International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 4, April - 2014

The Pollution of Lead Pb in the Soil of Baghdad City After 2003

Dr. Majid H. Hobi
Construction and Water Resources Dep.
University of Kufa,
Iraq, Baghdad

***Abstract*—Pb has been an important metal in human societies over many thousands of years. On the other side the Pb is very dangerous on the human because Pb is one of pollution metals on the life of human. The cancer is one of the disease results of this pollution. This study takes Babylon factory for batteries as case study. This factory is located in center of Baghdad city. By taken several samples of soil were used as indicator of Pb pollution from the different sources. Theses samples are taken in different sites in Baghdad within 5 Km as a "Range Study" to make the correct decision about this pollution. The mean Pb concentrations in the soils at these sites were ranging from 169 mg Pb/kg at the edges of city, to 5477 mg Pb/kg in the sidewall of this factory, the max. The results shown also the number of cars in the recent date is very dangerous on the citizen in this city especially with same area and limitation of area life. This study see also indicated to the error in the selection of this factory site. Noted that the range of study is divided to two parts, one in upwind and the other in downwind. This study also show the transfer mass of pollution of lead (Pb) due to air. This study also show, the dangerous faced Baghdad city after 2003 because the increasing in number of vehicles and generators (no rules to import vehicles and poor in electricity providing).**

Keywords*—pollution, Baghdad, Pb lead, dangerous, concentrations, Babylon factory, 2003

I. INTRODUCTION

Soil is the major reservoir for Pb in the environment and forms the initial link of the food chain through which the lead is transferred to man. Lead discharges from mans activities enter the soil from the depositions of polluted atmospheric or aquatic system or through land-based disposal of contaminated wastes. Pb occurs naturally in soil in low concentration, and transfers to the food chain from soil to plants and then to the animals and human. However, when the concentration increase it will become toxic and hazardous for the health and the balance of the environment itself, so knowledge of concentrations of lead is important (Khans, 1980). Pb can introduce to the environment from both natural and anthropogenic sources such as (Harrison and Laxen, 1981; WHO, 1981; Tong, 2000):

•Mining and smelting activities
•Lead recycling factories
•Emission from leaded gasoline
•Combustion of coal and oil
•Manures, sewage sludge usage in agriculture
•Use of lead compounds e.g. fungicides, insecticides, anti-fouling paints.

From 1920 petrol contained lead alkyls as anti-knocking agents was used and that lead to increase in lead concentration in air, surface water and soil. (Smith, 1986). According to Wixson and Davies (1993) and Tong (2000), the Pb from vehicles is the most widely distributed source of the metal in the environment.

II. TOXICITY OF LEAD

Pb is a heavy metal with a high toxicity. Pb is toxic at very low exposure levels and has acute and chronic effects on health and the environment. Pb is not degradable in nature and will thus, once released to the environment, stay in circulation (Ronald, 1988). Toxic effects of Pb have been known for almost as long as Pb itself. The Greek and Romans knew about Pb toxicity, and they were familiar with the symptoms of Pb poisoning (Smith, 1986). Pb has been known for centuries to be an accumulative metabolic poison; especially in young children, acute exposure is a serious problem. The continuous exposure to lower levels of lead as a result of widespread environmental lead contamination may result in adverse health effect (Nriagu, 1978).

Pb exposure has increased throughout the world. In many developing and industrializing countries, as well as in some developed countries, exposure to lead remains a serious problem. While in most developed countries introduction of lead into human environment has decreased in recent years, due to public health campaigns and the decline in lead commercial usage especially as petrol additives, chronic exposure to low levels of lead is still a public health issue in developing countries. In developing countries, the awareness of the public health impact of lead exposure is growing, but few of these countries have introduced regulations to solve this serious problem (Tong, 2000). People are exposed to lead in varying degrees in food, drinking water, and air as well as a number of other sources. The segment of the population at risk is thevery young, i.e. fetus, infants and children, Pb poisoning is one of the most important chronic environmental illnesses affecting modern children. Despite efforts to control it and despite apparent success indecreasing incidence, serious cases of lead poisoning still appear (Burke, 1983). Pb is more dangerous to children than adultsbecause babies and children often put their hands and other objects in their mouth; also the children's growing bodies absorb more lead, and children's brain and nervous system are more sensitive to the damaging effects of lead (U.S EPA, 2005).The neurotoxin effects of Pb on children are the focus of greatest attention; lead also affects many other organs in both children and adults (Nriagu, 1978). On the other hand, Pb causes adverse effects in adults including kidney disease, anemia, and impaired fertility; in addition, lead absorbed during childhood can be released back into the blood during pregnancy, harming the developing foetus as well as the mother (Nriagu, 1978).Figure 1-1 presents the relationship between dose-effect for adverse health effects of leadexposure.

