

## **Evaluation of Soil pollution by heavy metals in Baghdad city using GIS**

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### **Abstract**

*12 stations located selected on different parts of the city of Baghdad for the purpose of collecting samples of soil. The stations have been distributed on a regular basis so as to cover most areas of the city, with a focus on the type of each area as commercial, industrial or domestic, and then we were analyzed to determine concentrations of heavy metals contaminated. The study showed that concentrations of lead in soil samples in the city of Baghdad has exceeded the permissible limits of locally and globally, then the results also showed that zinc concentrations in the soil of the region did not exceed the permissible limits, while it was observed by measuring the concentrations of Cu, Co, Ni, Cd it had gone too far allowed, which indicates the presence of contamination with these elements in the soil of the city of Baghdad.*

*The reason high concentrations of heavy metals in the soil of the region to the impact of divorced and industrial plants, such as brick factories and smelters, as well as the impact of divorced vehicles due to combustion. As well as other industrial activities play a vital role in increasing concentrations of these elements, but by less than past years due to the closure of several of these actors to work due to war conditions in which the country, as well as the impact of adsorption by clay minerals and the presence of organic matter in soil, which plays a different role in increasing concentrations of these elements as well as the weathering and irrigation and drainage.*

*The environmental maps created using Geographic Information System (GIS) during the study to the concentrations of trace elements in the soil of the city of Baghdad, the conclusion that the city soil contaminated with elements Cd, Ni, Co, Cu, Pb, because the results refer to the high concentrations comprise with global limits.*

### **1. Introduction**

Environmental pollution is unwanted changes, which you get fully or largely as a product of accidental natural and human events through the direct impact of changes in the form of energy and the level of radiation, physical and chemical components and, or that these changes may affect humans directly or indirectly as a result of water use and agriculture and industry. Pollution is also known that any change in the natural conditions of air, water, soil, whose impact is not limited to humans, but also include animal and plant life which wants to preserve them (Sayegh and Takah, 2002). Because the world is moving ahead in the field of economic and industrial development it is essential to provide financial resources, information and environmental data, and continuously in order to take appropriate decisions and the issuance of new regulations and legislation that result in the result to preserve and protect the environment from the dangers of pollution.

Environmental data that the enormous and varied and complex needs of high technology for the purpose of processing and analysis to take the appropriate decision to protect and preserve the environment. Therefore, uses the system now known as environmental information system (EIS) Environmental Information System, which deals with environmental information management of all elements of the environment, and to collect and analyze this data (Günther,

1998). The recent trends in knowledge and management of the environment are the mapping of environmental groups, measurements and observations of the environmental elements. It is a modern system, and advanced software packages that have become an effective tool in the planning and design is a geographic information system (GIS), which is one of the basic components and critical environmental information management system (EIS), where geographic information is important and special type of environmental information (Foreman, 1998).

That the Geographic Information System (GIS) a very effective tool as it supports advanced computers for the collection, storage, analysis, processing and display various information, including the environment. It consists of the rules of visual information are interdependent and complementary can be displayed on the form of maps after the toppling of various information on the distribution of a particular geographic and can add any important information on these maps, such as observation and measurement of environmental variables.

## **2. Problem of the study**

The importance of environmental realities of the Baghdad city a vital fact because this city is the capital and occupy a large area of Iraq as well as a population of over five million, and most industrial and commercial activities stationed as well as agricultural activity. “the pollution rates increased in the soil of the Baghdad city because of overlapping set of factors increase the population of the city and the consequent environmental problems resulting from the depletion of natural resources and increasing waste of factories, landfills and increase the number of vehicles and other factors that lead to the introduction of many pollutants into the soil. These problems have increased the risks of environmental balance and ecosystem constituted a breach of the city”.

## **3. Aim of the Study**

The study aims to achieve the following:

- 1 - Measuring the concentrations of contaminants in the soil in the city of Baghdad, and the log concentrations compared to previous years and determinants of Iraq and the world.
- 2 - Application of software packages developed in some of the information systems as effective in the diagnosis and analysis and understanding of environmental variables across time and space, such as programs (GIS).
- 3 - Employ sophisticated information technology in the study of environmental variables in the city of Baghdad.
- 4 - Know the impact of human activities and industrial air pollution, water and soil city of Baghdad.

