Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

p-ISSN: 0972-6268
(Print copies up to 2016)
e-ISSN: 2395-3454

Vol. 21 | No. 5 (Suppl) | pp. 2241-2248 | 2022

Original Research Paper

https://doi.org/10.46488/NEPT.2022.v21i05.018

Open Access Journal

Estimation of Soil Contamination with Heavy Metals in the Streets of Al-Diwaniyah City in Al-Qadisiyah Governorate, Iraq

Kawthar Hassan Obayes
Department of Physics, College of Education, University of Al-Qadisiyah, Qadisiyah Governorate, Iraq
†Corresponding author: Kawthar Hassan Obayes; kawthar.aljelehawy@qu.edu.iq

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com

Received: 25-06-2022
Revised: 21-07-2022
Accepted: 30-07-2022

Key Words:
Heavy metals
Al-Diwaniyah city
Soil contamination
Human health

ABSTRACT

This study aims to calculate the contamination levels of the elements (Pb, Cr, Ni and Cd) in soil samples taken from the Iraqi city of Al-Diwaniyah in the Al-Qadisiyah Governorate. Twenty samples of dust collected between the street and the sidewalk were collected for some areas of Al-Diwaniyah city, and then analyses were conducted to determine the concentrations of toxic and carcinogenic elements with the global determinants. The study's findings revealed that there were very high concentrations of heavy metals compared to the internationally permissible limits, where the highest concentration of lead and chromium was in Main Street - Al-Asry District (112.6 ppm) and (115.1 ppm), respectively, and the lowest concentration of them was in Health Center Street - Al-Furat District (15.8 ppm) and (48.8 ppm), respectively, where the lowest lead value exceeded the internationally permitted limits and the lowest chromium value fell below the permissible limit. As for nickel and cadmium, the highest values of nickel and cadmium appeared in Main Street - Eastern Republican District which amounted to (135.2 ppm) and (2ppm), respectively, which is significantly greater than the internationally permissible limit, while the lowest values appeared in University Street - University District, which is (3.6 ppm) (0.05 ppm) respectively, which is less than the internationally permissible limit. It is noted from the results obtained that high rates of heavy metals concentrations in the soil samples of Al-Diwaniyah City indicate that the main factor in this rise is pollution caused by human activities, and the reason for this is due to the effect of vehicle launchers and some launchers of workshops and factories, as well as its presence in sand-laden dust of various sources. This rise might have an effect on the environment and human health at all of the selected sites.

INTRODUCTION

Heavy metals are natural elements from the Earth's crust that cannot be decomposed or broken down to a small degree. They enter the human body through air, food, and drinking water (Ibe et al. 2018). Some heavy metals are necessary for the human body, however, an increase in their concentration leads to poisoning (Al-Jaberi 2014). Exposed soils in many regions of the world pollute toxic heavy metals as a result of human activity in many fields, especially in industry, agriculture, and addition phosphate fertilizers, manufacturing, mining, and waste disposal. These activities are a significant source of the heavy metal-laden particles that pollute the air (Al-Dabbas et al. 2018). These particles are deposited directly on the surface of the soil or other surfaces, as rain washes them and transfers them to dissolved or suspended water, and ultimately to the soil (Banjanac et al. 2006). The sources of other pollution with heavy metals and important human activity in the sewage disposal plants water, reflected this pollution problem when using soil contaminated for food production by crop plants as easy to enter these elements in the food chain, which increases the risk to human health (Salman et al. 2021). Metal and semi-metal ions are environmental pollutants resulting from industrial human activity such as mining, metal smelting, internal combustion machine exhaust, petroleum production, dyes, and their waste, agricultural applications (fertilizers and pesticides), sewage, waste disposal, and others (Muhammad et al. 2021). The problem lies in the ions of these heavy elements (metals and metalloids). When available in high concentrations, they are toxic to humans and other organisms, even though some of this is necessary for living things in small concentrations (Jaradat & Momani 1999). When the concentration of these elements is high in the soil solution, they may seep into the surface and groundwater or be absorbed by plants, and then enter the food web and directly or indirectly be absorbed by humans or animals. Numerous elements are present in these metals, some of which are known for their physiological role in plants, such as copper (Cu), cobalt (Co), iron (Fe), nickel (Ni) and zinc (Zn). Among them are those whose physiological function is not known, such as cadmium (Cd), lead (Pb), selenium (Se), aluminum (Al), mercury (Hg), chromium (Cr), arsenic (As), and others (Al-Khashman 2007). It can be said that pollution with these heavy elements is one of the biggest problems at present for soils and water sources (Aydin et al. 2012). The study seeks to compare the results with the internationally permitted limits by measuring the concentrations of (Pb, Cr, Ni, and Cd) in soil samples taken from Al-Diwaniyah city in Al-Qadisiyah Governorate, Iraq.

