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HEAVY METAL POLLUTION OF ROADSIDE DUST SAMPLES WITH DIFFERENT TRAFFIC VOLUMES AT HILLA CITY

Suad Mahdi Glewa Al-Fatlawi
College of Engineering
University of Babylon
suadalfatlawi@yahoo.com

Mustafa Al-Alwani
School of Architecture Design and Environment
Plymouth University
mustafakhuder@yahoo.com

Abstract

To assess the pollution of heavy metal in roadside dust at Hilla city ,this research characterise road dust properties in roadside soils of two sites: along road with dense traffic (60 street, high traffic volume) and secondary road with lower traffic, a local road (40 street , low traffic volume).
Road dust samples (40 in total) were collected under stable weather conditions during the hot, dry season (August and September) of 2011. Road dust were collected from a total of 40 locations and analyzed for lead (Pb), Zinc (Zn), Nicle (Ni) , Chromium (Cr(III)) , Cobalt (Co) and Cadmium (cd) concentrations.The results showed that all heavy metal contents except Cd and Cr, are higher than acceptable values in natural soils. High contents of these elements could be attributed to anthropogenic effects related to traffic sources. The results of this study were compared with several cities around the world.

Keywords: Heavy metals, Dust, Pollution

الخلاصة

لتقييم مدى التلوث الحاصل من المعادن الثقيلة في الاتربة المجاورة للطرق في مدينة الحلة، تم دراسة الأتربة الماخوذة على جوانب الطرق من موقعين: شارع 60 ذو الكثافة المرورية العالية وشارع 40 ذو الكثافة المرورية الواطئة . تم جمع العينات في ظل ظروف الطقس مستقر خلال الموسم الحار والجاف (اب وايلول) من عام 2011. وقد تم جمع غبار الطريق من 40 موقعا وتحليلها لايجاد تراكيز كل من الرصاص والزنك (الخارصين)، النيكل، الكروم وا لكوبالت والكادميوم . أظهرت النتائج أن جميع محتويات المعادن الثقيلة باستثناء الكادميوم والكروم، هي أعلى من القيم المقبولة في التربة الطبيعية. ويمكن أن يعزى وجود تراكيز عالية من هذه العناصر إلى الآثار البشرية المرتبطة بمصادر حركة المرور. كم وتمت مقارنة نتائج هذه الدراسة مع العديد من المدن في مختلف أنحاء العالم.

Introduction

Roads are known as the second largest non-point source of creating pollution in urban environment (Fakayode and Olu-Owolabi 2003).
Human activity increases the levels of metals contamination in the environment. Metals pollution accumulates in the street dust, soil, and surface water samples

and influences the ecosystem in the world (Al-Radady, Davis, & French, 1994). The determination of metal in environmental samples including dusts, plants, soils and surface water is very necessary for monitoring environmental pollution (Tu¨ zen, 2003).

The most common heavy metals introduced to the environment by overland transportation are lead (Pb), zinc (Zn), and copper (Cu) (Kim et al. 1998; Sezgin et al. 2003; Banerjee 2003; Li et al. 2004). Use of leaded gasoline is primarily responsible for the Pb exposure (Chen et al. 2005), while tire wear and corrosion of roadside safety fences contribute to Zn pollution (Blok 2005). Cu is mainly released from the wear of brake linings, which is also an important source of Pb and Zn. All three metals are deposited in the form of dust and can form aerosols when resuspended (Han et al. 2007).The source of Ni and Cr in street dust is believed to be due to corrosion of vehicular parts (Lu*et al*., 2009) .

Road dust, particularly the fine particle, can be absorbed by human through ingestion, inhalation, and dermal absorption. In today's urban area, road dust has been disturbed severely by human activities. As a result, the components of road dust in cities are significantly affected by anthropogenic pollutants. Particularly, potential toxic metals from anthropogenic sources in road dust may significantly affect the human health and well-being. Pb, Cr, Zn, Cd, and other toxic metals will continue to accumulate in urban environment due to their non-biodegradability and long residence time, thus they are known as ''chemical time bombs'' (Shi et al. 2008).

Solid particles that accumulate on outdoor ground surfaces in urban areas are collectively referred to as ''street dust''. Street dusts are characterized by short residence times ''...although they may contain substantial metal concentrations while street dusts represent only rather recent accumulate of pollutant'' (Harrison, Laxen, & Wilson, 1981).

The two main sources of street dust and, consequently, of the trace elements found therein are deposited airborne particles and displaced urban soil particles (Baptista & De Miguel, 2005).

As there is no Iraqi limits concerning acceptable and maximum permissible values of heavy metals hold in soils Naturally , limits set by Fabis ,1987 are used to compare results of this study.

Study Area

60 street is the busiest and most heavily loaded traffic pathway in Hilla city . Most of the vehicles running on this road use gasoline and diesel. A large number of people traveling daily on this highway are subjected to its dusty environment. A map showing sample points location is presented in Fig. 1.