Pb can be found in organic and inorganic forms. Organic lead compounds such as tetra ethyl lead and tetra methyl lead are highly toxic compared to inorganic lead compounds (Nriagu, 1978). While inorganic forms of lead typically affect the Central Nervous System (CNS), the peripheral nervous system (PNS), and the hematopoietic, renal, cardiovascular and reproductive systems, organic lead toxicities tend to predominately affect the CNS (Nriagu, 1978).

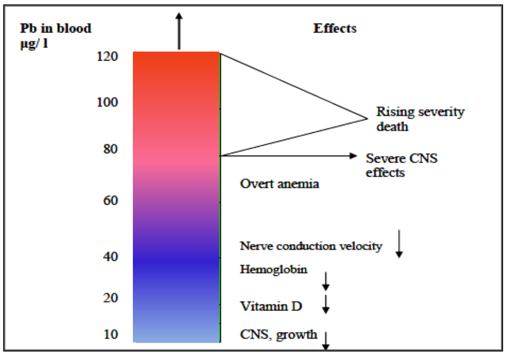

Fig. 1. Dose-effect relationship for adverse health effects of lead exposure (Tong et al, 2000)

III. THE REGION OF STUDY

Baghdad is the biggest city in Iraq, with a population of about six million and population density about 1160 persons per km2. With an area of about 660 km2, it is situated on the Tigris River at 33.23N latitude and 44.23E longitude. The dominant wind direction in Baghdad is North-West (Abdullah, 1990); Fig.2 and Fig.3 illustrates the wind distribution in Baghdad.The region was divided to two parts, one upwind direction and the second downwind direction Fig. 3. The selected areas were in north west of Baghdad " Al-Kazalia, AlTaji and AlShuala) and Center of Baghdad near Babylon factory at "Mohammed AlQasim Highway". The other selected area it was Al-Doraa and Al-Rasheed camp.

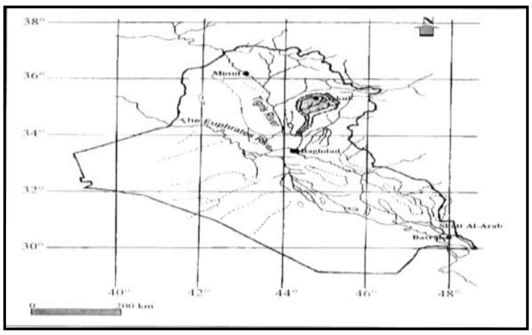

Fig. 2. Iraq Map and the location of Baghdad city

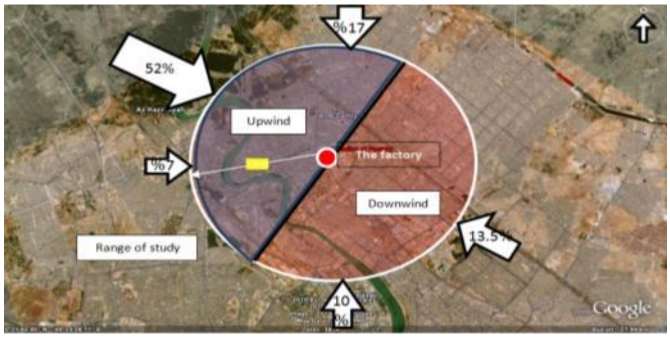

Fig. 3. Baghdad city and the percentages of directions of wind, Google® , NOAA

IV. EXPERIMENTAL WORKS AND EQUIPMENT

For this research, the region of study divided two parts. One of these parts is upwind and other part is downwind. This is because the effected of wind on the distributions of lead pollution. The experimental planning it was as the following steps:

