	Zn	zinc
ANOVA	Analysis of Variance test	SPSS	Statistical program
PO_4	Phosphate	PH	Alkanet
N	Number of Samples	MSE	Mean Square Error
MAE	Mean Absolute Error	MAPE	Mean Absolute Percentage Error
Xt	Observation During Time	Pb1	Predict Value of Lead
Cd1	Predict Value of Cadmium	Ni1	Predict Value of Nickel
Zn1	Predict Value of Zinc	Cu1	Predict Value of Copper
Fe1	Predict Value of Iron	d	Consecutive Difference

The study [4] showed the agricultural areas near roads in the area of rapid traffic barrier in Saudi Arabia and soil samples were examined in-depth (0-10), (10-20) cm, where this study had shown that the concentration of the surface layer of heavy elements more like lead, cadmium, cobalt, nickel, chromium, vanadium and mercury, including that of the bottom layer of depth (10-20 cm). The study [5] in industrial areas as a result of the events and it's especially contaminated with heavy metals and their values were (Zn 508.6 mg / kg, Pb 384.8 mg / kg, Cd 7.53 mg / kg, Cu 356 mg / kg, As 44.6 mg / kg). The work at [6] was concluded Soil samples tobacco and agricultural areas near industrial areas where soil samples were collected and examined and analyzed and the results of the tests to the values of the heavy elements within the parameters of the European part of the global extent of pH (4.3-8.4), respectively, and were Zn (57), Cu (5-61), Mn (156-2231), Cd (0.030-0.93), Pb (3-47) mg/kg. The study of [7] was showed prediction values convergence with the series values and the model efficiency with 0.05 significance. The work of [8] was used Predict production and the development of future plans for the development of manufacturing processes. Various studies are conducted on the soil of the lands near the industrial zones and factories, but none of them are studied the prediction of the values of heavy metal. In[9] summarize the findings scattered in the literature regarding sources, impacts, indicators, risk assessment, remediation, and the future problems of heavy metals in relation to soil and human health, and to provide directions for the improvement of soil management and the development of effective pollution control strategies and Future research should be directed to the understanding of the biogeochemistry of heavy metalsin soils and their subsequent impacts on soil health, food security, and the living standards of human beings. Efforts need to be made to develop international standards for the diagnosis and management of heavy metal pollutions. further research integrating biotechnological approaches with comprehensive multidisciplinary research is needed to improve plant tolerance and reduce the accumulation of toxic metals in soils. This review discusses harmful effects, sources of heavy metals, and the remediation technologies for soil contaminated by heavy metals [10].

2. Study Area

The study area is located south-east of Baghdad as shown in fig. 1 zone 3. Most of the factories are brick factories. These factories throw a group of polluting gases and liquids into the air without having systems for treating as well as throwing solid waste in the neighboring and open lands without transporting it to the places where waste is collected. Black oil is the main fuel material, especially in local brick production. As a result of partial or complete combustion of black oil, carbon compounds, hydrocarbons, and sulfur are emitted.