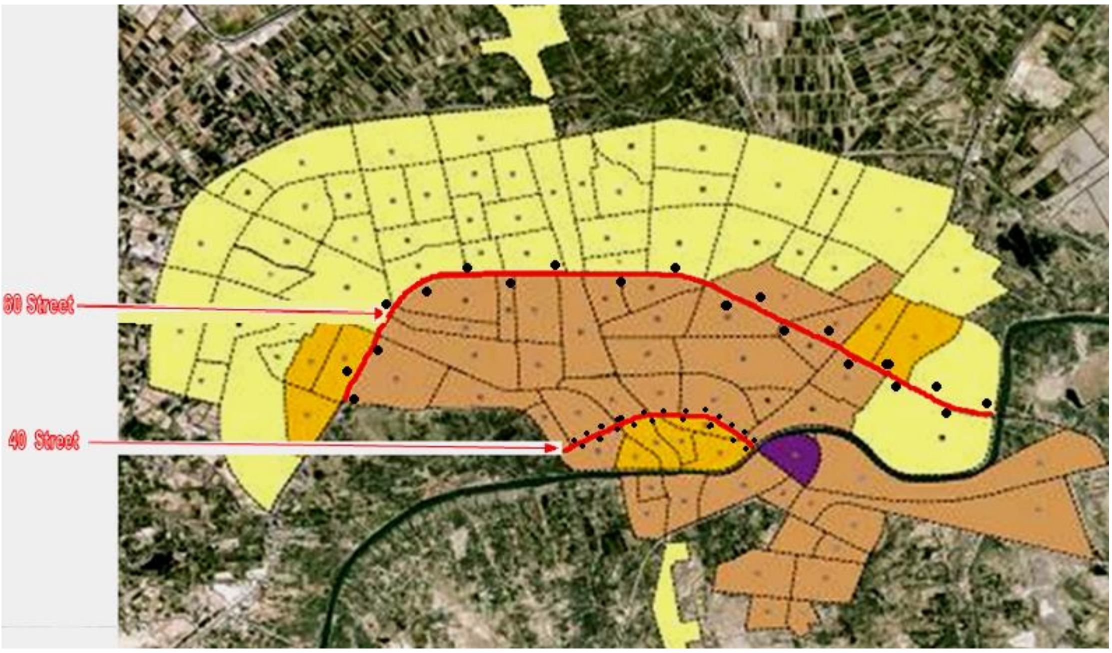

Fig. (1) 60 street and 40 street at Hilla city and sample points location

The region surrounding this highway is a rapidly developing residential and business area where high-rise buildings are also under construction. In other hand 40 street is lower traffic volume than 60 street.

Materials and Methods

Road dust and soil samples were taken from a total of 40 locations within the area. Twenty locations were adjacent road with dense traffic (60 street, high traffic volume) , at each of these 20 locations, dust samples were collected within 0.5 m distance from the edge of the pavement. These surface soil samples were taken from the top (0–2) cm of soil. the next 20 locations were along secondary road with lower traffic, a local road (40 street , low traffic volume), surface soil samples (0–2 cm) were taken within 0.5 m distance from the end of the pavement . At each sampling point, three sub-samples, were taken and then mixed to obtain a bulk sample. Such a sampling strategy was adopted in order to reduce the possibility of random influence of urban waste not clearly visible.

Samples were placed in plastic bags, carefully labeled and taken to the laboratories for analysis. Soil samples were digested with HCl, NHO_3 and H_2O_2 according to U.S.EPA 3050B method (USEPA 1992).
Heavy metal (Cr, Ni ,Cd, Co, Pb, Zn and Mn) contents in digested samples were determined using atomic absorption spectrometry (Buck Scientific 210 VP model equipped with deuterium lamp for background corrections). A standard sample (MESS-3) was used to check the precision of the analysis.

Results and discussion

Total Pb, Cr , Zn, Ni, Co, and Cd concentrations were determined in 60 street dusts and 40 street dust ; results are given in Figs. 2, 3, 4, 5, 6, 7, 8,9,10,11,12, and 13 as graphs.

According to mean values of heavy metals from the above graphs,the mean metal concentration values are arranged in the following order:
C Pb40 > C Zn60 > C Pb60 > C Zn40> C Ni60 > C Ni40 > C Cr40 > C Co60 >C Cr60 > C Co40 > C Cd60 > C Cd40 where C stands for Concentration.

