Rafidain Journal of Science

https://rsci.mosuljournals.com

Vol. 34, No. 4, pp. 26-38, 2025 (December)

Evaluation Of Heavy Metals in Different Soils Contaminate with Diesel from Multiple Areas in Nineveh Government/ Iraq

Faisal Qasim Haji **Hadeel A. Al-Ameri**

Department of Biology/College of Science/ University of Mosul

p-ISSN: 1608-9391
e -ISSN: 2664-2786

Article information

Received: 11/4/2025
Revised: 10/6/2025
Accepted: 17/6/2025

DOI: 10.33899/rjs.2025.190519

corresponding author:
Hadeel A. Al-Ameri
hadsbio43@uomosul.edu.iq

ABSTRACT

The study included evaluating soil pollution with some heavy elements and statistically analyzing it in the road linking Mosul, Sinjar and the road linking Mosul, Duhok, included industrial and residential areas within Nineveh Governorate in the season autumn of 2024. Different sites were selected from the two roads with 8 samples at a depth of (0-15) cm for the surface soil. The research included measuring the physical and chemical properties controlling the distribution of heavy elements in the soil and comparing them with global determinants. Physical examinations of the soil texture showed that it ranges between (mixed, mixed sand, mixed sandy clay). The results of the chemical examinations showed that the soil was neutral to alkaline, as its rates varied between (7.5-7.9), and its highest value was in sample No. 2 on the road linking Mosul, Sinjar. The rates of electrical conductivity values of the soil ranged between (1.8-17.7) micro siemens / cm, in addition to the rates of organic matter values, which were between (3.13-5.2). The results of soil sample analysis showed that all industrial areas were polluted with zinc, as the average concentration of the element was (9.489) ppm, and sample No.1 was the most polluted area with the element. As for the chromium element, the concentration rates ranged between (0.104-0.657). The results of the study showed that there was a difference in the rates of cadmium concentrations in the soils of the study areas, as the highest rate was (0.444) ppm in sample No. (3) from the Mosul-Duhok Road, while the highest value of zinc was (20.5) ppm in sample No. (1) from the Mosul-Sinjar Road. there is a difference in the concentration rates of chromium in the soils of the study areas, as the highest rate was (0.657) ppm in sample No. (4) from the Mosul-Duhok Road.