1- Form study field taken the soil sampling.
2- Samples sieving it was as second step (Prepare fine (disaggregated) samples for extraction.
3- Drying the samples (Preparing dry samples for extraction).
4- Extraction of Pb by chemical solution, Total Pb analysis by AAS
5- Extraction of Pb by Na2EDTA solution, Bioavaliable Pb analysis by AAS
6- Measurement of some physical and chemical soil properties (pH, organic material %, clay content.
7- Assessing the level of total Pb in the sampling areas, indicate the relation between total Pb level and sources.
8- Indicate the correlation between soil properties and bioavailable Pb in soil samples.

Assessing the level of Bioavailable Pb to the food chain, indicate the percentage of bioavailable Pb (next studies).

A. Total Pb Measurement

The purpose of this method was to determine the total Pb in the soil samples by using atomic absorption spectrophotometry (AAS). The National Center of Construction Laborites it was the location of Experimental works. The specific apparatuses used were:

1. Hot plate
2. Filter paper (Whatman No.52)
3. Atomic absorption spectrophotometer (Buck Scientific Model 210 VGP)
4. Polyethylene (PE) and Bottles Glassware

The specific reagents used were:

1. Hydrochloric acid, 37% HCl, ARGrade:Merck
2. Nitric acid, 65% HNO3, ARGrade:Merck
3. Hydrogen peroxide, 30% H2O2, ARGrade:Merck
4. Demineralized Water

B. Procedure

For the estimation of total Pb, sub-samples of 1.25 g from each dried sample were extracted (extraction was done in duplicate) with 50 ml HCl/HNO3 3:1, with a flask placed over a hot plate. The temperature of the hot plate was gradually increased and the material was digested until the appearance of white fumes; about 5 ml of acid was left to avoid over- heating (heating at 200°c); after cooling 3 ml 30%, H2O2 was added. After destructing for 10 minutes, 50 mL demineralized water and 25 mL HCl was added and the sample was heated until boiling; after cooling, the whole sample was diluted with demineralized water to 250 mL, using a volumetric flask. After waiting to let settle, the clear supernatant was filtered using Whatman No. 52 filter paper. The Pb analysis was done by using flame atomic absorption spectrometry; using a wavelength of 283.3 nm and a flame air-acetylene mixture.

V. BIOAVAILABLE PB MEASUREMENT

To estimate the bioavailable Pb, a Na2EDTA solution (disodium ethylene diamine tetra acetic acid) was used to extract soil Pb according to Ure et al, (1993). The specific apparatuses and reagents used were:

1. shaker (176 oscillation per minute)
2. Centrifuge
3. Atomic absorption spectrophotometer (Buck Scientific Model 210 VGP)
4. Filter paper (Whatman No. 54)
5. Polyethylene (PE) Bottles and Glassware.
6. Demineralized Water Procedure

Pb was extracted from soil (extraction was done in duplicate) by shaking 10 g prepared samples (dried and sieved) for 2 hours with 50 ml 0.04 M Na2EDTA, centrifuging for 10 min at 10,000 rpm, and filtering the supernatant solution through a Whatman No. 54 filter paper. Pb concentration in the filtrate (Pb extract) was determined using flame atomic absorption spectrophotometers (AAS). A wavelength of 283.3 nm and a flame air acetylene mixture were used.

Fig. 4.: Preparation soil solution for bioavailable Pb measurements

VI. MEASUREMENTS OF SOIL PHYSICAL AND CHEMICAL PROPERTIES

A. pH in soil

Soil pH was determined in duplicate by using a standard glass electrode pH meter (JENWAY 3320); a soil paste was made by adding demineralized water to soil in a 1:2 fraction (5 g soil +10 ml deminerlized water). A shaker was used to mix the sample well for 15-20 minute; after that, pH measurements were taken. (ANR Analytical Lab, 2005).

B. Organic Matter

Organic Matter was determined in duplicate by a modified Walkley-Black wet oxidation method. This method quantifies the amount of oxidizable organic matter in which organic materials (O.M) is oxidized with a known amount of $K_2Cr_2O_7$ in the presence of sulfuric acid. The remaining Cr^{3+}chromate was determined spectropho to metrically at 600 nm wavelength. The calculation of organic matter is based on organic matter containing 58% carbon.