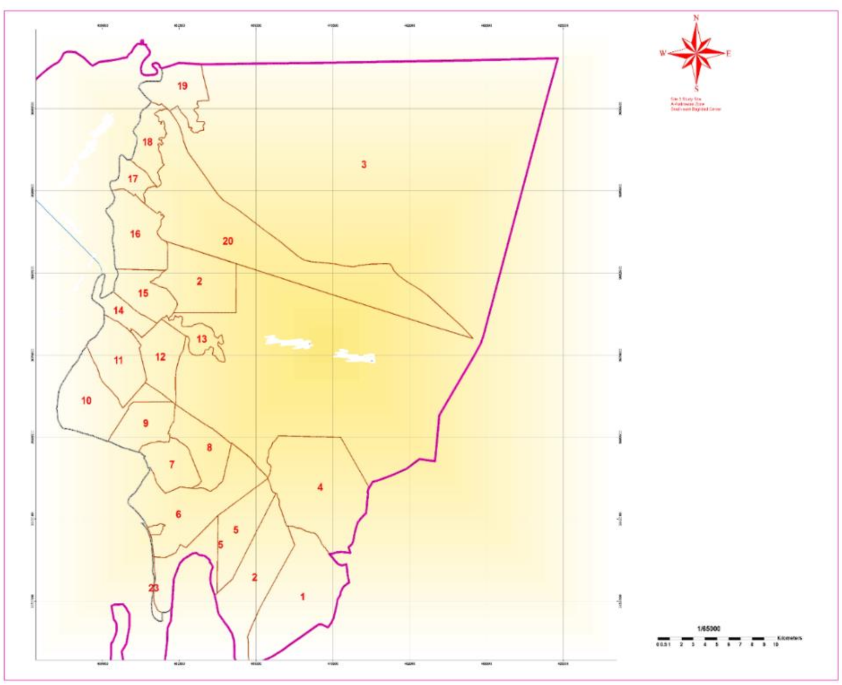

Fig 1. Location of study area from Baghdad, Qatha, al madian, Zone 3

3. Data Collection

Soil samples were taken randomly from nine sites around factories and waste, each hole is a square 15 * 15 with three depths of (0-10) (10-30), (30-50) cm, the soil extracted from the pits was placed in clean plastic bags and closed Well each of the depths individually. Soil samples were transferred to the laboratories of the Ministry of Environment in the Baghdad Environment Department. In Tables (1), (2), (3) the results of heavy metal concentrations were obtained for the three layers of lead (Pb), cadmium (Cd), nickel (Ni), zinc (Zn), copper (Cu) and iron (Fe); In addition to phosphates (PO_4) and (pH). The results obtained will be a database for that area.

Table 1 Data collection of the soil surface layer (10-0) cm, with each site

Metal	site (1)	site (2)	site (3)	site. (4)	site (5)	site (6)	site (7)	site (8)	site (9)
pH	7.43	6.7	8.13	7.39	7.3	7.26	6.89	6.9	6.8
Po_4mg/kg	1.5	4.9	1.3	3.3	7.2	4.8	2.7	5.1	9.4
Pb mg/kg	8.5	3.05	3.3	4	11	4.2	6.5	10.5	4.25
Cd mg/kg	0.15	0.05	0.1	0.3	0.15	0.15	0.05	0.1	0.1
Ni mg/kg	21	0.25	2.2	23	14.55	10.2	23.35	23.75	16.3
Zn mg/kg	8.5	0.3	0.4	9.85	15	3.95	5.25	13.05	12.4
Cu mg/kg	4	0.15	0.45	3.65	7.75	1.8	1.9	3.95	2.2
Fe mg/kg	207.5	200	100.9	2.5	125	173	162	132	99

Table 2 Data collection for the second layer depth (10-30 cm), with each site

Metal	site (1)	site (2)	site (3)	site. (4)	site (5)	site (6)	site (7)	site (8)	site (9)
pH	7.35	6.95	7.56	7.31	7.6	7.32	6.8	6.94	7.03
Po_4 mg/kg	29.9	10.7	20.2	11.7	10.9	9.1	20.1	19.4	19.4
Pb mg/kg	7.5	2.5	16.6	4.45	13	5	7.5	6.4	4.5
Cd mg/kg	0.2	0.05	0.15	0.1	0.2	0.2	0.15	0.1	0.15
Ni mg/kg	9.5	3	35	15.4	14.75	16.7	20.75	8.55	14.1
Zn mg/kg	3.1	0.6	12.4	6.15	22.5	10.4	3.15	2.75	12.15
Cu mg/kg	0.5	0.35	7.5	2.25	8.55	3.3	1.1	0.6	2
Fe mg/kg	3	3.2	5.2	7.1	2.8	3.3	5.5	5.01	6.2

Table 3 Data collection of soil tests third layer depth (30-50 cm) with each site

