# ESTIMATE THE POLLUTION IN DIYALA SOILS USING INTERPOLATION METHOD

**L. N. M. Tawfiq*** **I. N. Abood****

## ABSTRACT

**The aim of this paper is to estimate the rate of contaminated soils by using suitable interpolation method as an alternative accurate tool to evaluate the concentration of heavy metals in soil. In particular, interpolation methods are extensively applied in the models of the different phenomena where experimental data must be used in computer studies where expressions of those data are required.**

**In this paper the Newton divided difference method is used and extended in two dimensions to solve suggested problem. Then, the modification method is applied to estimate the rate of contaminated soils in Diyala Governorate, in Iraq.**

## INTRODUCTIO

**A particular and important aspect in the numerical methods subject is the approximation of the different values, operation designated as interpolation, which is employed in most of the branches of the science, such as: engineering Oanta (9), economics Oanta (10), etc.**

**The problems of polynomial interpolation and approximate the functions of several independent variables are important but the methods are less well developed than in the case of functions of a single variable. An immediate indication of the difficulties inherent in the higher dimensional case can be seen in the lack of uniqueness in the general interpolation problem. In many problems in engineering and science, the data consist of sets of discrete points, being required approximating functions which must have the following properties:**

- **The approximating function should be easy to determine;**
- **It should be easy to evaluate;**
- **It should be easy to differentiate;**
- **It should be easy to integrate.**

**It can be noticed that polynomials satisfy all four these properties, moreover it have many important properties say: continuity and orthogonally.**

**The study of interpolation method and its applications in contamination of soil by heavy metals are firstly beginning with Tawfiq, et al. (11 and 13). In this paper the extending of Newton divided difference method in two dimension are proposed then applied to estimate the concentration of heavy metals in Diyala government in Iraq, then estimate the rate of contamination in that soil.**

## Polynomial Interpolation

**The interpolation can be performed by approximating the unknown law of variation with an analytical function. The problem of function approximation arise when are known only the numerical values of function or when the function is very complicated. Generally, a problem solved by interpolation approximation can be formulated as: let f :A→ B; A , B non null sub set from real sets, we suppose known the value $y_i$ of function f on given data points $x_i \in A$. That means $f(x_i) = y_i$, i= 0,1,...,n . We must find a real interpolation function F, which has to**

* College of Education for Pure Sci. Ibn Al-Haitham, Baghdad Univ., Baghdad,Iraq.
** College of Diala, Diala Univ., Diala,Iraq.

satisfy the following conditions:

$F(x_i) = y_i$ , i = 0,...,n. Geometrically, we have to find a curve by equation y = F(x), which should pass through the points $x_i$, i= 1, …,n.

The theoretical base of polynomial approximation is the Weierstrass theorem (4). This theorem shows that any continuous function can be approximated with accuracy on an interval, using a polynomial function. The interpolation polynomial function is unique for a function on any given interval. The most know methods for polynomial interpolation are: Lagrange, Newton, Hermite, Birkhoff polynomial interpolation, trigonometric and rational interpolation (for details see (4 and 5)). In this paper we suggest Newton divided difference method to solve suggested problem.

## Newton Divided Difference Method

Let f(x) be a continuous function given at the distinct point $x_i$, i= 0,1,2,…,n, define the zeros divided difference of the function f with respect to $x_i$ denoted $f[x_i]$ by

$f[x_i] = f(x_i)$, The first divided difference of the function f with respect to $x_i$ and $x_{i+1}$ denoted $f[x_0, x_1]$ and is defined as (4):

$$f[x_0, x_1] = \frac{f[x_1] - f[x_0]}{x_1 - x_0}$$

The second divided difference denoted $f[x_i, x_{i+1}, x_{i+2}]$ and is defined as:

$$f[x_0, x_1, x_2] = \frac{f[x_1, x_2] - f[x_0, x_1]}{x_2 - x_0}$$

Similarly the nth divided difference relative to $x_0, x_1, \ldots, x_{n-1}, x_n$, is given by

$$f[x_0, x_1, \ldots\ldots, x_{n-1}, x_n] = \frac{f[x_1, x_2, \ldots\ldots, x_n] - f[x_0, x_1, \ldots\ldots, x_{n-1}]}{x_n - x_0}$$