C. Clay Content Measurement

Particle Size Analysis of sand, silt, and clay in soil suspension was determined in duplicate by a hydrometer (ANR Analytical Lab, 2005). This method quantitatively determines the physical proportions of three sizes of primary soil particles as determined by their settling rates in an aqueous solution using a hydrometer. In our procedure we used a sodium hexametaphosphate solution (galgoon) and subsequent measurement based on changes in suspension density. The ASTM 152 H-Type hydrometer method was used; a standard temperature of 20°C; a particle density of 2.65 g cm^{-3} were assumed. By taking a hydrometer reading of a blank solution, corrections were made for temperature and for solution viscosity.

VII. RESULTS

A. Annual means air Pb concentration in Baghdad centre

There are many studies that show concentrations of lead in air, but here we focus on some of them and private study area. As shown in Tables 1, 2 and 3. In tables it can show the increase in the annual means air Pb concentration in Baghdad centre with the increase in the number of cars and consumptions in gasoline fuel. (Tabel.1, Fig.5)

Table 1. : The Annual mean Pb. Conc. In Baghdad

Year	Annual mean Pb conc. in air in Baghdad centre(µg/m3)	Annual mean Pb conc. in air in Baghdad rural areas(µg/m3)	WHO regulation average of 3months values(µg/m3)	Source of Data
1985	3.73	0.6	1.5	Environmental Protection Centre, (1990)
1988	3.42	0.5		Al-Kendy (2005)
1999	3.12	0.3		
2000	3.6	0.8		
2002	3.9	Not available		Hanosh (2004)
2009	4.5	Not available		Environmental news service

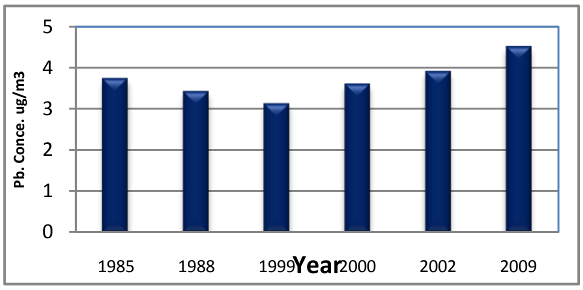

Fig. 5. Annual mean Pb conc. in air in Baghdad centre (µg/m3)

B. Calculation of amount of Pb discharged to the Baghdad atmosphere

According to Hana and Al-Bassam (1983), 75% of the Pb added to the gasoline is discharged out of the exhaust.
Amount of Pb that discharged to the air (tones/year) = amount of gasoline used per year*amount of Pb added * 0.75

•For 1980 = $222*10^6*0.6*0.75$ = 99.9 tones/year
•For 2005 = $730*10^6*0.4*0.75$=219 tones/year
•For 2009 = $1450*10^6*0.4*0.75$=435 tones/year

Table.2 :The amount of gasoline consumed and Pb. By the years

Year	Amount of gasoline consumed (l/ year)	Amount of Pb added to gasoline (g/l)
1980	$222*10^6$(Hana and Al- Bassam,1983)	0.6 (Al-Ajizan, 1984)
2005	$730*10^6$(Environmental news service, 2005)	0.4 (Hanosh, 2004)
2009	$1450*10^6$(Environmental news service, 2009)	0.4 (this study)

C. Amount of Pb discharged to Baghdad atmosphere (tones)

Table.3 :The amount of gasoline consumed and Pb. Discharged to atmosphere By the years

year	Number of cars in Baghdad	Amount of gasoline consumed (l/year)	Amount of Pb discharged to atmosphere (tones)	Mean soil Pb. concentration in city Centre(mg Pb/kg)
1981	250,000(Hana and Al-Bassam, 1983)	$222*10^6$ (Hanaand Al-Bassam, 1983)	99.9	308 (Khalid et al ,1981)
2004	805,440(Traffic Police Authority,2005)	Not available	Not available	Not available
2005	1,000,564(Traffic Police Authority,2005)	$730*10^6$ (Environmental news service, 2005)	219	1253 (Njim Aldin)
2009	2,010,315 (Traffic Police Authority, 2009)	$1450*10^6$ (Environmental news service, 2009)	435	**2067 (not covered)**

D. The Number of Cars in Baghdad

In the last years the number of cars are increasing progressively and non-uniform. There are many reasons for this increasing. The change in the sociality life of peoples and the ability of buy of peoples. The Fig. (6), show the increasing in this number between 1981 to 2009. The number of cars increased 8 times in 28 years. The number of cars caused the increasing in the Pb to atmosphere of Baghdad.