THE HEAVY METALS

Lead (Pb)

Lead is one of the elements that must be monitored continuously due to its high danger to humans and the environment. Continuous and regular exposure to lead leads to mental retardation. This element may accumulate in the bones and does not remain there all the time. It is transmissible through the bloodstream and may pass, for example, to the fetus through the placenta in pregnant women. It may also come out dissolved in the mother's milk for her newborn (Arifin et al. 2015). Long exposure to lead or one of its compounds leads to lower levels of intelligence, and an increase in lead level can lead to miscarriage, infertility, hormonal changes, menstrual disorders, and delayed puberty (Borošová & Klöslová 2006).

Chrome (Cr)

Inhalation of chromium-containing dust produced by laboratories leads to severe damage to the nasal tissue, which leads to perforation of the nasal septum. Chromium fumes are harmful as they cause asthma, shortness of breath, and coughing and lead to pneumonia. Inhalation of large quantities of chromium dust leads to the occurrence of lung tumors (Ferreira-Baptista & De Miguel 2005). Eating foods containing high concentrations of chromium leads to stomach cancer (Ferreira-Baptista & De Miguel 2005). Also, skin contact with chromium for a long time leads to itching (allergy in the skin), which leads to skin redness, and the appearance of a rash on it similar to eczema (Gowd et al. 2010).

Nickel (NI)

Found on a large scale in the environment, the natural sources of nickel are volcanic dust emissions, erosion of rocks and dust, burning of fuel, emissions during mining and refining processes, and consumption of large quantities of nickel-containing products inevitably lead to environmental pollution (Tapsoba et al. 2009). The most significant sources of this element's pollution are landfills, which contaminate groundwater, and acid rain, which raises the concentration of this element in the soil and then the groundwater, which increases the consumption of this element by microbes, plants, and animals. Exposure to nickel occurs through inhalation and ingestion are the most common cases among workers in the metallurgical industry. Epidemiological studies show an increase in mortality rates among refinery workers from cancer in the lung and sinuses, and chronic exposure to dust and nickel fumes is associated with smelting, welding, and the oil refining industry (Tapsoba et al. 2009).

Cadmium (Cd)

Cadmium is one of the most dangerous elements, toxic to humans and animals. Cadmium is found in all natural soils, which is very low, not exceeding a maximum of one part per million. Industrial development has led to the pollution of soil, water, air, and plants with this element, and it results from various industries that throw their waste into the surrounding environment without treatment. Studies reveal a significant concentration of cadmium in soils close to industrial facilities that discharge this element into the environment, whether by chimney nozzles discharging gases or dust that can poison people and animals. The risk of this element to the human body comes from the fact that it can accumulate in key organs and tissues and that the excretion process for it can be nearly nonexistent (Morais et al. 2012).