Keywords: Heavy metals, Diesel, Soil pollution, Electrical conductivity

INTRODUCTION

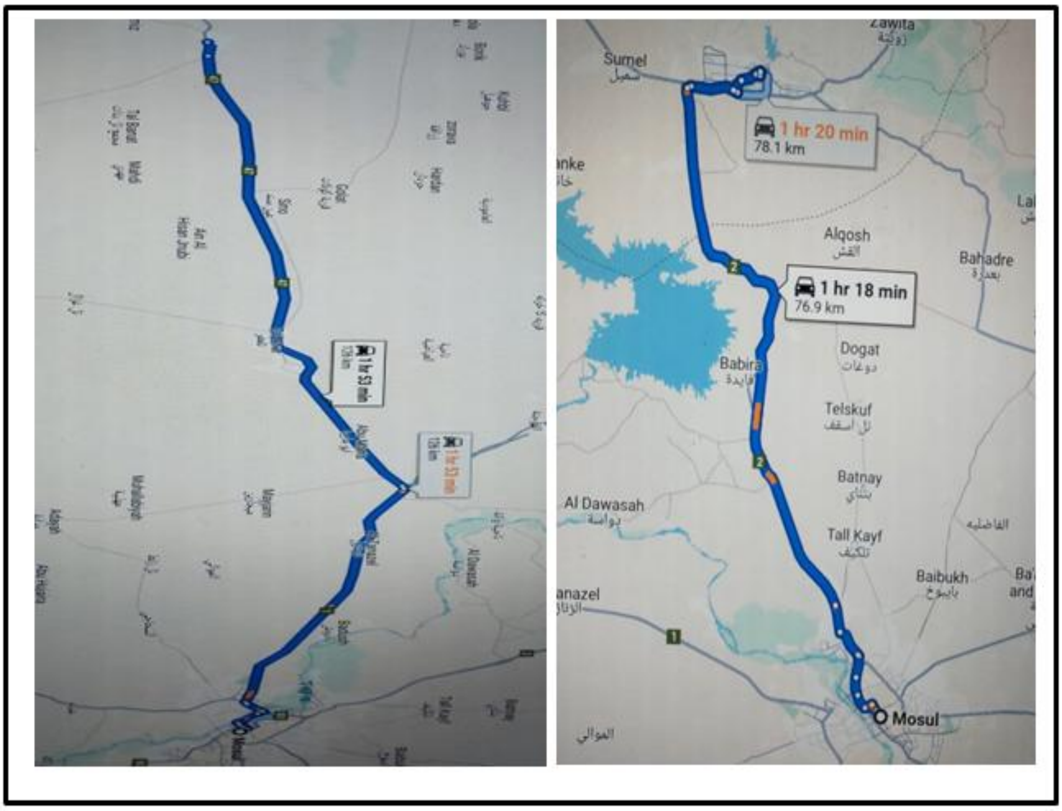
Environmental pollution is one of the most important challenges facing the world in general and our region in particular. Man is primarily responsible for environmental pollution due to the lack of environmental awareness among citizens and their poor treatment of the environment, as well as the lack of proper environmental planning and the spread of industrial areas in neighborhoods, which has led to an increase in environmental problems and the inability of the environment to absorb this pollution (Al-Qaysi *et al*., 2014; Al-Sarraj *et al*., 2018) and restore the activity of its natural resources Knowing the state of soil pollution is essential to assessing the potential effects of heavy metal pollution, as soil degradation leads to the loss of some of its physical and chemical properties and affects its fertility and the growth of living organisms in it (Zhou *et al*., 2022). Therefore, it is necessary to protect and improve the ecosystem of contaminated soil and to establish legislation to protect public health and the environment at the international and local levels , One of the negative effects of heavy metals on the environment is their inability to decompose and accumulate in human tissues, affecting their health and causing health disorders and damage to the kidneys and brain when exposed to them for long periods (Sonayei *et al*., 2009; Al-Sarraj *et al*., 2019), In addition, it is one of the reasons for the difference in the plants' content of enzymes and phytoalexins, such as alkaloids and phenols (Al-Ameri, 2023) Since assessing the concentrations of heavy metals in the soil is the basic step to know the state of pollution in the soil and measure the extent of soil degradation, which leads to the loss of some of its physical and chemical properties. Many researchers have moved towards evaluating heavy metals locally in Iraq, such as (Jankeer *et al*., 2001; Al-Tamimi *et al*., 2022) in Basra Governorate, who measured the concentrations of lead, copper, cadmium and chromium, and the concentration rate was (0.135, 0.842, 0.045 and 1.162) respectively. Also, the researcher (Heety *et al*., 2021) in Ramadi city measured the concentrations of heavy metal elements including chromium, nickel, zinc, lead and cadmium, and the concentrations were (360.9, 286.6, 190.96, 130.75 and 2.55) respectively. In a study conducted by (Al-Azzawi, 2020) in Mosul city, soil contamination with heavy metal elements in industrial areas was investigated, including copper, cobalt, cadmium, zinc and nickel. The study revealed that all soil samples were contaminated and exceeded the permissible limits in it.

In the Arab Republic of Egypt, the researcher (Hammam *et al*., 2022) evaluated the soil pollution with heavy metals for zinc, lead, cadmium, copper, cobalt, and chromium if the concentration rates were as follows (23-91, 29.44, 53.83 1.12, 36.04 and 101.29) respectively. The researchers (Salem and Al-Walid, 2019) in Libya evaluated the physicochemical properties of the soil as the results of the pH were (6.88-7.32) and the electrical conductivity was (0.14-0.26) mS/cm. As for the organic matter, it was at a rate of (0.49-0.53) mS/cm, Due to the lack of a comprehensive study of soil pollution with heavy elements on the road linking the cities of Mosul and Dohuk on the one hand and the road linking the city of Mosul and Sinjar district on the other hand, this study was proposed.

The aim of the current study is to evaluate and identify soil pollutants resulting from human activities (industrial and commercial) in two roads (the road between Mosul and Sinjar and the road between Mosul and Duhok city) and to estimate of some the concentrations of heavy metals such as Cadmium (Cd), Zinc (Zn), Chromium (Cr) and Lead (Pb) in these soils and analyze them statistically.