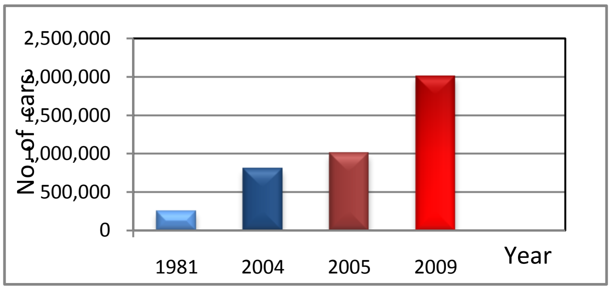

Fig. 6 . The No. of cars with years in Baghdad city

E. Total Pb concentrations in soil Up -wind direction

The results of total Pb for the samples up to 5 km from the factory (see Fig.3) as showed. Start near factory walls to the range of study. The results of total Pb concentrations upwind direction show the highest value in the end of the circumference for the range of study i.e. in the Al-Kazalia , Al-shuala and the Taji with high value 5477 mg Pb/kg near the factory walls and lowest values 169 mg Pb/kg. (Table. 4, Fig. (7 and 8).

Table 4: Total Pb concentration in up-wind direction

Distance (m)	Total Pb concentration mg Pb/kg
0	5477
10	4322
20	2100
30	1001
40	899
50	870
100	794
500	698
1000	543
3000	210
5000	169

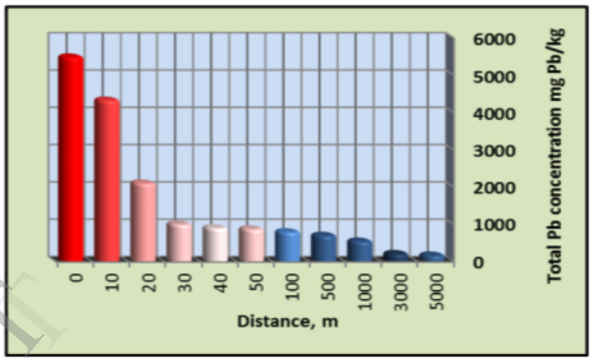

Fig. 7. Total Pb concentration in soil for the Babylon factory up-wind

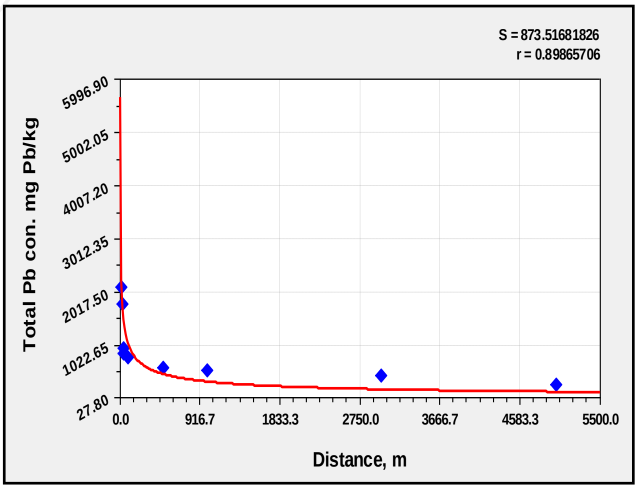

Fig. 8. Total Pb concentration in soil for the Babylon factory up-wind

F. Total Pb concentrations Down -wind direction

The results of total Pb for the samples up to 5000 m from the factory (Fig. 9) showed an average of 12875 mg Pb/kg . Table 4 illustrates this values. The highest concentration of 12875 mg Pb /kg was found in samples close to the factory; then the soil Pb concentration decreased following exponential decline (see Fig.10), which was however less steep than for the up-down wind (see Fig.9-10). The Pb concentration at 5000m distance represented only 7% of the Pb concentration at 0 m distance from the factory. These High values found near battery factory and near the high ways (Mohammed Al-Qasim High Way) on the both sides.