MATERIALS AND METHODS

Twenty soil samples were collected from some areas of Al-Diwaniyah city in Al-Qadisiyah Governorate, Iraq (Fig. 1), distributed over industrial, commercial, residential, and traffic areas. The samples were taken from the dust collected between the street and the sidewalk and kept inside nylon bags equipped with a special modeling form for each area, including the sample number, the name of the area, information about the nature of the area, the movement of transportation and the coordinates of the site shown in (Table 1). Then the samples were prepared for the final analysis according to the Jackson method, where the sample was crushed and placed in a beaker washed with distilled water and dried, and placed in the oven at a temperature of (100°C) for 2h utilizing a delicate balance and a beaker with a capacity of, for drying the dried sample (250 mm). The sample was then digested by adding (15 mL) of acid HCl and (5 mL) of concentrated nitric acid HNO3 to the sample. The sample was then placed in a sand bath at a temperature of (200-225) for (45-60) min, after which the beaker was cooled to laboratory temperature and added (5 mL) of acid HCL and heated in a sand bath until dryness, where this stage took about (10-15)

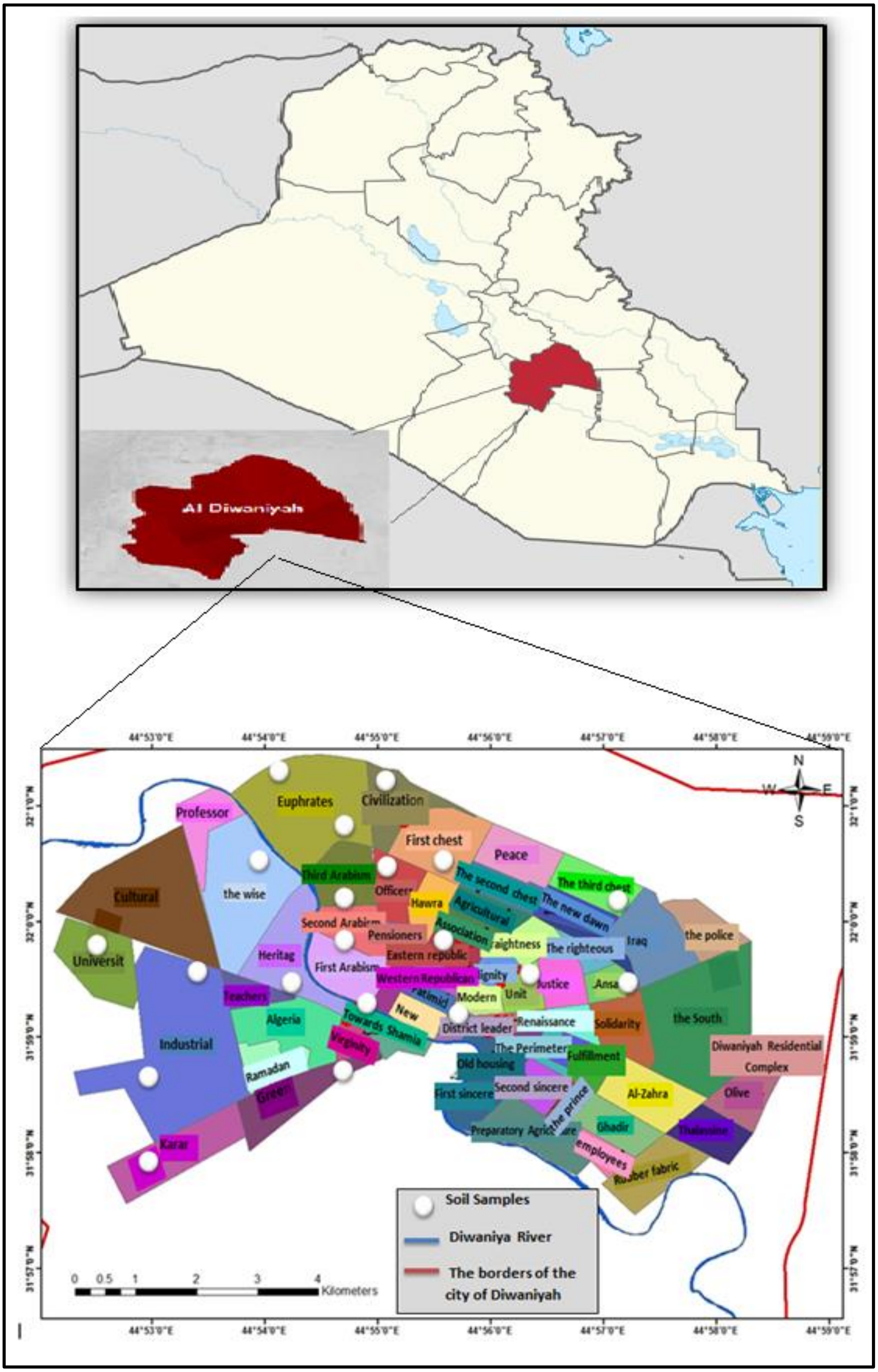

Fig. 1: Iraqi map with sampling locations from Al-Diwaniyah city.

Table 1: The regions for collecting samples in the streets of Al-Diwaniyah city.

Sample No.	Area name	Nature of the area	Transportation movement	Coordinates X	Coordinates Y
S1	University Street / University District	Residential + Commercial	High	44°52'25"	31°59'39"
S2	Al-Jawahiri Street / Al-Hakim District	Residential + Commercial	High	44°53'42"	32°0'17"
S3	Al-Gomhoria School Street / Al-Askari District	Residential + Commercial	High	44°55'22"	32°0'47"
S4	College of Medicine Street / Al-Furat District	Traffic	High	44°54'37"	32°0'59"
S5	Main Street / Eastern Republican District	Old residential + commercial + industrial (blacksmith shops)	High	44°55'42"	31°59'33"
S6	Main Street / Al Wahda District	Residential + Industrial (Blacksmith shops)	High	44°56'16"	31°59'35"