The results showed that all heavy metal contents except Cd and Cr, are higher than acceptable values in natural soils. High contents of these elements could be attributed to anthropogenic effects related to traffic sources.
Lead The highest Pb mean concentration is found to be at 40 street, 738.4 mg/kg , as it seen from figure (12) . In these road dusts, the sampling sites were associated with high frequency of stop and startup of vehicles. Pb comes mainly from automobile exhaust and vehicle emissions, for example tire wear, bearing wear, wear of brake linings However, the mean concentration of lead for street dust samples was lower than for dust samples reported by other literature, such as 1,030 mg/kg for London. The mean concentrations of lead at 60 street is 430.8 mg/kg so it was lower than for dust samples reported by Bahrain 697.2 mg/kg and for Aviles, Spain, 514 mg/kg . The higher level of Pb might be attributed to the wide use of leaded gasoline in Hilla city.
The ratios of the highest mean concentrations of the Pb to the background metal levels of uncontaminated soils as it seen from table (1) are approximately 7.38 .
Zinc The highest Zn mean concentration has been found to be at 60 street, 697.35 mg/kg , as it seen from figure (7) . Zn compounds are used extensively as anti-oxidants and as detergent/dispersant improving agents for motor oil. Huhn et al. (1995) have identified vehicle brakes and tire wear as possible sources of Zn.bThe ratios of the highest mean concentrations of the Zn to the background metal levels of uncontaminated soils are approximately 2.3. However, the mean concentration of Zinc for 60 street dust samples was lower than for dust samples reported by the city of Aviles, 4829 mg/kg . For 40 street, Zn mean concentration is 436.5 mg/kg as it seen from figure (13).
Nickel has many common industrial uses due to its unique chemical properties. The source of Ni in street dust is believed to be due to corrosion of vehicular parts (Lu *et al*., 2009) .The high rate of corrosion and wear from old vehicles (as a result of the high patronage in imported used cars) plying these roads could have accounted for the significant levels of anthropogenic contributions of Ni in the road dust. The highest Ni mean concentration has been found to be at 60 street, 98 mg/kg . The ratios of the highest mean concentrations of the Ni to the background metal levels of uncontaminated soils are approximately 1.9, However, the mean concentration of Ni for street dust samples was lower than for dust samples reported by the Tokat city . In the other hand , for 40 street, Ni mean concentration is 81.6 mg/kg as it seen from figure (9).
Chromium the source of Cr in street dust is believed to be due to corrosion of vehicular parts (Lu *et al*., 2009) . The mean Cr level in the road dust at 60 and 40 streets (40.2 and 48.1 mg/kg respectivily) are not exceeded the Acceptable values of 100 mg/kg ,so, they were considerable with a slight dependence with traffic volume (fig.2 and fig.8 respectivily) , moreover, However, the mean concentration of Cr for 60 and 40 streets dust samples was lower than for dust samples reported by the city of Bahrain, Kayseri and Xian**.**
Cobalt The highest mean Co concentration has been found at 60 street (42.25 mg/kg). Inspite of the higher concentration of this metal with respect to all other cities in litrature (table 1) , this concentation was within acceptable value as it

seem from table (2) , so as to Ni mean concentrationv at 40 street (37.8 mg/kg) as it seen from figure (11).

Cadmium is a relatively rare heavy metal, which occurs naturally in combination with other metals. Cadmium has been observed in road dust due to its presence in automobile fuel and in soil. Therefore inhalation exposure to Cd can occur from road dust. After inhalation, the absorption of Cd compounds may vary greatly depending upon the particle sizes and their solubility. Cadmium is a metal, which can cause severe toxicity in humans. Prolonged exposure to Cd can affect a variety of organs with the kidney being the principal target. Compared with Pb,Zn, Ni, Cr the level of Cd contamination was not heavier,The highest mean Cd concentration has been found at 60 street (3 mg/kg) . In this work, Cd concentrations were found to be lower than the other studied metals. Naturally in soils, acceptable values of Cd concentrations vary around (3 mg/kg) dry soil (Fabis 1987), so that in this study, Cd concentrations of road dusts are within the acceptable limite .Cd concentrations found in this study are higher than of dust samples reported by other literature such as Amman, Birmingham, Coventry, Luanda and Yozga. For 40 street, Cd mean concentration is 2.6 mg/kg as it seen from figure (10).

Table 1 Heavy metal concentrations likely to exist in soil as milligram per kilogram dry soil (Fabis 1987)

Metals	Concentrations	Acceptable values	Maximum values
Lead	0.1-20	100	100
Cadmium	0.1-1	3	3
Chromium	10-50	100	100
Copper	5-20	50	100
Nickel	0.1-50	50	50
Mercury	0.1-1	2	2
Zinc	10-50	300	300
Boron	5-30	25	-
Cobalt	1-10	50	-
Molybdenum	1-5	5	-
Selenium	0.1-5	3	-
Arsenic	2-20	20	-
Titanium	-	500	-
Vanadium	10-100	50	-
Uranium	-	5	-