Metal	site (1)	site (2)	site (3)	site (4)	site (5)	site (6)	site (7)	site (8)	site (9)
pH	7.4	7.15	7.12	7.29	7.65	7.52	7.0	7.03	7.42
Po_4 mg/kg	24.6	0.11	5.6	2.8	7.2	0.22	3.1	0.33	0.3
Pb mg/kg	8	3.5	3.0	2.6	13.5	8.6	6.0	6.0	4.35
Cd mg/kg	0.1	0.05	0.1	0.2	0.25	0.25	0.1	0.1	0.15
Ni mg/kg	9.0	2.0	1.7	7.35	15.75	26.5	3.55	11.2	46
Zn mg/kg	2.8	0.2	0.7	0.6	19.5	17.35	0.4	1.85	36.5
Cu mg/kg	1.0	0.2	0.6	0.35	7.25	7.0	0.5	0.5	6.9
Fe mg/kg	0.5	0.5	0.2	0.3	0.25	0.41	0.32	0.23	0.5

4. Methodology

Research methodology for this study by using a flowchart to illustrate the steps before getting into the details as below.

Analysis of variance test for average soil layers

F test and Signification difference (Sign.) value determination

Sign.>0.05

There are no influencing factors

Sign<0.05

Determine the influencing factors.

Multiple comparisons and Least Square differences (LSD) method.

The relationship between heavy metals will be shown for each layer of soil.

Identify the most polluted layer of soil by MSE, MAE, MAPE.

Use Minitab.

Predicting the future values of heavy metals by Time Series.

Analysis of Variance (ANOVA) test, is used to compare the averages of three or more samples that follow one or more independent variables, and it depends on the following steps: Establishing statistical hypotheses in the following manner (table 4):

H0: μ1 = μ2 = μ3 the null hypothesis (1)

H1: μ1 ≠ μ2 ≠ 3 Alternative Hypothesis (2)

Table 4 Analysis of Variance

Variance sources	Sum Squares	Degree freedom(df)	Variance	F
Between groups	$SSB=\sum\frac{T_k^2}{n_k}-\frac{T^2}{N}$ (3)	K-1	$S_B^2=\frac{SSB}{K-1}$ (6)	$F=\frac{S_B^2}{S_W^2}$ (8)
Inter groups	$SSW=\sum_{K=1}^{K}\sum_{i=1}^{n}X_{Ki}^2-\frac{T_K^2}{n_K}$ (4)	N-K	$S_W^2=\frac{SSW}{N-K}$ (7)	
Sum	$SST=\sum_{K=1}^{K}\sum_{i=1}^{n}X_{Ki}^2-\frac{T^2}{N}$ (5)	N-1		

μ1, μ2, μ3: average each test within soil layer
K: represents the number of samples K = 1,2,3
T^2_k: represents the sum of squares of sample K
n_K: represents the sample size K
T: Represents the overall sum of the sample views
N: represents the total number of observations
X^2_{Ki}: represents the square of the values of the observations in each of the samples
F: Fisher's test of more than two groups
df: degree freedom

Using the SPSS software version (18) Results obtained from Pb, Cd, Ni, Zn, Cu, Fe, PO_4, pH, the resulting significant value in (ANOVA) table is compared with 0.05, if it appears that it is less than 0.05, meaning that there are significant differences for the averages of the nine tests in same layer, in other words, the Mean difference of the two tests is not equal. The test show that, the significance differences Least Square Difference (LSD) method of Multiple Comparisons. The program Minitab version (16) was used to draw the time series for all the tests The first consecutive difference was taken (d = 1) to achieve stability in the arithmetic mean, as well as taking Logarithmic conversion to make the series stable in variance, then choosing Auto regressive models and stationary averages consistent with the data. The prediction process was by using, The independent component analysis is used to find the regression equation with the desired regression coefficients, as well as to get rid of the problem of multiple linear relationships between the independent variables, with the following steps; Finding components that are qualified to explain the total variance of the original values and are orthogonal between them Pci to replace the original variables and thus get rid of the problem of multiple linear relationships between the values of the original variables Xi. Find the characteristic vector values(aij) of the covariance and covariance matrix and then find the characteristic equation which is polynomial, Result the distinct roots and arrange them so that they are:

λ1> λ2> λ3> ----> λn> 0 (10)
Values, the characteristic vector corresponding to the characteristic roots so that get:
$PCi = a_{1j} X_1 + a_{2j} X_2$ +------- - + $a_{mj} X_m = X_{ai}$ (11)
The multiple regression equation, which is used in prediction, is obtained as follows:
$Yi = V0 + V1\ Pc_1 + V2\ Pc_2$ (12)
V0, V1, V2= Regression coefficients.