S7	General Teaching Hospital Street / Al-Orouba Third District	Traffic	High	44°55'14"	32°0'52"
S8	Maternity Hospital Street / Al-Orouba District	Traffic	High	44°54'44"	31°59'29"
S9	Main Street / Industrial District	Industrial (auto repair shops)	High	44°53'9"	31°58'58"
S10	Main Street/ Al-Hadara District	Residential + Industrial (fuel filling station + ice lab)	High	44°55'5"	32°0'58"
S11	Al-Qadisiyah Filling Station Street / Al-Sadiq District	Traffic	High	44°56'4"	31°58'37"
S12	Health Center Street / Al-Furat District	residential	medium	44°54'37"	32°0'59"
S13	Main Street - Al-Asry District	Residential + Industrial (gas filling station + ice lab + blacksmith shops)	High	44°55'54"	31°59'21"
S14	Al Thawra Street - Sob Al Shamiya District	Residential + commercial + industrial (car repair shops + gas station + blacksmith shops)	High	44°55'10"	31°59'7"
S15	Old Camp Street - Al-Karar District	Residential + Industrial (car repair shops + blacksmith shops)	High	44°52'47"	31°57'57"
S16	Car Showroom Street - Industrial District	Industrial (car repair shops + gas filling station)	High	44°53'18"	31°59'7"
S17	Main Street/ Officers District	Traffic	High	44°55'9"	32°0'10"
S18	Al-Saah Square Street / Al-Adaria District	Traffic	High	44°54'44"	31°59'9"
S19	Algeria Street - Algeria District	Residential + Commercial	High	44°54'9"	31°58'57"
S20	City Street - New District	Old residential + commercial + industrial (car repair shops + blacksmith shops)	High	44°55'22"	31°59'23"

minutes. Then the beaker was cooled and (5 ml) of HCL acid and (50 ml) of hot distilled water were added to wash the sides of the beaker from the traces of the sample. Then heat the mixture to boiling point for 2-3 minutes. Then the filtration was done with filter paper, where the filtrate was placed in a volumetric vial with a capacity of (100 mL). The insoluble precipitate was washed with distilled water, the washing water was added to the filtrate, and the volume was completed to 100 mL (Al-Dabbas et al. 2018), and then sent for analysis by atomic absorption spectrometer in the service laboratory of the Department of Biology, College of Science/University of Baghdad.