## **3. Location of the study area**

The study area is located in central Iraq, within the sector of the stable sedimentary plain which represents the western part of the pavement is stable, Fig.(1), (Ministry of Interior, the Directorate of Urban Planning, 2001). Where is located between latitudes ( $33^{\circ} 44'-33^{\circ} 25'$ ) and longitudes ( $44^{\circ} 29'-44^{\circ} 16'$ ), and runs through the city of the Tigris River in Baghdad, a mature component winding river and a number of islands because of slow speed and increase in nitrogen denominator city of Baghdad into two Karkh and Rasafa, and is bounded by the eastern Diyala River, which flows in the Tigris River southeast of Baghdad, the military as well as the channel, which receives water from the Tigris River in the northern part of the study area as it is in the southern part of the Diyala River, also includes the city of Baghdad,

nine municipal units, five of which are located in Rusafa and four in the Karkh district and each unit containing a number of municipal districts, and associated with all units of the municipal network of highways. The area of the Municipality of Baghdad municipality towards its units (869,031) km<sup>2</sup>, (Tamas, 1997). The rate of decline of the earth's surface (0.1) m / km to the south, as the average height between (32-36) meters above sea level, Fig. (2), (Hitti, 1985).

The study area is also characterized by the presence of industrial sites and communities and agricultural land, with an area of land inhabited, including the postcard beaches of the limits of industrial facilities (67%), while the land area is uninhabited, including agricultural land (33%), (Hitti, 1985) .



Fig.(1): Map of Baghdad city (study area)