The value of $f[x_0, x_1, \ldots\ldots, x_n]$ is independent of the order number $x_0, \ldots\ldots, x_n$.

i.e., if i= 0, 1, 2, then $f[x_o, x_1, x_2] = f[x_1, x_0, x_2] = f[x_2, x_1, x_0]$

## Materials and Methods

### Sampling

Diyala governorate located in the middle of Iraq (Figure 1), its area about (17685 $km^2$) and represents (4.1 %) from the area of Iraq, consist of 19 administrative units, Figure 2, illustrate the area of study, The 20 soil samples were collected with depth (0- 10 cm) using iron shovel (the quantity of each sample was 1 kg), isolation of foreign materials such as plant leaves, debris etc. were removed from the collected soil samples then all the samples were put in plastic bags to measure the concentration of heavy metals (Cd, Co, Cr, Fe, Ni, Pb and Zn).

The samples are carefully collected from each source area in different land using types with a stainless steel spatula. They were air–dried in the laboratory, homogenized and sieved through a 2mm polyethylene sieve to remove large debris, stones and pebbles, after they were disaggregated with a porcelain pestle and mortar. Then these samples were stored in clean self–sealing plastic bags for further analysis. Metal determinations were done by X– ray fluorescence analysis (XRF).

These samples represent the initial data which used to get interpolation function that is substituting in divided difference formula (9).