RESULTS AND DISCUSSION

The concentrations of (Pb, Cr, Ni, Cd) were calculated in soil samples for the streets of Al-Diwaniyah city in Al-Qadisiyah Governorate, Iraq using atomic absorption spectroscopic device after conducting geochemical analyzes on all samples, where the calculations and statistical equations were performed within the values and concentrations that were obtained for the elements. The concentration rates of lead, chromium, nickel, and cadmium in the soil of some streets of Al-Diwaniyah city reached (59.04 ppm) (83.075 ppm) (58.515 ppm), and (0.579 ppm), respectively, as shown in (Table 2).

Lead (Pb)

The results of the research showed that the concentration of this element in the soil in some selected sites from Al-Diwaniyah city in Al-Qadisiyah Governorate, Iraq were higher than the internationally permissible limit. The general

Table 2: Concentrations of heavy metals in units (ppm) in soil samples for the streets of Al-Diwaniyah city.

Sample No.	Pb	Cr	Ni	Cd
S1	20.3	66.7	3.6	0.05
S2	29.5	78.3	15.7	0.12
S3	18.9	61.2	8.9	0.09
S4	38.0	78.2	16.7	0.20
S5	88.7	95.3	135.2	2.00
S6	98.2	103.0	49.0	0.33
S7	18.6	60.6	54.4	0.70
S8	27.5	75.3	56.0	0.72
S9	63.5	88.7	82.2	0.60
S10	110.2	109.5	65.2	0.65
S11	32.8	70.3	45.9	0.60
S12	15.8	48.8	64.9	0.55
S13	112.6	115.1	67.6	0.70
S14	97.7	102.3	88.2	0.40
S15	93.8	99.5	59.0	0.82
S16	88.3	95.1	98.5	1.60
S17	60.2	85.9	62.5	0.30
S18	50.4	70.3	43.8	0.25
S19	37.3	73.5	54.3	0.40
S20	78.5	83.9	98.7	0.50
Average	59.04	83.075	58.515	0.579
World average (Lindsay 1979)	10	100	40	0.5

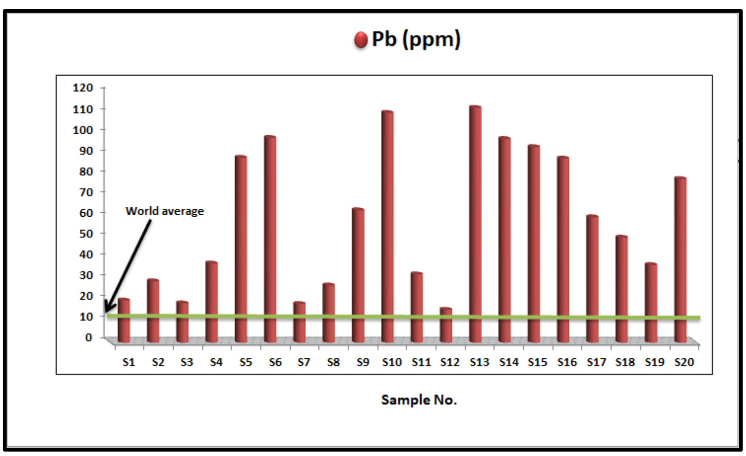

Fig. 2: Pb concentration in soil samples selected from Al-Diwaniyah city.

average of lead concentration in the soil of Al-Diwaniyah city areas according to the results of the current study was (59.04 ppm) when compared with the global average concentration of lead in unpolluted soils (10 ppm) (Lindsay 1979). The concentration of lead exceeded the normal rate by nearly (5 times), as shown in (Fig. 2). This rise is evident in the industrial areas if the results are compared to the natural rate of lead concentrations in uncontaminated soil, as these areas contain many factories such as the ice factory and the Al-Kashi factory, as well as containing electric power plants, blacksmithing workshops, and vehicle repair workshops of various kinds. In addition, it can be considered that heavy traffic in these areas is the second main cause of lead pollution in these areas. The more factories there are in the region, the more vehicles, cars, and various means of transportation move, and this, in turn, releases large amounts of burnt fuel exhaust containing lead compounds added to tetraethyl lead (Steinbock 1979).