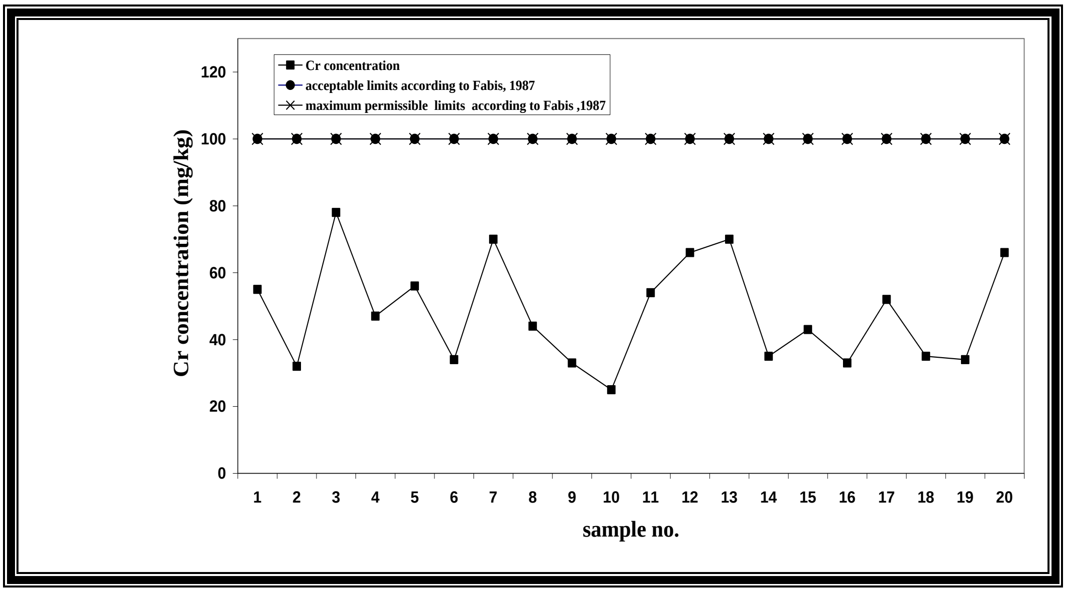

Fig (2) variation of Cr concentrations with number of dust samples of 60 street.

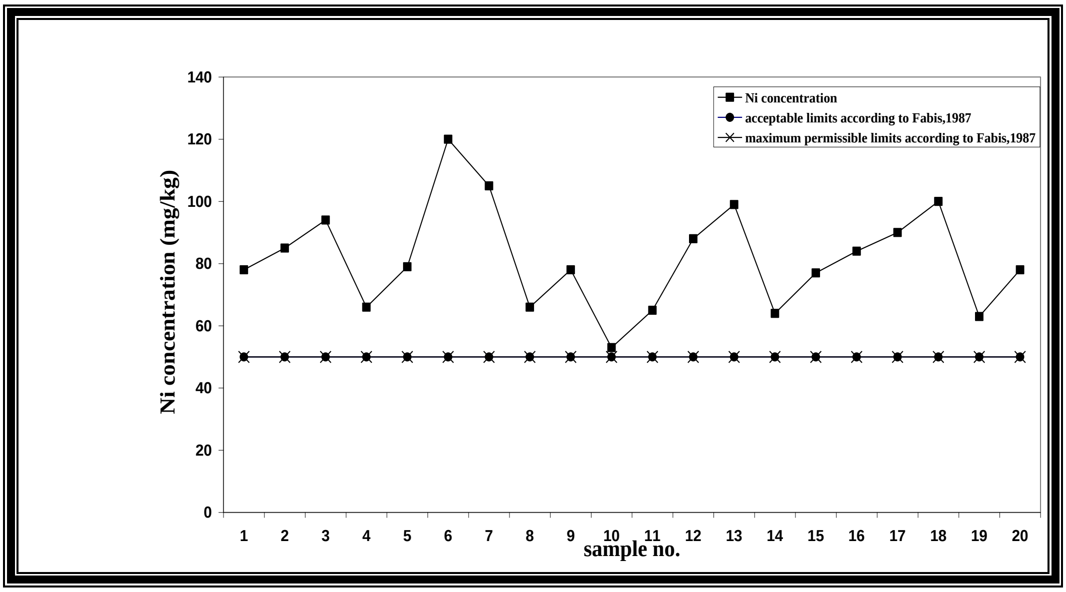

Fig (3) variation of Ni concentrations with number of dust samples of 60 street.