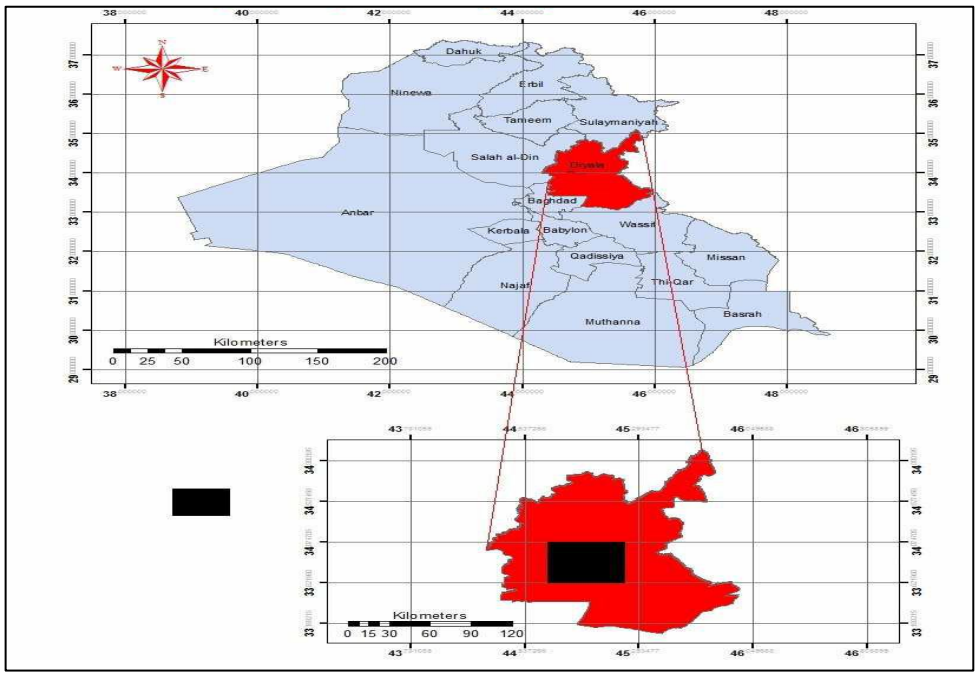


**Fig. 1: Map of Iraq illustrate Diyala Governorate.**

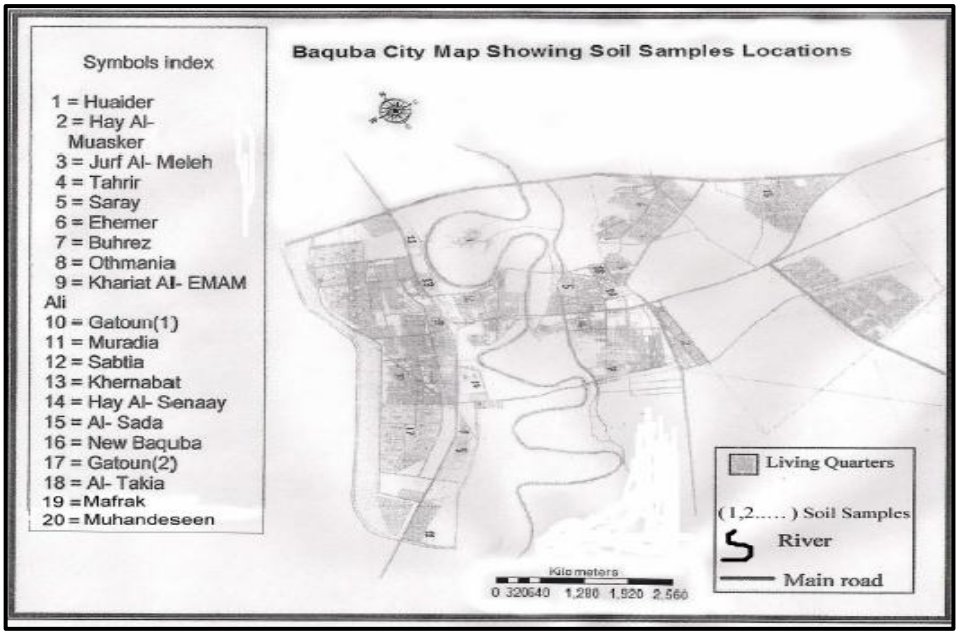


**Figure 2: illustrate the area of study and soil samples locations**

## Results and Discussion

The data obtained from laboratory dissecting represent the concentration of heavy metals for selected soils which compared with standard universal for concentration of heavy metals in soil depending on (1) to knowledge the rate of contamination in soil in that time and given in Table (1). Then the laboratory data are substituting in the equation (9) to get the concentration of heavy metals in those soil for any times and any neighboring area, so we can

estimate the rate of contamination in that soil for any times and any neighboring area without laboratory dissecting.

Figure (3) illustrate the results of interpolation by suggested method for each metal. Figure 4, illustrate the accuracy of suggested method by using a comparison between the results of suggested method, laboratory dissecting and standard universal.

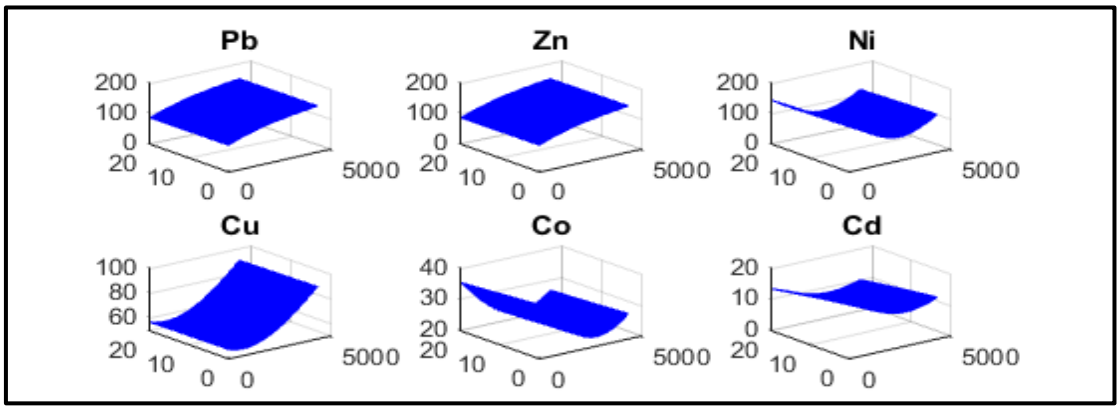


Figure 3: Results of interpolation by suggested method for Diyala Soils.