Table 4: Total Pb concentration in soil for up-wind direction

Distance (m)	Total Pb concentration mg Pb/kg
0	12875
10	10840
20	10050
30	8567
40	6998
50	7100
100	6870
500	4356
1000	1134
3000	783
5000	890

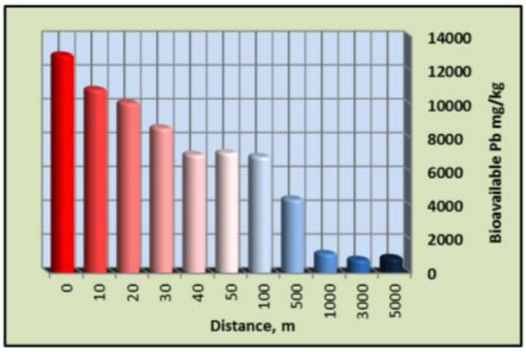

Fig. 9. Total Pb concentration in soil for the Babylon factory Down-wind

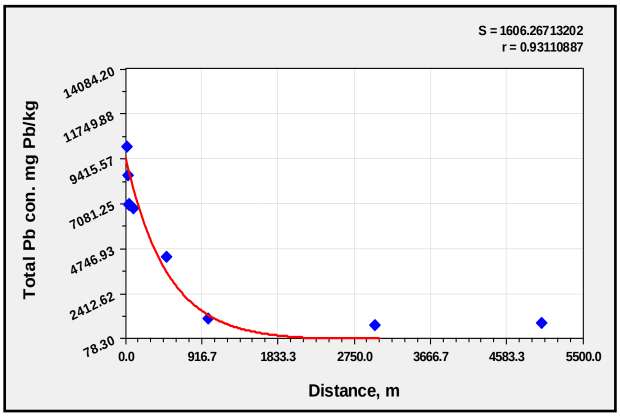

Fig. 10. Total Pb concentration in soil for the Babylon factory down-wind

In Fig. (11), it can show the clear comparison between the values of concentrations of Pb. That mean the wind is one of the important factors on the distribution of Pb concentrations on the air or on the surface of ground. The velocity is also effect factor on the dispersion of Pb concentrations.

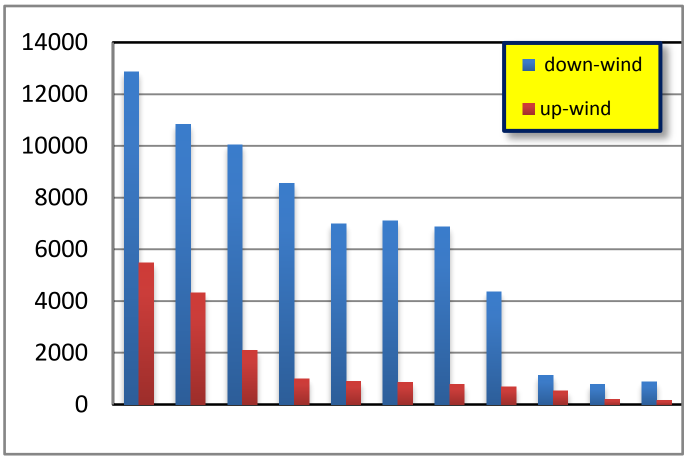

Fig. (11): Total Pb concentration in soil for the Babylon factory Down-wind vs up-wind as bar chart