5. Results and Discussion

5.1. Heavy metals concentration Analysis

Atmospheric deposits and the disposal of a variety of wastes on land have recently been found to increase a range of biologically important metals in soils, sometimes to harmful levels. Soil acts as a buffer by controlling the bioavailability and transport of toxic substances in the environment. Many contaminants are thus immobilized by soil, and the risk to ecosystem health is therefore reduced. The concentration of heavy metals is associated with biological and geological cycles [11]. Tables (1), (2), (3) shows the results of tests of soil samples from three layer; the first layer depths (0-10), the second (10-30), and third layer (30-50) cm respectively.
pH**:** The pH of the study sites ranged from (6.7-8.13) at first layer and increased in third layer (7- 7.65) while range second layer (7-7.03), low pH in the surface soil indicates the affected industry [12] Decreasing soil PH conditions increase the solubilization of metals [13]. Range of pH (6-8) where nutrient availability to the plant is optimal [14].
PO_4^{-3}**:** Concentration range of PO_4 in surface layer recorded (1.3-9.4) mg/kg, second layer recorded (9.1-29.9) and rang third layer (0.3-24.6), shows the second layer has a higher phosphate concentration than the first and third layers, this indicates that the fertilizer added from recently been plowed, note that the parameters are different for this factor from one region to another depending on the type of soil [12]. Phosphorus is the second most important crop nutrient. It is an essential macronutrient that plays important role in all crop biochemical [15].
Pb: Concentrations rang of lead recorded (3.05-8.5) (2.5-16.6), (2.6-13.5) mg/kg surface, second and third layer respectively, Pb was below the [16] permissible limit (50) mg/kg for soil. Considered the lead of the elements to be pursued because of the danger that lies on humans.

[17] Recommended that all Lead-related industries and markets should be far enough from human living to avoid environmental lead pollution.
Cd: Cadmium concentration for all layers and depths was recorded at a value less than 3 mg / kg of the limit for [16].
Ni: Concentrations of nickel recorded at surface layer (0.05-0.15), second layer recorded (0.05-0.2) and third layer (0.05-0.25) mg/kg; all concentration below permissible limit [16] of 50 mg/kg. "Nickel is generally uniformly distributed in the soil profile and typical soil nickel contents vary widely based on the parent rock, with elevated levels at surface soils been associated with soil-forming processes and anthropogenic contamination principally ascribed to agricultural and industrial activities, toxicity symptoms that may arise from the presence of too little or too much nickel is also interest" [18].
Zn: Concentration zinc range (0.3-15) in surface layer in second range (0.6-22.5) third layer (0.2-36.5) mg/kg, all concentrations were below permissible limit [16] of 300 mg/kg for soil." Zinc is an essential element in photosynthesis and its deficiency may play a reduction in the rate of photosynthesis in plants"[19].
Cu: Surface layer recorded concentration of Copper (0.15-7.75) mg/kg, in second layer recorded (0.35-8.55), rang concentration in third layer (0.2-7.25), all sites recorded below the [16] permissible limit of 100 mg/kg.
Fe: the surface layer recorded a concentration of (2.5-207.5) mg / kg, the second layer recorded (2.8-7.1), the third layer recorded (0.2-0.5). There is no permissible limit for this heavy metal. High concentrations of iron are considered non-toxic specially to soils with good aeration, as shown in table 5 [20].

Table 5 Permission Limits of WHO / FAO (2001) [16]

Heavy metal	**mg/kg**
cadmium	3
copper	100
nickel	50
lead	50
zinc	300

5.2. Multi Comparison and Least square differences

In the ANOVA Table (6) there is significant differences between the averages of the tests in the surface layer, table (7) there is significant differences between the averages of the tests in second and in table (8) there is significant differences between the averages of the tests in third layer of soil; that means of at least two tests were not equal. The ANOVA test showed that all layers of all the sites examined had an impact on the environment because the significance test (Sig) was less than 5%.