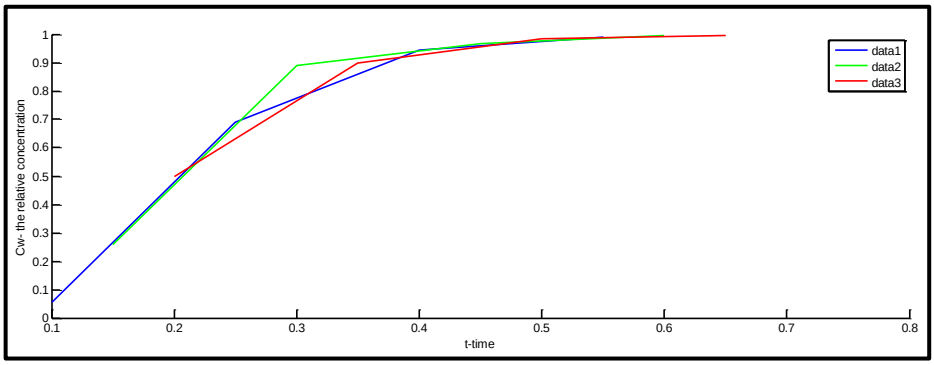


Figure 4: Comparison between suggested method (data2), laboratory dissecting (data3), and standard universal (data1).

## Cadmium

The concentration of Cadmium (Cd) in the soil samples was ranging (1-4.2ppm) with a mean (2.4 ppm), it was within the range in the soil (5 ppm). Highest value of Cd was in the sample of (Mafrak, see Table 1, and Fig.3). Increasing of Cd due to the incineration of plastic materials that can cause an increasing of Cd concentration in the atmosphere then accumulates on the soil.

## Cobalt

The concentration of Cobalt (Co) in this study ranging (11- 17ppm) with mean (13.8ppm) the mean was within the range in the soil. The highest values were in the samples of (Khariat Al- Emam Ali and Gatoun (9), see Table 1 and Fig.3). Increasing in the concentration of Co in the soil affected by different factors: the origin and the formation of the soil, weathering processes, anthropogenic activities, in addition to sewage water.