Chromium (Cr)

The results showed that the average concentration of chromium in soil samples selected from Al-Diwaniyah city was (83.075 ppm) less than the internationally permissible rate (Lindsay 1979). However, its concentrations exceeded the permissible limit globally in some areas, including (S6, S10, S13, and S14) which are shown in (Fig. 3). These areas are considered industrial because they contain car repair workshops, paint shops, car garages, gas filling plant, and the widespread use of electric power generators.

Industrial wastes and emitted gases and vapors release chromium into the air and then deposit it on the surface of the soil. As for residential areas and commercial areas, the concentration of chromium is less than the permissible limit, because these areas are considered free from the reasons and factors mentioned previously that helped the high concentration of the chromium in the environment (Muhammad et al. 2020).

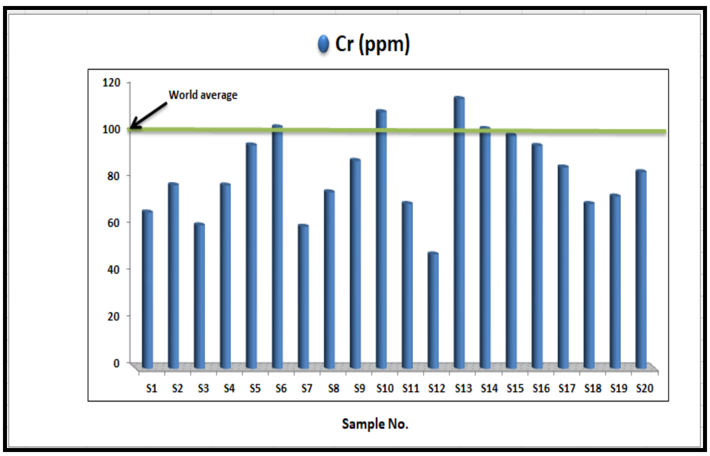

Fig .3: Cr concentration in soil samples selected from Al-Diwaniyah city.

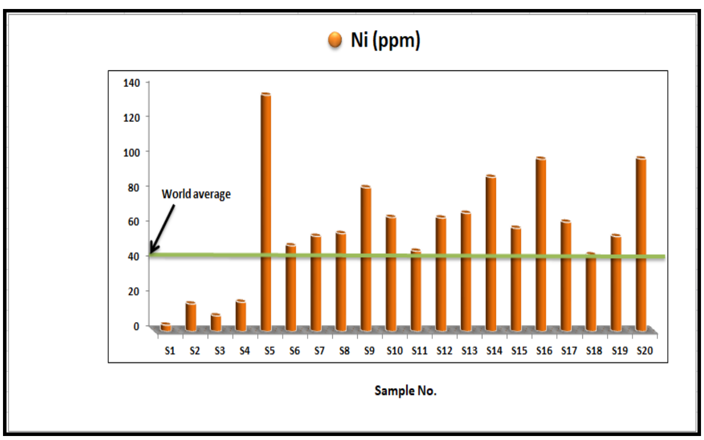

Fig .4: Ni concentration in soil samples selected from Al-Diwaniyah city.

Nickel (Ni)

It was noted through the results of this research that the average concentration of this element in soil samples selected from Al-Diwaniyah city exceeded the permissible limits globally (Lindsay 1979), which amounted to (58.515 ppm) as shown in Fig. 4. This is because the areas contain a gas and fuel filling plant and the frequent use of electric power generators. As used fuel burns, a high concentration of elements, including nickel, is released into the atmosphere and deposits itself on the soil's surface as smoke. The direct dumping of sewage and household waste into the soil increases the concentrations of heavy metals in the soil because sewage water contains high amount of nickel. This is another major factor that led to the high concentrations of nickel in the study area. Hence, the main cause of pollution with this element is the presence of factories, electric power plants, sewage water, and household wastes (Muhammad et al. 2020).