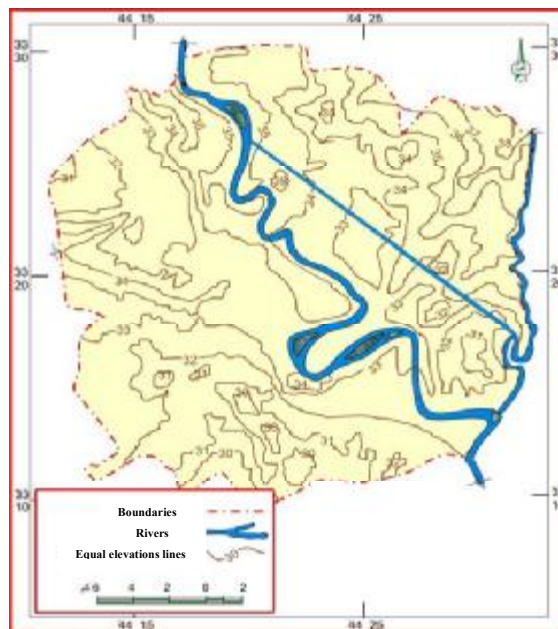


Fig.(2): Map of Baghdad city showing rate of earth slop

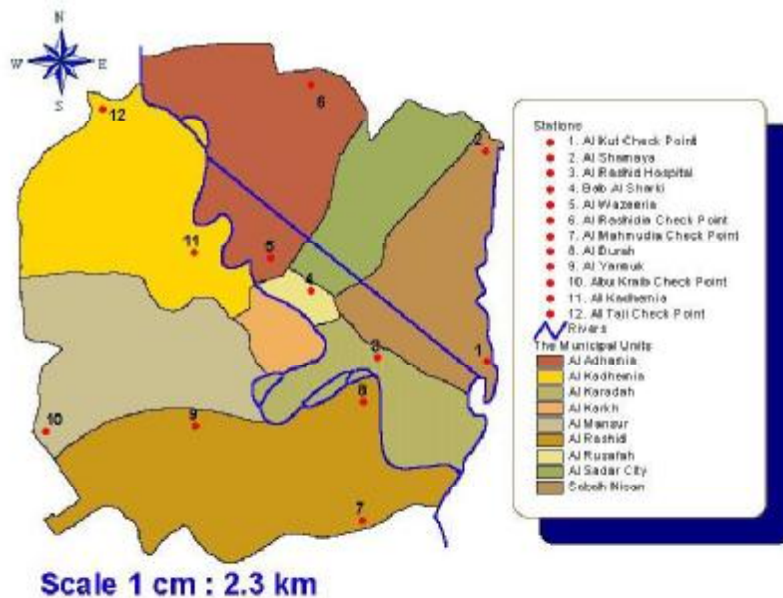
## **5. Soil area of study**

The nature of sediment constituents of the soil reflects the characteristics of the soil. So the soil is characterized as being the city of Baghdad is not homogeneous (Non Homogeneous) and variable laterally and vertically and suddenly within short ranges, due to the impact of human activity, particularly agriculture, where several methods used in irrigation and drainage to cause a rapid variation of the soil from one area to another in Baghdad (Hatab, 1985), also the variation in the constituent layers due to the succession of flood seasons and change the course of the river where the lead to the heterogeneity of river sediment, when less than the speed of the river will fail the river from the payload and the grains are soft in the middle of the river and the coarse sand on the edges and then the bottom of the course of the river rising by the sequence of sedimentation leading to the river is trying to take the course of the lower reaches of the former, and so returned the process. It also found that the soil of the study area containing the salt deposits of salts, chlorides and sulfates, and this is due to the dry climate and low rainfall and poor irrigation of agricultural land. Therefore, the soil of Baghdad characterized the nature of the alluvial sand and mixed and irregular (Adli, 1998).

The advantage of being the city of Baghdad soil as the base value of the (PH) to more than (7) and the ratio of total dissolved salts (TDS) are relatively small so it is valid for structural work, the ratio of sulfate salts in some areas, which take into account the high Wizards put the foundations of buildings, ranging from the values of natural humidity (W%) between (18-34%) and various depths of the soil, and the amount of the difference in the values of natural moisture due to several factors, such as the proportion and quality of clay minerals contained in the mud and their water retention, However, the percentage variation in the values of natural moisture is relatively small, (Baghdad Municipality, Directorate of Laboratories, 1990). The main industries of the contaminated soil the city of Baghdad are: Petrochemical and oil industries, Power plants, Textile Industries, Chemical industries, Engineering Industries, Extractive Industries, Construction industry.

## **6. Methods and Materials**

Were collected environmental data and information on soil contaminants in the city of Baghdad from the previous studies and then incorporated in an integrated database with the results of measurements made in this study. Selected (12) stations located on different parts of the city of Baghdad for the purpose of collecting samples of soil, plants have been distributed on a regular basis so as to cover most areas of the city, with a focus on the type of each area as commercial, industrial or residential, as shown in Fig. (3), (Table 2).



**Fig. (3): Map of Baghdad city showing study stations**  
**Table (1): Stations name and types**

St. Type	St. Name	St. No.
Vehicles transport	Cut control	1
Industrial	Achammaai	2
Industrial	Al-Rasheed Hospital	3
Industrial-Traditional	Bab Alsharji	4
Industrial	Al-Wazeeria	5
Vehicles transport	Al-Rashedia control	6
Vehicles transport	Al- Mahmudiyah a control	7
Industrial - Domestic	Al-Durah	8
Domestic	Yarmouk	9
Industrial - Domestic	Abu Ghraib	10
Industrial - Domestic	Kadhimiya	11
Vehicles transport	Al-Taji control	12

Soil were analyzed to determine concentrations of heavy metals contaminated it, which takes samples from a depth of 10-20 cm and placed in bags and sent to the laboratory for analysis to determine the concentrations of heavy metals by atomic absorption spectrometer after digestion according to standard methods used to transform any solution will be dealt with in accordance with method analysis. Soil samples were collected from stations distributed in the study area increased by four soil samples from various regions within the same region, and has been chosen one model represents the four models through Composite Sample, and then analyzed.

In the end, one of the software packages used in environmental mapping of the limits of the Municipality of Baghdad and under Geographic Information System environment (GIS) in the

diagnosis and analysis of the levels of pollution in the city and build an integrated database of pollutants in order to take the necessary measures to preserve and protect the environment from pollution.

## 7. Results and Discussion

Table (2) shows the results of analysis of the concentrations of trace elements in soils and areas of Baghdad, compared with the determinants of global concentrations in the soil, and table (3) summarize the comparison between the concentrations of trace elements in the soil of the city of Baghdad with Bas soils in the world.