Table 6 ANOVA signification(sig.) <0.05surface layer

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	128878.600	7	18411.229	35.895	.000
Within Groups	32826.516	64	512.914		
Total	161705.116	71			

Table 7 ANOVA signification(sig.) <0.05second layer

	Sum of Square	df	Mean Square	F	Sig.
Between Groups	2080.372	7	297.196	11.445	.000
Within Groups	1661.969	64	25.968		
Total	3742.341	71			

Table 8 ANOVA signification(sig.) <0.05third layer

	Sum of Square	df	Mean Square	F	Sig.
Between Groups	1306.363	7	186.623	3.271	.005
Within Groups	3651.245	64	57.051		
Total	4957.608	71			

In tables (9), (10) and (11) the method of least square differences (LSD) was used for multiple comparisons. The use of the LSD method has the advantage that only significant and influential values appear within the table with an asterisk at the top.
Excluding PH and PO_4 because they are not heavy metals for tables (9), (10) and (11), in table (9) the LSD method showed, Fe has a significant significant difference in the effect and a clear association of this heavy element with all heavy metals of the surface layer of soil (Pb) 127,389), Cd (133,417), Ni (118,589), Zn (125.911), Cu (130,672). Fe is a heavy metal that has an effect on the surface layer.
Table (10) shows that there are significant differences for all heavy metals (Pb, Cd, Ni, Zn, Cu, Fe) in the second layer and for all sites. Since there is a significant difference for these heavy elements, therefore, the heavy metals present in the layer have an impact on the environment and the ocean in which they are located, and as a result, they affect the environment. The numerical values in the table, whether negative or positive, have a large or small value, which is evidence that they have an environmental impact.
In Table (11) the LSD test showed a significant difference for heavy metals in the third layer of soil and for all sites Pb, Cd, Cu, Ni, Fe,.Zn.

The three tables showed that the three layers of soil have a significant difference, that is, there is an interrelationship and an effect between them on the one hand and on the other hand their impact on the environment. All soil layers showed their influence on heavy metals through the values found in LSD tables.

Table 9 Differences signification in surface layer

Test	N	Subset for alpha (sig. level) = 0.05							
		PH	PO_4	Pb	Cd	Ni	Zn	Cu	Fe
PH	9		126.344*	129.077*	127.389*	133.417*	118.589*	125.911*	130.672*
PO_4	9								
Pb	9								
Cd	9								
Ni	9								
Zn	9								
Cu	9								
Fe	9	126.344*	129.077*	127.389*	133.417*	118.589*	125.911*	130.672*	

Table 10 Differences signification in second layer

Test	N	Subset for alpha = 0.05							
		PH	PO_4	Pb	Cd	Ni	Zn	Cu	Fe
PH	9		-9.6155*		7.06222*	7.06222*			
PO_4	9	9.61556*		9.32778*	16.6778*		8.68889*	13.9167*	12.2322*
Pb	9		-9.32778*		7.3500*	-7.81111*			
Cd	9	-7.06222*	-16.6778*	-7.35000*		-15.1611*	-7.98889*		
Ni	9	8.09889*		7.81118*	15.1611*		7.17222*	12.4000*	10.7156*
Zn	9		-8.68889*		7.98889*	*-7.17222*		5.22778*	
Cu	9		-13.9167*			-12.4000*	-5.22778*		
Fe	9		-12.2322*			-10.7155*			

Table 11 Differences signification in third layer

Test	N	Subset for alpha = 0.05							
		PH	PO_4	Pb	Cd	Ni	Zn	Cu	Fe
PH	9				7.14222*				
PO_4	9					-8.75444*			
Pb	9					-7.5000*			
Cd	9	-7.14222*				-13.5277*	-8.73333*		
Ni	9		8.75444*	7.50000*	13.5277*			10.9722*	
Zn	9				8.73333*				8.52111*
Cu	9					-10.9722*			
Fe	9					-13.3155*	-8.5211*		

Table (12) Simple comparison between the three soil layers using of mean square error (MSE), mean absolute error (MAE) and mean absolute percentage error (MAPE). The table shows that the second layer has the highest values MSE=24.432, MAE=1.164, MAPE=96.21; the second layer of soil is the worst because of its contamination more than the other two layers.