Cadmium (Cd)

Through the results of the research, it was found that the concentration of this element in soil samples selected from Al-Diwaniyah city in many areas has exceeded the permissible limit globally (Lindsay 1979), as shown in Fig. 5. One of the reasons for the increase in the concentration of cadmium in the soil is the burning of plastic materials, as these combustion products increase the concentration cadmium in the atmosphere and then its deposition in the soil. Fuel combustion (during vehicle movements and transportation) increases the concentration of cadmium in the atmosphere and then it is also deposited on the surface of the soil. The direct dumping of sewage and household waste into the soil, as well as the byproducts of fuel combustion in electric power generators, both contribute to an increase in the concentration of cadmium (Arifin et al. 2015).

CONCLUSIONS

Through the results of the research, very high concentrations of heavy metals were found in soil samples selected from the city of Al-Diwaniyah in Al-Qadisiyah Governorate, Iraq. Whereas the results indicated that lead concentration values (Pb) exceeded the internationally recognized limit, most concentrations of chromium, nickel, and cadmium (Cr, Ni, Cd) exceeded the permitted levels. The reason is due to the presence of a gas filling plant, an ice plant, a Kashi factory, blacksmith shops, and car repair workshops that dump their industrial waste directly into the soil, as well as crowding the streets with vehicles, which are the main pollutant with lead because the gasoline supplied to vehicles contains additives such as (tetraethyl lead and tetramethyl lead). Also, the practice of dumping domestic waste directly into the ground, which when it decomposes raises the concentrations of elements in the soil and sewage that contains high concentrations of elements, are contributing factors. To reduce pollution with heavy metals, quick solutions must be developed for traffic jams, which have become a major

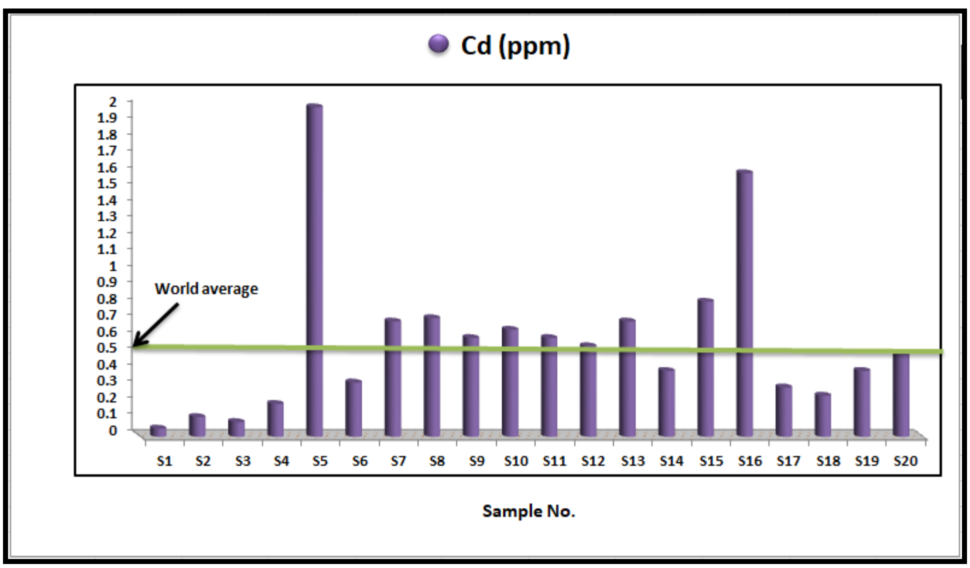

Fig. 5: Cd concentration in soil samples selected from Al-Diwaniyah city.

problem as a result of the increase in the number of vehicles and means of transport in recent years. Additionally, it is important to measure the percentage of emissions emitted from the exhaust of these vehicles, and conduct a study of the use of unleaded gasoline, and replace the lead added to gasoline with less toxic substances and damage to the public the environment.

ACKNOWLEDGEMENTS

The author would like to thank workers in the service laboratory of the Department of Biology, College of the Science/University of Baghdad. for his help in accomplishing this study.