MATERIALS AND METHODS

The study included conducting a site survey in Nineveh Governorate located in the northwestern part of Iraq, which is located between longitudes (41) (44) east and latitudes (35) – (37) north, as shown in Fig. (1). The Tigris River passes through the city of Mosul, dividing the city into two parts, the right side and the left side. Therefore, three sites were selected from each side. Soil samples were collected from the study sites at a depth of (0 – 15) cm (due to the high percentage of heavy metal pollution at this depth), and the specified period was October 2024, with (8) samples (4) samples of the Mosul-Duhok Road and (4) samples of the Mosul-Sinjar Road, with two replicates for each sample, Gas stations and generator locations were selected. The Mosul-Dohuk Road begins in Mosul city and extends north toward Dohuk Governorate. Areas close to large car repair shops and gas stations were also selected. Samples were taken, placed in sterile polyethylene bags, and transported to the laboratories of the Biology Department, College of Science, University of Mosul, for the study.



(A) (B)

Fig. 1: Map of two roads (A) Mosul-Sinjar Road (B) Mosul-Duhok Road

Some laboratory tests were conducted on soil samples, as both the acidity (pH) were examined in the (1:1) extract followed in the (ICARDA, 2003) guide and the electrical conductivity as well, using the same steps followed in examining the acidity function.

Evaluation of heavy metals in different soils from multiple areas within Nineveh Governorate. Organic matter according to the Walkley-Black method, the soil texture was also examined using the hydrometer method recommended by George Wren, the soil was examined for some heavy metals (cadmium (Cd), zinc (Zn), lead (Pb) and chromium (Cr)) using Atomic Absorption Spectrophotometer (Hitachi Z-8100, Tokyo, Japan) in Central Laboratory/College of Agriculture and Forestry/University of Mosul

(AAS) device Statistical analysis of the data was conducted according to the factorial experiment system and using the complete randomized design (CRD) and the Duncan multiple range test (SAS) was used using a software package of the type to compare the treatments, as the different treatments were distinguished by different alphabetical letters under the probability level ($0.5 \leq p$) (Antar and Al-Waka, 2017)

RESULTS AND DISCUSSION

1- Soil (pH):

The results showed that the pH values of all samples were close, as the highest pH value was (7.9) in sample No. 2 on the Mosul-Sinjar Road. This is due to the fact that the sample was taken from an industrial area and does not contain agricultural soil, so it tends to be alkaline, as shown in Fig. (2). This is what Salem and (Al-Walid, 2019) reached. The lowest value was (7.5) in three samples, sample No. (1) and (4) on the Mosul-Sinjar Road and sample No. (3) on the Mosul-Duhok Road, (Ismael, 2022 and Ahmed, 2019)

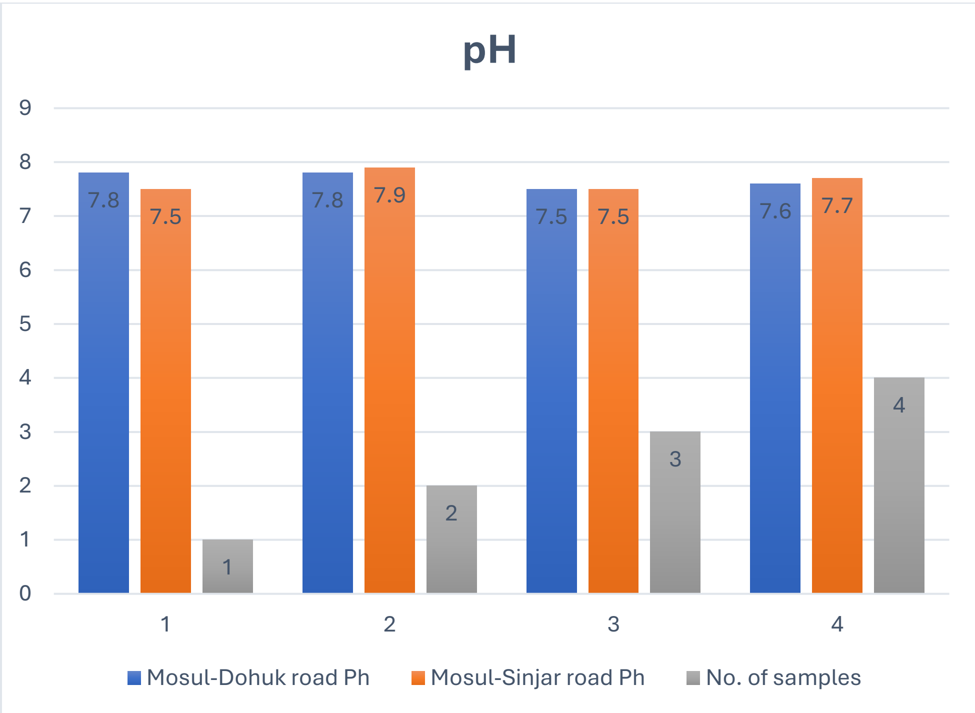


Fig. 2: pH values in the study areas

The results of the statistical analysis according to Duncan's multiple range test in the table below indicate that there are no significant differences between the samples. It was found that the average value of the pH function on the Mosul-Sinjar Road was (7.65), and the average value of the pH function on the Mosul-Duhok Road was (7.675).