VIII. CONCLUSION

1. Maximum Pb levels were found in soils near to the Pb emissions sources (highway, batteries factory and urban streets), therefore residents near these areas are at high- risk for Pb pollution and these sites can be a significant source of Pb intake by children.
2. For the highway the maximum Pb concentration was found close to the highway fence; the distance (0-20) m from the highway (both sides), represent the most effect zone for Pb emission; while after 100 m distance, highway influence had nearly disappeared.
3. More Pb in the soil was observed on the downwind side for both the highway andBabylon factory zones; the dominant wind direction have a significant effect on the Pb distribution.
4. The Pb concentration in the Baghdad city centre and the area near the Babylonfactory was above the standards of Pb in soil, indicating that the soil pollution with Pb has reached critical values that need remediation. Although the high way samples are within the Pb standards, they may reach to critical levels in future, as Pb is still introduced in the highway environment.
5. The area around the bus stations showed very low Pb contamination compared with the other studied areas (highway, Babylon factory, city centre). This can be ascribed to the relatively clean fuel used by the buses. (next studies).
6. Relatively high percentages of bio available Pb were found in polluted areas(Babylon factory zone, city centre and highway), compared with backgroundzone. This indicates that the bio available Pb especially comes from anthropogenic sources. Bio available Pb may easily transfer into the food chain rather than the Pb in the background area.

REFERENCES

[1] Abdullah SA (1990). Climatologically Atlas of Iraq, Iraqi Metrological Organization, Baghdad.

[2] Al-Ajzan (1984). Lead in the Roadside Environment in the City of Baghdad.

[3] Al-Kendy GY (2005). Lead Concentration in Soil of Mohamed Al-Kasim Highway.M.Sc thesis, Technological University, Baghdad, Iraq.

[4] Burke T (1983). Lead in Drinking Water. Technical Report, TR 187, WRC Environment, Medmenham Laboratory.

[5] Environmental Protection Centre (1990). Pollution Emissions from Cars. Technical Report, Iraqi Ministry of Health.

[6] Environmental News Service (2005). Iraq has Plenty of Oil but no Gasoline

[7] Hana AA and Al-Bassam KS (1983). A Survey of Lead Pollution in Baghdad. Water, Air and soil Pollution.

[8] Hanosh AH (2004). Iraqi Environment: Problems and scopes [Arabic].Al-Aarajee Press, Baghdad.

[9] Harrison RM and Laxen DPH (1981). Lead Pollution: Causes and Control, University Press, Cambridge.

[10] Khalid BY, Salih BM, and Isaac MW (1981). Lead Contamination of Soil in Baghdad City, Iraq.

[11] Khans DH (1980). lead in the Soil Environment. Technical Report, Chelsea College.

[12] University of London.Moore MR (1986). Lead in Human. In: Lansdown R and Yule W (Ed) Lead Toxicity, the John Hopkins University Press, Baltimore.

[13] Najimaldin A. M. (2008). Lead (Pb) Contamination of Soils. Baghdad, Iraq.

[14] NOAA (1999). National Oceanic Atmospheric Administration, Environmental Data Rescue Program.

[15] Nriagu JO (1978) the Biogeochemistry of Lead in the Environment, Biomedical Press, Amsterdam

[16] Ratcliffe JM (1981). Lead in Man and the Environment, Ellis Harwood Limited, Chichester.

[17] Ronald E (1988). Lead Hazards to Fish, Wildlife, and invertebrates: A Synoptic Review. Contaminant Hazard Reviews. [PDF]

[18] Smith M (1986). Lead in History .In: Lansdown R and Yule W (Ed) Lead Toxicity. The Johns Hopkins University Press, Baltimore.

[19] Tong S, Schimding EY, and Prapamontal T (2000). Environmental Lead Exposure: A public Health Problem of Global Concern. Bulletin of the World Health Organization.

[20] Tong S, Schimding EY, and Prapamontal T (2000). Environmental Lead Exposure: A public Health Problem of Global Concern. Bulletin of the World Health Organization.

[21] US.EPA (2005). Residential Lead Hazard Standards-TSCA Section 403.

[22] Ure AM, Quevauviller PH, Muntau H and Griepink B (1993). Speciation of Heavy Metals in Soil and Sediments an Account of Improvement and Harmonization of Extraction Undertaken under auspices of the BCR of the Commission of the European Communities.

[23] Wixon GB and Davies EB (1993). lead in Soil: Recommended Guidelines, Science Review, Northwood.

[24] Xintras C (2005). Impact of Lead-Contaminated Soil on Public Health. U.S Department of Health and Human services. [Online].