**Table 1: The concentration of the studied heavy metals in the soil of Diyala city**

| No | Cities of Baquba | Measures of heavy metals | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd (SMC=1) | | Co (S.M.C=1) | | Cr (S.M.C=100) | | Fe (S.M.C=38000) | | Zn (S.M.C=70) | | Ni (S.M.C=50) | | pb (S.M.C=50) | |
| | | Conc. | Poll Am. | Conc. | Poll Am. | Conc. | Poll Am. | Conc. | Poll Am. | Conc. | Poll Am. | Conc. | Poll Am. | Conc. | Poll Am. |
| 1 | Al Huaider | 2.5 | 1.5 | 14 | 13 | 127 | 27 | 16040 | -21960 | 111 | 41 | 126 | 76 | 75 | 25 |
| 2 | Hay Al-Muasker | 1.8 | 0.8 | 12 | 11 | 119 | 19 | 24750 | -13250 | 121 | 51 | 121 | 71 | 128 | 78 |
| 3 | Jurf Al-Meleh | 1.5 | 0.5 | 13.5 | 12.5 | 275 | 175 | 26600 | -11400 | 96 | 26 | 58 | 8 | 17 | -33 |
| 4 | Tahrir | 2 | 1 | 15 | 14 | 118 | 18 | 16500 | -21500 | 98 | 28 | 126 | 76 | 45 | -5 |
| 5 | Al-Saray | 1.3 | 0.3 | 11 | 10 | 146 | 46 | 1733 | -20670 | 82 | 12 | 123 | 73 | 56 | 6 |
| 6 | Al-Ehemer | 1 | 0 | 12.2 | 11.2 | 101 | 1 | 21223 | -16777 | 83 | 13 | 127 | 77 | 38 | -12 |
| 7 | Buhrez | 2.7 | 1.7 | 12.5 | 11.5 | 105 | 5 | 23202 | -14798 | 156 | 86 | 100 | 50 | 83 | 33 |
| 8 | A -Iothmania | 2.9 | 1.9 | 13 | 12 | 111 | 11 | 25801 | -12199 | 122 | 52 | 188 | 68 | 91 | 41 |
| 9 | Khariat Al-EMAM ALI | 3 | 2 | 17 | 16 | 191 | 91 | 15304 | -22696 | 104 | 34 | 115 | 65 | 48 | -2 |
| 10 | Gatoun (I) | 2.1 | 1.1 | 13 | 12 | 229 | 129 | 24262 | -13738 | 99 | 29 | 178 | 128 | 47 | -3 |
| 11 | Muradia | 3.2 | 2.2 | 11 | 10 | 122 | 22 | 20998 | -17002 | 86 | 16 | 134 | 84 | 85 | 35 |
| 12 | Sabtia | 2.2 | 1.2 | 16 | 15 | 115 | 15 | 21325 | -16675 | 80 | 10 | 108 | 58 | 21 | -29 |
| 13 | Khernabat | 2 | 1 | 14 | 13 | 112 | 12 | 16878 | -21122 | 91 | 21 | 111 | 61 | 32 | -18 |
| 14 | Hay Al-Senaay | 1.1 | 0.1 | 12 | 11 | 100 | 0 | 18543 | -19457 | 83 | 13 | 98 | 48 | 24 | -26 |
| 15 | Al-Sada | 2.3 | 1.3 | 15 | 14 | 96 | -4 | 19664 | -18336 | 94 | 24 | 103 | 53 | 15 | -35 |
| 16 | New Baquba | 2.5 | 1.5 | 14.5 | 13.5 | 121 | 21 | 18774 | -19226 | 97 | 27 | 93 | 43 | 33 | -17 |
| 17 | Gatoun (2) | 2.6 | 1.6 | 13.3 | 12.3 | 133 | 33 | 23546 | -14454 | 103 | 33 | 87 | 37 | 21 | -29 |
| 18 | Al-takia | 3.5 | 2.5 | 15.5 | 14.5 | 116 | 16 | 29885 | -8115 | 90 | 20 | 83 | 33 | 42 | -8 |
| 19 | Mafrak | 4.2 | 3.2 | 16 | 15 | 97 | -3 | 27353 | -10647 | 88 | 18 | 103 | 53 | 68 | 18 |
| 20 | Al-Muhandeseed | 3.6 | 2.6 | 15 | 14 | 124 | 24 | 22654 | -15346 | 92 | 22 | 115 | 63 | 77 | 27 |

**Pb and Zn at levels above the background concentration in the international soils, which may give rise to various health hazards, while the concentrations of Cd, Co and Fe were under the background concentration in soil. The study of factors pH, that controlling the distribution of heavy metals in soil showed that these factors didn't influence on the concentration of heavy metals in the soil samples which reveal the anthropogenic activities role in increasing of the concentration of some heavy metals in the soil of Diyala government, in addition the practical results showed the suggested method is easy implemented, high accuracy, efficient and rapid compared to other method.**

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# تخمين التلوث في تربة محافظة ديالى باستخدام طرق الإندراج

لمى ناجي محمد توفيق اسراء نجم عبود

## الملخص

الهدف من البحث هو تخمين نسبة التلوث في تربة محافظة ديالى بالمعادن الثقيلة باستخدام طرق عددية مناسبة. للعمل تم من خلال تحديد تراكيز المعادن الثقيلة في التربة ضمن منطقة الدراسة من خلال الفحوص المختبرية و مقارنتها بالقيم والمحددات العالمية، لغرض تحديد نسبة التلوث ثم استخدام تلك العينات لتصميم انموذج رياضي باستخدام طريقة نيوتن للفروق المنتهية وتطويرها بحيث يتم من خلالها تحديد قيم تراكيز المعادن الثقيلة في تلك التربة أو أية عينة أخرى و في أي وقت واي عمق في التربة لتحديد مدى تلوث التربة بتلك المعادن دون استخدام الفحوص المختبرية التي تُعدُّ مكلفة وفي أوقات تكون تلك الأجهزة غير متوفرة.

* كلية التربية للعلوم الصرفة ابن الهيثم ، جامعة بغداد،بغداد العراق.

** كلية العلوم ، جامعة ديالى ، ،ديالى ،العراق.