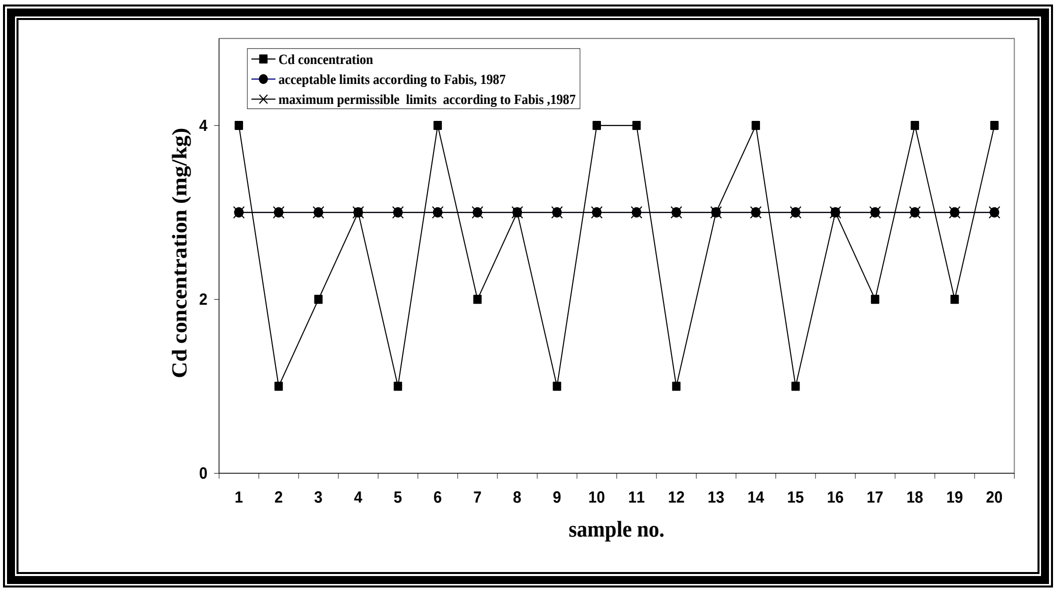

Fig. 4 variation of Cd concentrations with number of dust samples of 60 street

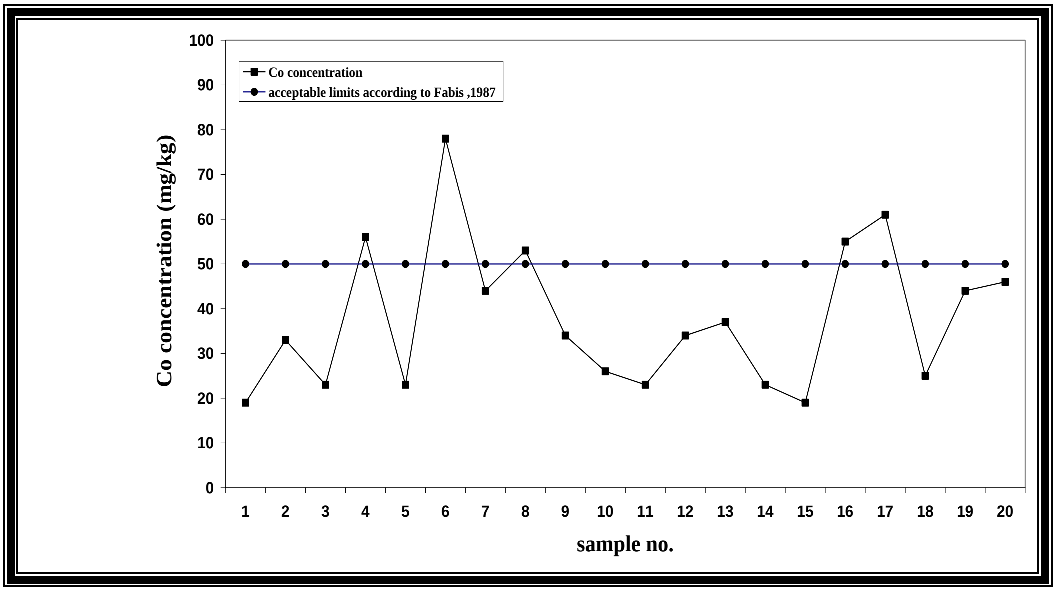

Fig (5) variation of Co concentrations with number of dust samples of 60 street.

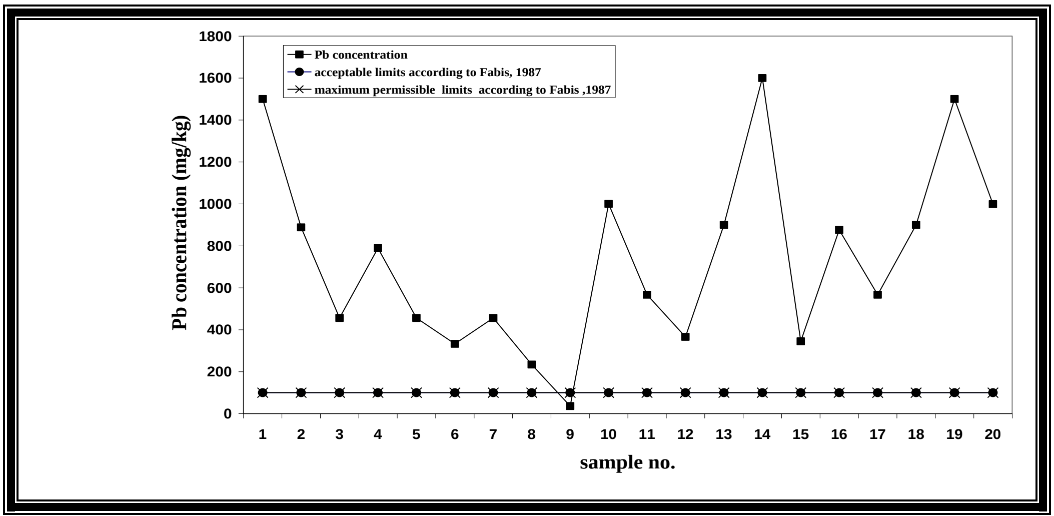

Fig (6) variation of Pb concentrations with number of dust samples of 60 *street.*