Table 12 MSE, MAE, MAPE for three soil layers

Layers	MSE	MAE	MAPE
Surface layer	1.136	0.416	9.13
Second layer	24.432	1.164	96.21
Third layer	5.612	0.571	10.38

5.3. Prediction

The Time Series is the set of observations of Xt that occurred during time t, which can be written in the form of the amount of time, X1, X2, Xn, where X1 is the observation of time t1, and so on for the rest of the values. The purpose of analyzing the time series data is to predict the future value that enables decision makers to take the appropriate solution [21]. The prediction values for heavy elements present in the second layer of soil are acceptable due to industrial activity and random agricultural activity, table 13. Values for heavy metals only in second layer in from fig. 2 to fig. 7.

Table 13 Predict values second layer to nine sites for all tests

Sites	PH	PO_4	Pb	Cd	Ni	Zn	Cu	Fe
1	8.01	31.23	8.11	0.31	11.04	4.21	1.12	3.9
2	7.32	12.45	3.15	0.09	4.41	0.9	0.62	4.21
3	8.34	23.13	17.35	0.25	37.08	14.11	8.31	7.08
4	8.83	11.86	4.89	0.09	16.22	7.78	4.21	9.22
5	9.22	13.12	15.01	0.28	16.61	24.1	10.21	3.61
6	8.79	8.22	6.13	0. 27	18.19	13.31	4.05	4.1
7	7.43	21.38	9.21	0.31	23.09	5.02	1.73	6.84
8	8.21	21.03	7.41	0.27	11.1	4.36	0.9	7.07
9	9.03	20.84	6.10	0.21	15.85	15.86	3.19	7.81