Table (2): Concentration of heavy metals in Baghdad city soil

Cd	Ni	Co	Cu	Zn	Pb	Stations	No.
3	54	22	22	190	70	Cut control	1
10	85	31	32	140	340	Achammaai	2
2	85	33	45	370	192	Al-Rasheed Hospital	3
3	55	39	760	120	125	Bab Alsharji	4
5	150	53	74	120	150	Al-Wazeeria	5
2	87	12	20	170	54	Al-Rashedia control	6
2	21	12	16	50	45	Al- Mahmudiyah	7
2	10	13	10	50	40	Al-Durah	8
25	200	23	21	75	29	Yarmouk	9
5	220	51	43	100	410	Abu Ghraib	10
2	190	28	40	165	300	Kadhimiya	11
2	180	13	20	50	90	Al-Taji control	12
5.25	111.4	27.5	91.9	133.3	153.7	Average	
5	100	10	20	300	150	World limits	

Table (2): Comprise between heavy metals in Baghdad city soil with world soil

Country	Pb	Zn	Cu	Ni	Cd
Baghdad	153.7	133.3	91.9	111.4	5.25
USA	480	2200	700	52	12
England	700	3000	800	80	-
Sweden	180	1567	560	51	6.7

### 1 - Lead (Pb):

Reached the highest concentration of lead in the soil of the city of Baghdad during the current study in the Abu Ghraib area, (410) ppm, while the lowest concentration in the Yarmouk district (29) parts per million. The overall rate of lead concentrations in the soil of the study area (153.7) ppm as in the table (2). This rate was higher than rates in the soil of the city of Baghdad, compared with previous studies (1998.2002), as shown in Figure (4). From table (3) we find that the concentration of lead in the soil of the city less than concentrations in some soils the world. In comparison with the determinants of global concentrations of lead in soil,

shown in table (2) we find that the lead in the soil of the city of Baghdad has exceeded the permissible limits, especially in some areas, such as Abu Ghraib, and Achammaai Kadhimiya. From this we can deduce that the soil of some areas of Baghdad under the influence of lead contaminated divorced and industrial plants such as the smelter and battery plant in Abu Ghraib and Waziriya and brick factories polluting to the air and soil existing in the Achammaai region, as well as the impact of vehicles with gasoline, which took increasing dramatically, leading to increased air pollution in lead and thus contamination of soil, as well as the impact of foundries and workshops with public and private sector in the city areas.

### **2 - Zinc (Zn):**

Table (2) note that the highest concentration of zinc in the soil of the city of Baghdad was in the Rashid Hospital (370) ppm, and Lower concentration was in the areas of Mahmudiyah and the session and the coronary (50) ppm. That the overall rate of zinc in the soil of the study area (133.3) ppm. When comparing this rate with the results of previous studies found higher rates than in the past (1998.2002) as in Figure (4), but much lower than the concentrations in the ground of some of the world described in the table (4). When comparing the concentrations of zinc in the soil of the city of Baghdad with the global parameters we find that it did not exceed the permissible limits of the (300) ppm, indicating the absence of zinc pollution in the soil of the city except the Rashid Hospital, where the concentration of zinc exceeded the permissible limits.

The reason for increased concentrations of zinc in the soil of the city of Baghdad to increase the acidic soil because the easy assimilation of zinc, as well as a result of increased soil organic matter, and has indicated several studies have suggested that increased concentrations of zinc in the soil due to the influence of vegetation as well as the impact of human activities and of laboratories and foundries and the use of Nutraceuticals and pesticides in the soil.

### **3 - Copper (Cu):**

The results of the analysis of soil the city of Baghdad, the highest concentration of copper was in the eastern section (760) ppm and the lowest concentration was in the session (10) ppm As (Table 2). The overall rate of concentration of copper in the soil of the study area amounted to (91.9) ppm, much higher rates than in the past (1998.2002) and shown in the figure (4), but much lower than the concentrations in some soils the World As shown in Table (3 ). When comparing the concentrations of copper in the study area with the determinants of the global note that the concentrations of copper in this study may exceed the limits, especially in the far eastern section, which indicates that the soil of this area is contaminated with copper significantly and there is also this element pollution in other areas such as Waziriya and Rashid Hospital. The cause of increased concentrations of copper in the soil of the city dates back to adsorption by clay minerals and its transmission over long distances with the river sediment as well as increasing organic materials, and increased copper in the soil due to industrial activities such as workshops, foundries and smelting operations in addition to the impact of irrigation water and drainage.