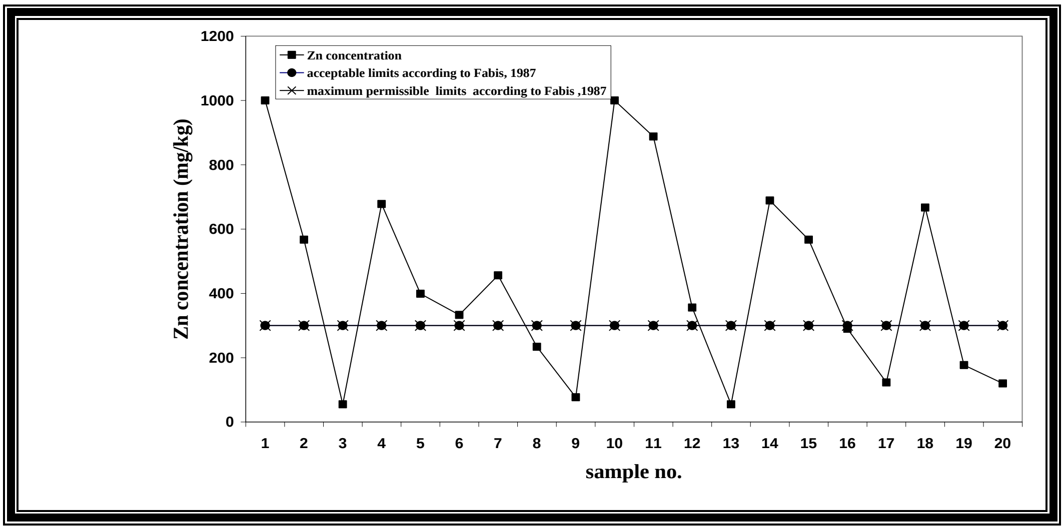

Fig (7) variation of Zn concentrations with number of dust samples of 60 street.

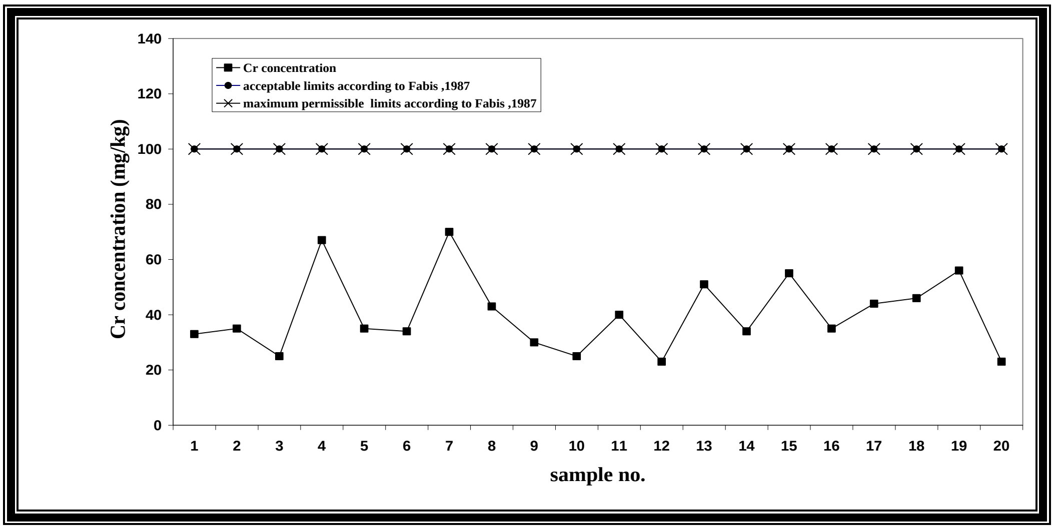

Fig (8) variation of Cr concentrations with number of dust samples of 40 street.