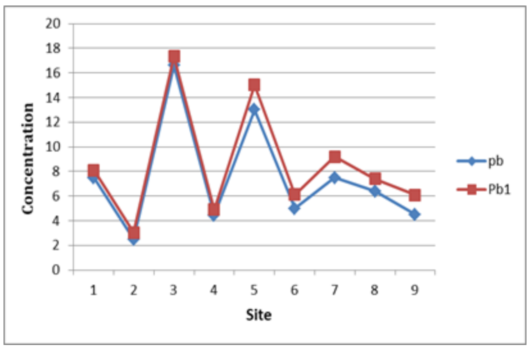

Fig 2. Variation of Pb test value, Pb1 predict value

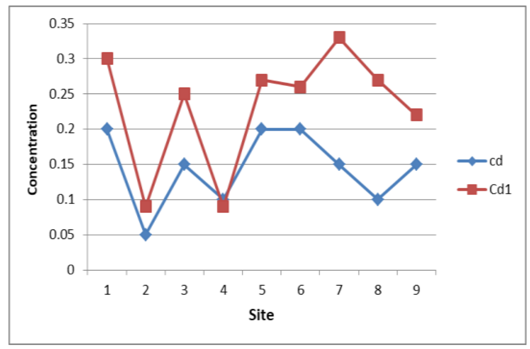

Fig 3. Variation of Cd test value, Cd1 predict value

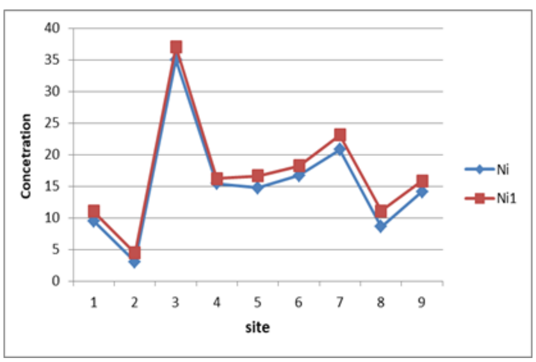

Fig 4. Variation of Ni test value, Ni1 predict value

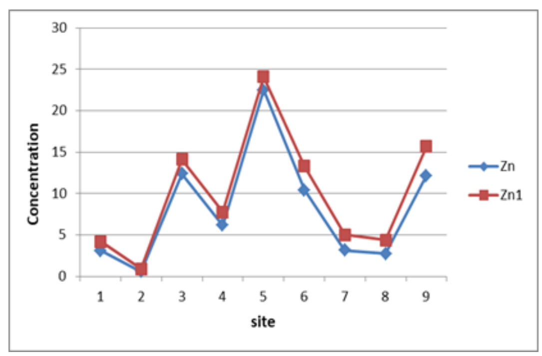

Fig 5. Variation of Zn test value, Zn1 predict value

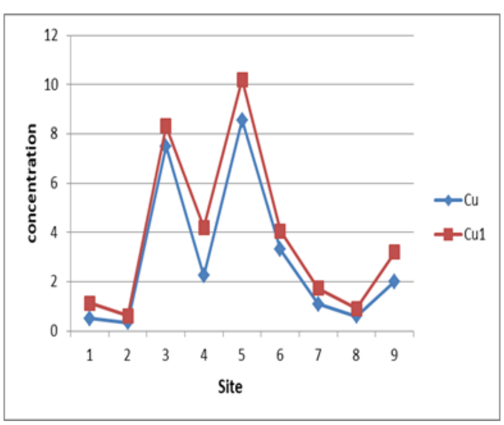

Fig 6. Variation of Cu test value, Cu1 predict value

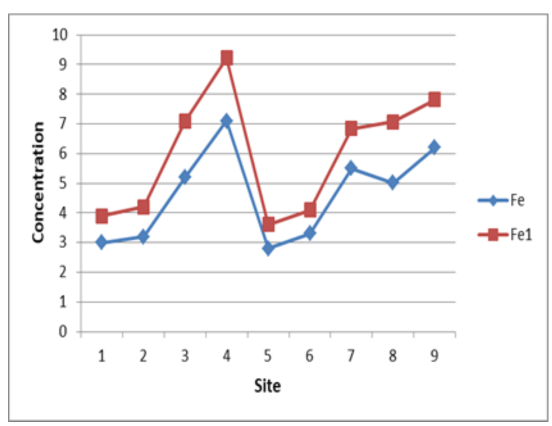

Fig 7. Variation of Fe test value, Fe1 predict value

6. Conclusion

Soil samples from random sites around the brick factories showed that the second layer had a significant difference for all heavy metals with each other even though no heavy metal exceeded the permissible limits. The predicted values showed consistency with the real values. Soil samples from random sites around the brick factories showed that the first layer has a significant difference in Fe with the rest of the heavy metals. This indicates the burning of waste containing Fe. The use of fertilizers of all kinds of agricultural activities in the lands surrounding the brick factories naturally contributes to the increase of heavy metals with a high concentration in the second layer of soil and a lesser effect in the third layer. There is another reason for the pollution of cultivated soil sites, especially because it is irrigated from wastewater contaminated with industrial and human wastes, and over time it is dangerous for crops to accumulate heavy metals as it becomes toxic.

7. Recommendations

Treat the polluted air from brick factory chimneys with treatment systems. Treating plantation irrigation water before using it. The need to use organic fertilizers to reduce the heavy metal load on the soil. Using statistical software and linking it to engineering issues, as it proved its accuracy and clarity.

Acknowledgement

I extend my sincere thanks to everyone who helped complete research, especially Dr. Mustafa Tariq and staff of Ministry of Environment - Baghdad Environment Department OF LABORATORIES.