REFERENCES

Al-Dabbas, M.A., Mahdi, K.H., Al-Khafaji, R. and Obayes, K.H. 2018. Heavy metals characteristics of settled particles of streets dust from Diwaniyah City-Qadisiyah Governorate-Southern Iraq. J. Phys. Conf. Ser., 1003(1): 12023.

Al-Jaberi, M.H.A. 2014. Heavy metals characteristics of settled particles during dust storms in Basrah city-Iraq. J. Phys. Conf. Ser., 3(10): 14-18.

Al-Khashman, O.A. 2007. The investigation of metal concentrations in street dust samples in Aqaba city, Jordan. Environ. Geochem. Health, 29(3): 197-207.

Arifin, Y.I., Sakakibara, M. and Sera, K. 2015. Impacts of artisanal and small-scale gold mining (ASGM) on the environment and human health of Gorontalo Utara Regency, Gorontalo Province, Indonesia. Geosciences, 5(2): 160-176.

Aydin, F., Aydin, I., Erdogan, S., Akba, O., Isik, B. and Hamamci, C. 2012. Chemical characteristics of settled particles during a dust storm. Pol. J. Environ. Stud., 21(3): 65.

Banjanac, R., Dragić, A., Grabež, B., Joković, D., Markushev, D., Panić, B. and Aničin, I. 2006. Indoor radon measurements by nuclear track detectors: Applications in secondary schools. Facta Univ. Ser. Phys. Chem. Technol., 4(1): 93-100.

Borošová, D. and Klöslová, Z. 2006. Estimating uncertainty and lead quality determination in blood in the occupation exposure. Trans. Univ. Košice, 11: 2-3.

Ferreira-Baptista, L. and De Miguel, E. 2005. Geochemistry and risk assessment of street dust in Luanda, Angola: A tropical urban environment. Atmos. Environ., 39(25): 4501-4512.

Gowd, S.S., Reddy, M.R. and Govil, P.K. 2010. Assessment of heavy metal contamination in soils at Jajmau (Kanpur) and Unnao industrial areas of the Ganga Plain, Uttar Pradesh, India. J. Hazard. Mater., 174(1-3): 113-121.

Ibe, F.C., Opara, A.I., Ibe, B.O., Adindu, B.C. and Ichu, B.C. 2018. Environmental and health implications of trace metal concentrations in street dust around some electronic repair workshops in Owerri, Southeastern Nigeria. Environ. Monit. Assess., 190(12): 1-12.

Jaradat, Q.M. and Momani, K.A. 1999. Contamination of roadside soil, plants, and air with heavy metals in Jordan: A comparative study. Turk. J. Chemi., 23(2): 209-220.

Lindsay, W.L. 1979. Chemical Equilibria in Soils. John Wiley and Sons Ltd, NJ.

Morais, S., Costa, F.G. and Pereira, M.L. 2012. Heavy metals and human health. Environ. Health–Emerg. Issues Pract., 10(1): 227-245.

Muhammad, J. S., Jasim, K. A. and Shaban, A. H. 2020. Evaluation of (Ni, Cr, Cu) concentration in the soil of Diyala utilizing GIS techniques. IOP Conference Series: Materials Science and Engineering, 928(7): 72111. IOP Publishing.

Muhammad, J.S., Jasim, K.A. and Shaban, A.H. 2021. Determining heavy metals and other elements concentrations in the soil at Baquba-Iraq. Key Eng. Mater., 886: 273–280.

Salman, N.A., Al-Saad, H.T. and Al-Imarah, F.J. 2021. The status of pollution in the southern marshes of Iraq: A short review. South. Iraq's Marshes, 11: 505-516.

Steinbock, R.T. 1979. Lead ingestion in history. New Eng. J. Med., 301(5): 277.

Tapsoba, I., Bourhis, S., Feng, T. and Pontié, M. 2009. Sensitive and selective electrochemical analysis of methyl-parathion (MPT) and 4-nitrophenol (PNP) by a new type p-NiTSPc/p-PPD coated carbon fiber microelectrode (CFME). Electroanal. Int. J. Devoted Fund. Pract. Aspects Electroanal., 21(10): 1167-1176.