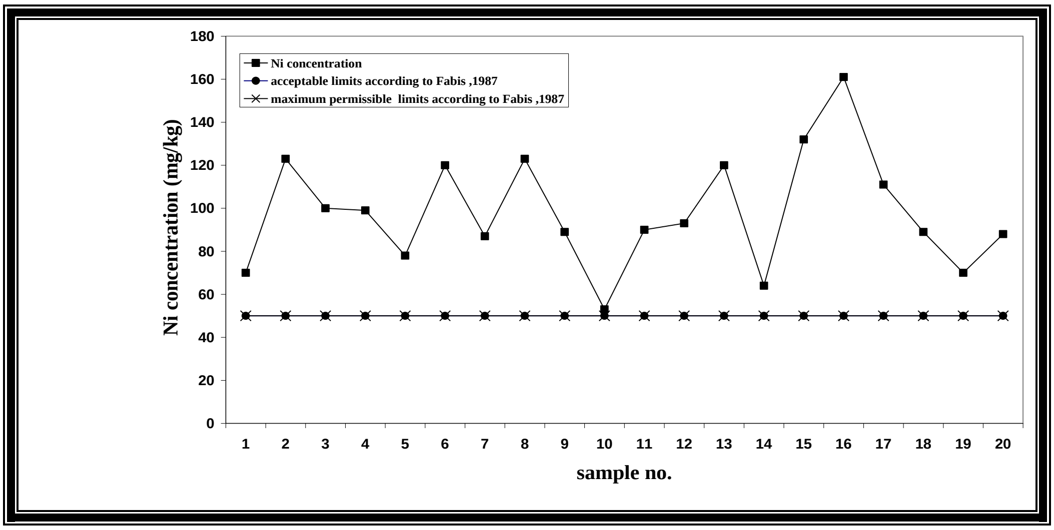

Fig. 9 variation of Ni concentrations with number of dust samples of 40 street

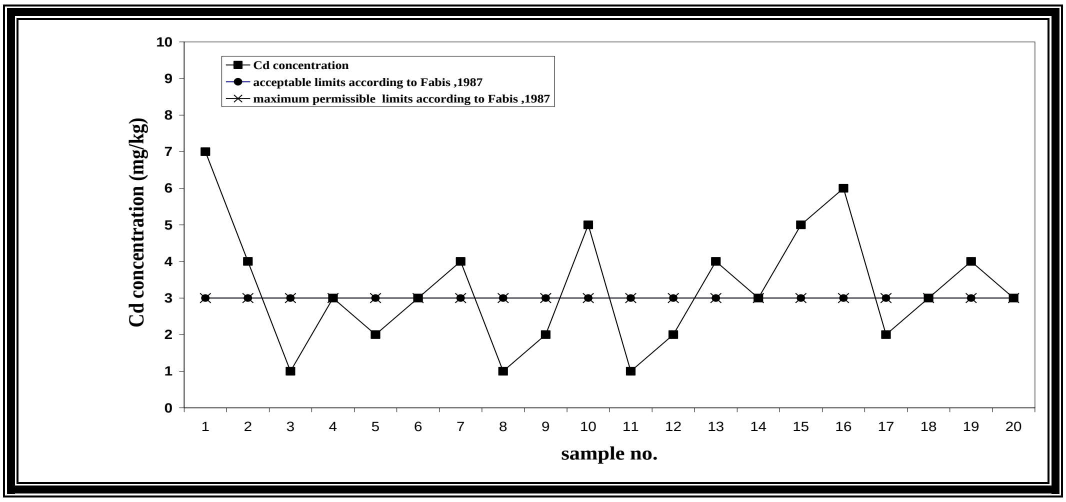

Fig. 10 variation of Cd concentrations with number of dust samples of 40 street

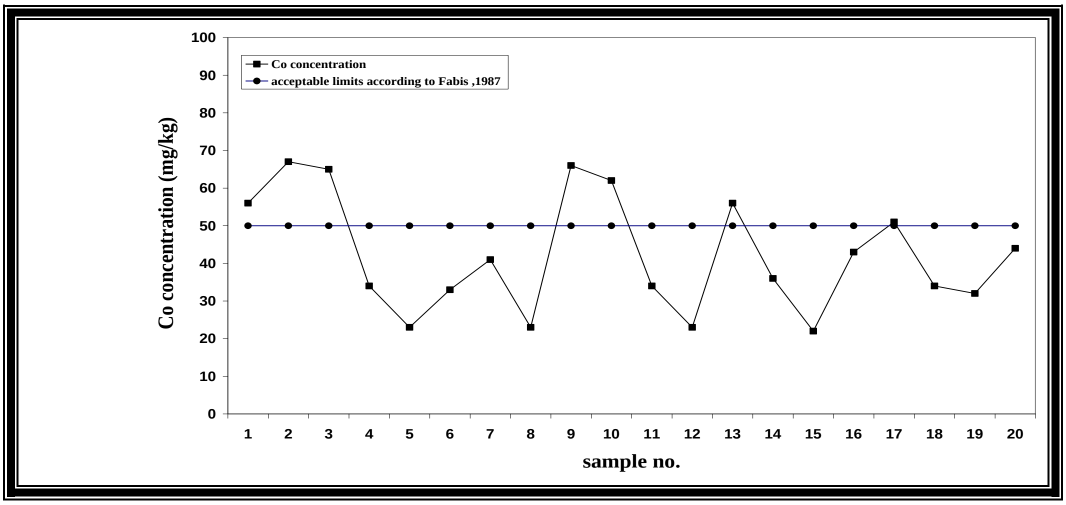

Fig (11) variation of Co concentrations with number of dust samples of 40 street.

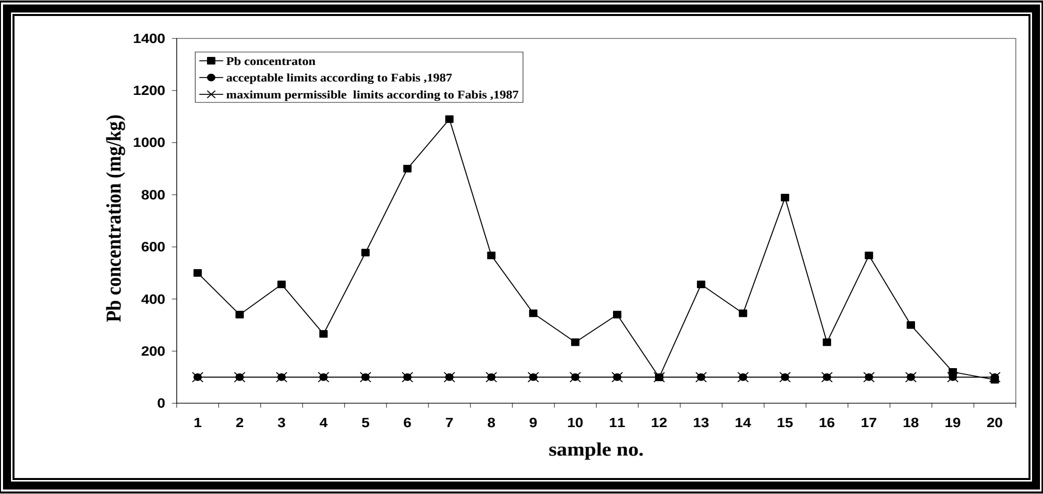

Fig (12) variation of Pb concentrations with number of dust samples of 40 street.