Reference

[1] M.L. Berrow, J.C. Burridge (1979) *Proc. Int. Conf.*, London, CEP Consultants Ltd., Edinburgh, 304.
[2] Djordje nikolić1 *, Novica milošević, živan živković1, Ivan Nenad, Mihajlovic (2011) ". Multi-criteria analysis of soil pollution by heavy metals in the vicinity of the Copper Smelting Plant in Bor (Serbia)", J. Serbian Chem . Soc. 76 (4) 625—641.
[3] W. Grzebisz1, L. Cieśla2, J. Komisarek3, J. Potarzycki1 (2002), "Geochemical Assessment of Heavy Metals Pollution of Urban Soils", Polish Journal of Environmental Studies Vol. 11, No. 5 493-499.
[4] Sana'a Odat [1] and Ahmed M. Alshammari [2], (2011) "Spacial Distribution of Soil Pollution along the Main Highways in Hail City, Saudi Arabia", Jordan Journal of Civil Engineering, Volume 5, No. 2.
[5] LIAO Guo-li, LIAO Da-xue, LI Quan-ming, (2007) "Heavy metals contamination characteristics in the soil of different mining activity zones", Mine Safety Technology Institute, China Academy of Safety Science & Technology.
[6] K. Mitsios, e. E. Golia and C. D. Tsadilas, (2007), "Heavy metal concentrations in soils and irrigation waters in Thessaly region, central Greece"Wiky Online Library,Journal of the Science of Food and agriculture.
[7] Shehab Ahmed Ammar (2017) "Use time series to predict how much of Iraq's oil exports for the year 2016-2017."Dental Medicine / University of Baghdad College of Economic Sciences Journal, Issue 52.
[8] Sahar A.S.Ibrahim, Rania F, Mahmoud "PREDICTING TOMATO CROP PRODUCTION" Cent.Lab. for design and stat.Analysis Res., ARC EGYPT.J.Agric.Res., 95 (1), 2017.
[9] Santanu Bakshi Zhenli He. Chumki Banik," The impact of heavy metal contamination on soil health"https://www.researchgate.net/publication/32689489,Chapter 2019.
[10] Changfeng Li,Kehai Zhou,Wenqiang Qin,Changjiu Tian,Miao Qi"A Review on Heavy Metals Contamination in Soil: Effects, Sources, and Remediation Techniques"Soil and Sediment Contamination:An International Journal,Vol.28,2019,Issue 4,pages 380_394.
[11] Ana-MariaRusu,William Dubbin, Nicolae Har, Katalin Bartok,Willam Purvis,Bin Williamson(2000)"Heavy Metal Soil Content as an indicator of pollution"Studia Universitis Babes-Rolyal,Geologia,XL V,1.
[12] Gary M .. Berzinski, c. Thomas Sims, George F. Vance. (2003), "Land and environmental quality," the national project for translation.
[13] Angamuthu Manikandan, (2005) "Heavy metal pollution in soil." research gate, ICAR-Central Institute for Cotton Research.
[14] Steve Grattan, AL Auchli, (2012) "Soil pH Extremes" Publisher CAB International, In Book "Plant stress".
[15] Esther Mwenda, (2019) "Understanding Soil Phosphorus" International Journal of plant and soil science.
[16] WHO / FAO (2001) Codex Alimentarius commission Food additives and contaminants.Joint FAO / WHO Food Standards Program, ALINORM 10/12A.Retrieved from www.transpaktrading.com/static/pdf/research/achemistry/intro To fertilizers.pdf.
[17] Abdirashid Adam Isak (2019) "Determination of lead in soil" International Journal of Scientific and Engineering Research Vol. 10, Issue 5, May, Issn: 2229-5518.
[18] Yahaya Iyaka "Nickel in Soil" (2011) A review of its distribution and impacts, Scientific research and Essays 6 (33).
[19] Shaon Kumar, Ravikant Avasthe, Matber Singh, Sudip Kumar (2018) "Zinc in plant -Soil system and management strategy" Indian Council of Agricultural Research, Research Complex for NEH Region.
[20] Shehab Ahmed Fadel glorious and unique festival (2008), "contamination of the soil." Dar Yazori for publication and distribution. Amman - Jordan.
[21] Peter J.Brockwell ,Richard A.Davis(2001),"Introduction to Time Series and Forecasting",Second Editing Springer-Verlag New York,Inc