### **4 - Nickel (Ni):**

Table (2) reached the highest concentration of nickel in the soil of the city of Baghdad in the Abu Ghraib area, (220) ppm and the lowest concentration in the session (10) ppm, while the overall rate of concentration of nickel in the soil of the study area (111.4) ppm, From figure (4) note that this rate was lower than average during the year (1998), but more than the year

(2002). When comparing the concentrations of nickel in the soil of the city of Baghdad, with concentrations in some soils the world described in the table (3), we find it more. In comparison with the determinants of global nickel concentrations in the soil, we find that it had exceeded the permissible limits of the (100) ppm, especially in areas (12,11,10,9,5) which means that the soil of these areas contaminated nickel. The cause of increased concentrations of nickel in the soil due to adsorption processes by clay minerals and to the al Qaeda presence in the rocks and sedimentary rocks, and organic materials play an important role in increasing concentrations of nickel in the soil. Industrial activities also play an equally important role in increasing concentrations of nickel in the soil through the spread of the electrical industry and laboratories as well as batteries, workshops and foundries with the private sector and deployed in the city.

#### **5- Cobalt (Co):**

Table (2) note that the highest concentration of cobalt in the soil of the city of Baghdad in the Waziriyah area (53) ppm, and less focus in the areas of Mahmudiyah and Al Rashidiya (12) parts per million, has reached the overall rate of cobalt concentration in the soil of the study area (27.5) ppm. A comparison between the rate of concentration of cobalt in this study with the results of previous studies (1998.2002) note that less than the rate of concentration of copper during the year (1998) and more than normal rates in the year (2002), as in Figure (4). Compared with the global parameters we find that the concentrations of cobalt in the soil of the city of Baghdad has exceeded the permissible limits and are described in the table (3), which conclude that some of the city contaminated soils crusts. The increase in the concentrations of cobalt in the soil are the result of several factors, including the origin and composition of soil and weathering processes and the impact of human activities as well as the impact of irrigation water.

#### **6 - Cadmium (Cd):**

The results of the analysis of cadmium in the soil of the city of Baghdad, the highest concentration was in the Yarmouk district (25) ppm and the lowest concentration (2) parts per million in the stations (12,11,8,7,3) As shown in table (2), while the the overall rate of concentration of cadmium in the soil of the study area (5.25) ppm. From figure (4) note that the average concentrations of cadmium in the soil of the study is less than that in the past (1998.2002), also note from the table (3) The concentrations in the soil of the city of Baghdad to be within the limits of concentrations compared with some of the soils of the world. When comparing the concentrations of cadmium with the determinants of the global note to be more than the permissible limits in most areas, which indicates that the soil contaminated with cadmium city. Increasing concentrations of cadmium in the soil due to the increase of organic matter in the soil and the presence in the rock base and as a result of industrial activities as well as the use of conditioners, pesticides, and the impact of water drainage.



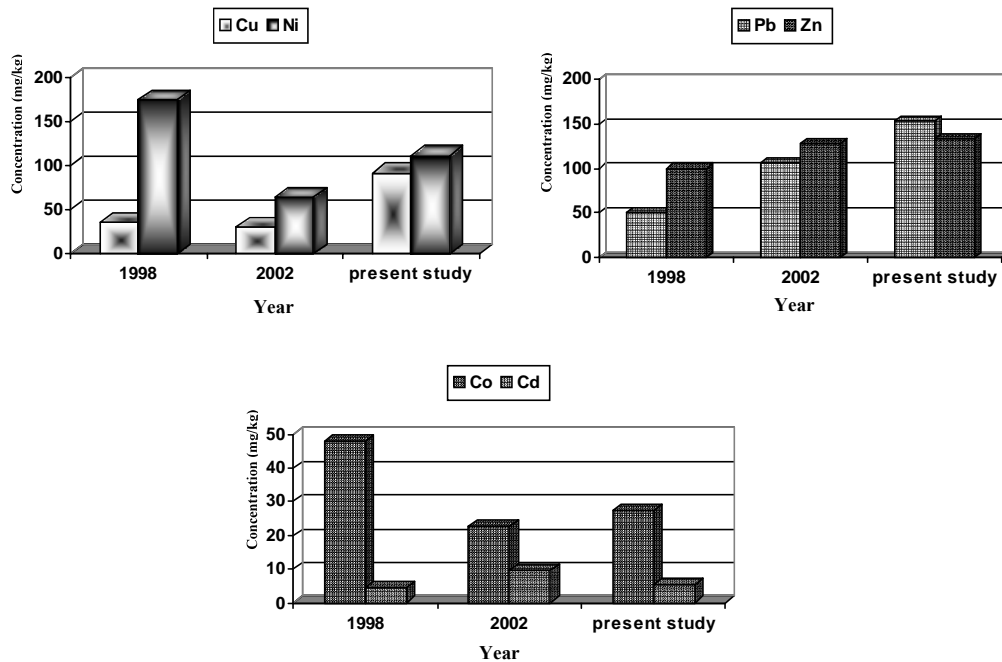


Fig. (4): concentration of heavy metals in Baghdad soil comprise with previous studies

## 8. Geographic Information System: (GIS)

Data were entered in the Special analyzes the soil in the city of Baghdad that has been obtained from such studies and the current study in an integrated database for the purpose of the mapping of environmental pollution of the soil in the city of Baghdad.