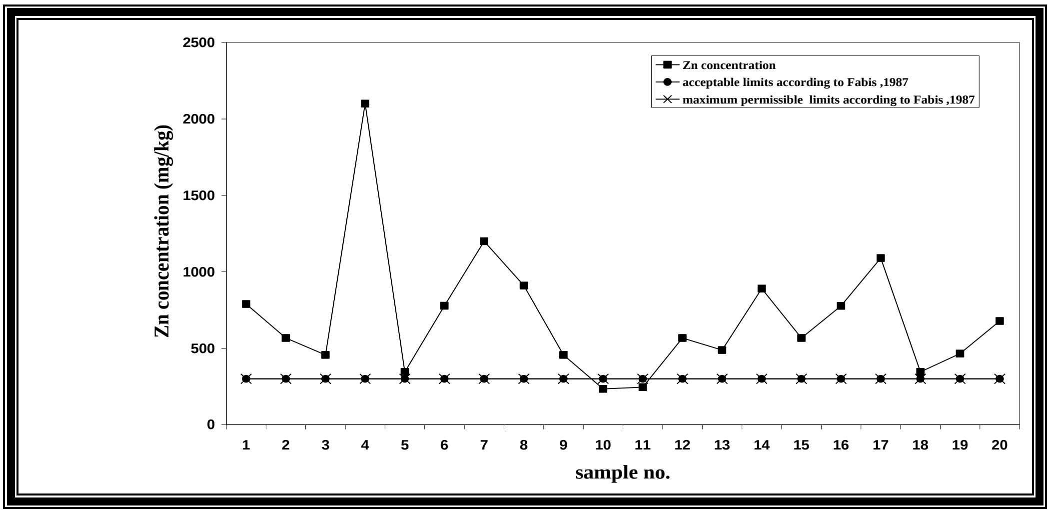

Fig (13) variation of Zn concentrations with number of dust samples of 40 street

Table (2) Mean concentration of metals (mg/kg) in street dust in several cities.

City	Fe	Cu	Cd	Pb	Zn	Cr	Co	Mn	Ni
Amman[a]	7.13	177	1.7	236	358	_	_	_	88
Aviles[b]	42.2	183	22	514	4,829	42	_	_	_
Bahrain[c]	_	_	72	697.2	151.8	144	_	_	_
Birmingham[d]	_	467	1.6	48	534	_	_	_	_
Coventry[e]	_	226	.9	47.1	385	_	_	_	_
Kayseri[f]	_	66.7	10.9	165.5	_	73	26.1	274	57
London[g]	26000	155	3.5	1,030	680	_	_	258	_
Manchester[h]	8.7	113	_	265	653	_	_	415	_
Luanda[I]	11.5	42	1.1	315	317	26	2.9	_	10
Tokat[j]	_	38	5.4	266	98	41	22	_	128
Xian[k]	_	95	_	230.5	421.4	167	_	687	_
Yozga[tl]	_	37.7	3	69.2	_	32.7	24	852	77

[a]Al-Khashman (2006); [b] Ordonez, Loredo, De Miguel, (2003); [c] Akhter and Madany (1993); [d] Charlesworth ,et al., (2003); [e] Charlesworth et al., (2003); [f] Divrikli et al., (2003); [g] chwar,Moorcroft, Laxen, Thompson, & Armorgie (1988); [h] Robertson, Taylor, & Hoon (2003); [I] Baptista and De Miguel (2005); [j] Tu¨ zen (2003); [k] Yongming et al., (2006); [l] Divrikli et al., (2003)

Conclusions

Road dust is an increasing problem for developed and developing countries and is a source of various diseases . In this research ,the mean metal concentration values are arranged in the following order: C Pb40 > C Zn60 > C Pb60 > C Zn40> C Ni60 > C Ni40 > C Cr40 > C Co60 >C Cr60 > C Co40 > C Cd60 > C Cd40 where C stands for Concentration.

As it could be seen the mean concentration of most heavy metals in the soil samples of the study area are higher than maximum and acceptable values in soils. The highest levels of most studided metal concentrations were found in the samples from 60 street which is heavy traffic. While the lowest levels of studed metal ions were noted in the 40 street dust samples which is low traffic .
Due to the rapidly increasing population of Hilla city , the pollution status along this roads is expected to increase in the coming years. Some protective measures such as use of public transport; conversion of liquid fossil fuel to gaseous fuel and having more green areas is suggested to combat this problem. It is recommended that in addition to regular monitoring of heavy metals in road dust of the roads, periodic air sampling should be conducted in order to observe the seasonal pollution trends in this region.

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