### 1. The Tables Function:

Figure represents (5) Map of Baghdad showing all available data for each station study, which was conducted by analysis of soil contaminants during the year (2002), where you can identify these statements by the attached table with the map. Fig.(6) represents the map of the city of Baghdad, described by the data analyzes soil that was obtained from the current study and through the attached table with the map.

### 2. The Chart Function:

Been possible to map the concentration of lead in the soil of the city of Baghdad, as shown in Figure (7), where it is possible to identify plants that contain high concentrations of lead in soil and through the existing graph with a map, where we find that the stations (11,10,1) contain high concentrations of lead in soil.

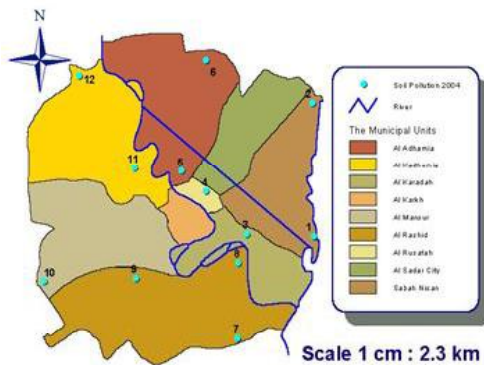
### 3. The Identify Function:

Can identify all the information for each station separately represented on behalf of the station and the results of the analysis, this is done by selecting the function definition as soon as any pressure on the station gives the program window that contains all information for that station and this can be included with the map as in Figure (8).

### 4. Color Graduate:

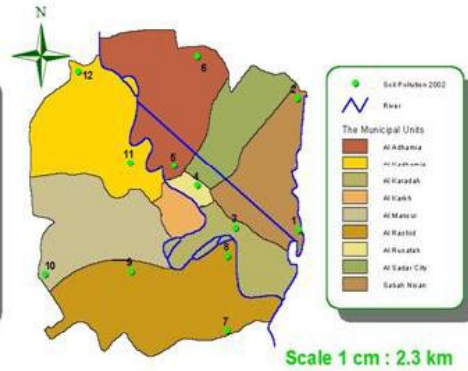
Figure (9) shows a map of zinc concentrations in the soil of the city of Baghdad in 2002, and the current study was prepared using a gradient of each symbol of the stations of the study,

namely that every form of icons representing the particular concentration. Fallon light focus is less access to dark color, which represents the highest concentration, in this study, we find that the soil containing plant Rashid Hospital, the highest concentration of zinc, because the symbol of the station painted dark and the focus is (191-370) mg / kg.



مunicipal Units	Concentration	Color	Concentration	Color	Concentration	Color	Concentration	Color	Concentration	Color
Al Athmaniya	12	Red	12	Red	12	Red	12	Red	12	Red
Al Kadisya	11	Orange	11	Orange	11	Orange	11	Orange	11	Orange
Al Karadah	10	Yellow	10	Yellow	10	Yellow	10	Yellow	10	Yellow
Al Karkh	9	Light Green	9	Light Green	9	Light Green	9	Light Green	9	Light Green
Al Mansour	8	Light Blue	8	Light Blue	8	Light Blue	8	Light Blue	8	Light Blue
Al Rashid	7	Light Purple	7	Light Purple	7	Light Purple	7	Light Purple	7	Light Purple
Al Rusayfa	6	Light Brown	6	Light Brown	6	Light Brown	6	Light Brown	6	Light Brown
Al Sader City	5	Light Grey	5	Light Grey	5	Light Grey	5	Light Grey	5	Light Grey
Sabah Nayan	4	Light Yellow	4	Light Yellow	4	Light Yellow	4	Light Yellow	4	Light Yellow

Fig (6): map of Baghdad city showing soil pollutants using table function/2004



مunicipal Units	Concentration	Color	Concentration	Color	Concentration	Color	Concentration	Color	Concentration	Color
Al Athmaniya	12	Red	12	Red	12	Red	12	Red	12	Red
Al Kadisya	11	Orange	11	Orange	11	Orange	11	Orange	11	Orange
Al Karadah	10	Yellow	10	Yellow	10	Yellow	10	Yellow	10	Yellow
Al Karkh	9	Light Green	9	Light Green	9	Light Green	9	Light Green	9	Light Green
Al Mansour	8	Light Blue	8	Light Blue	8	Light Blue	8	Light Blue	8	Light Blue
Al Rashid	7	Light Purple	7	Light Purple	7	Light Purple	7	Light Purple	7	Light Purple
Al Rusayfa	6	Light Brown	6	Light Brown	6	Light Brown	6	Light Brown	6	Light Brown
Al Sader City	5	Light Grey	5	Light Grey	5	Light Grey	5	Light Grey	5	Light Grey
Sabah Nayan	4	Light Yellow	4	Light Yellow	4	Light Yellow	4	Light Yellow	4	Light Yellow

Fig (5): map of Baghdad city showing soil pollutants using table function/2002

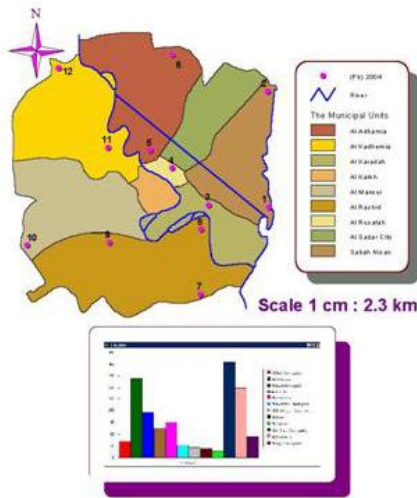


Fig (7): map of Baghdad city showing soil pollutants using chart function

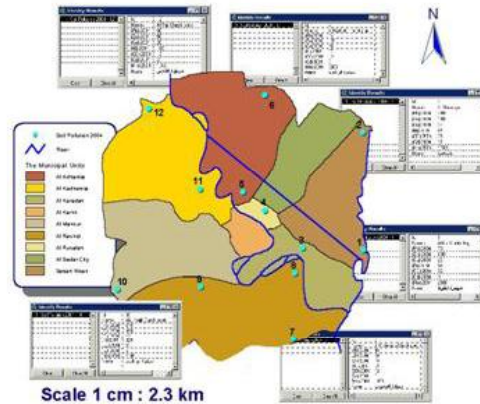


Fig (8): map of Baghdad city showing soil pollutants using identify function

## 5. Query Function

This is a function of the possibilities offered by the program task to identify any areas contaminated or not contaminated. In Figures (10), which represents a map of the concentrations of cadmium in the soil of the city of Baghdad were prepared using the following query: [(Cd 2004) >5] and thus we get the areas in which soil contaminated with cadmium because the concentrations of cadmium exceeded the permissible limits, with the distinction Achammaia, Yarmouk and the rest of the regions through the yellow colored by the code areas contaminated by cadmium, this application applies to the rest of the way in figure (11).

## 9. Conclusions

The results of the analysis of lead in soil models city of Baghdad, said the concentrations of this element has exceeded the permissible limits in some regions is due to the impact of divorced and industrial plants such as brick factories and smelters as well as the impact of divorced vehicles due to combustion.

The results showed that concentrations of zinc in the soil did not exceed the permissible limits, indicating the presence of contamination of this element in the soil of the city of Baghdad.

observed by measuring the concentrations of Cu, Co, Ni, Cd it had exceeded the permissible limits, which indicates the existence of these elements in the soil of the city of Baghdad, and the reason for the increase in the concentrations of these elements is due to several reasons including the impact of industrial activities, but by less than in previous years due to suspension of many of these actors to work due to war conditions experienced by the country as well as the impact of adsorption by clay minerals and the presence of organic matter in the soil that play an important role in increasing concentrations of these elements as well as the weathering and irrigation and drainage.

Said environmental maps drawn during the study to the concentrations of trace elements in the soil of the city of Baghdad, the cities contaminated soil elements Cd, Ni, Co, Cu, Pb result of high concentrations on the determinants of global stations in most of the study.

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