2- Electrical conductivity E.C. of soil:

The results of measuring the electrical conductivity rates of soil samples during the study period showed a difference in electrical conductivity rates according to the regions, as the highest value reached (17.7) us/cm in sample No. (1) on the Mosul-Sinjar road and the lowest value was in sample No. (3) on the Mosul-Sinjar road and was (1.8) us/cm as in Fig. (3) and these results are consistent with what was reached by (Shannon *et al*., 2020)

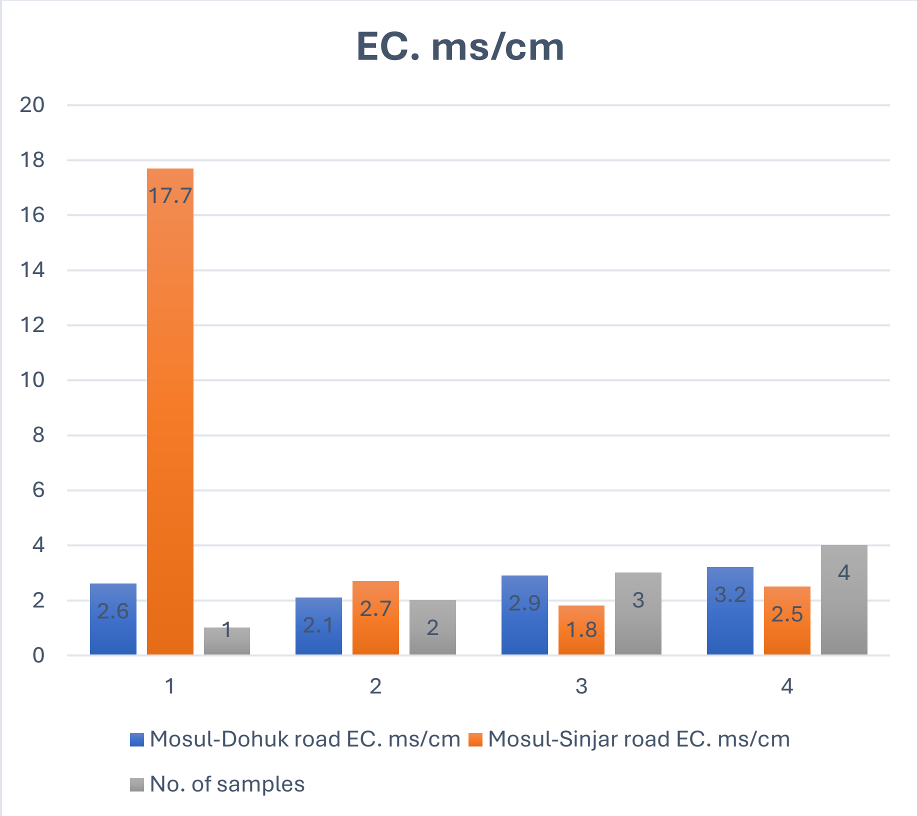


Fig. 3: Electrical conductivity values in the study areas

The results of the statistical analysis showed that there is a significant difference between the two roads in terms of industrial and residential areas in their impact on the value of electrical conductivity, as the Mosul-Sinjar Road outperforms the Mosul-Duhok Road in terms of its electrical conductivity rate by (3.475) and the reason is that the electrical conductivity in the industrial areas is higher than in the residential areas. The results of the statistical analysis in the table below also indicate that there is no significant difference between the study areas, and that the overlap between the study areas, industrial areas and residential areas has a significant impact on the value of electrical conductivity.

3- Organic matter:

The results of the study showed that the rates of organic matter values ranged between (3.13-5.2), where the highest was in sample No. (2) on the Mosul-Sinjar Road, because the soil of the region is agricultural, as organic matter accumulates on its surface as a result of the decomposition of plant and animal matter (Salem and Al-Walid, 2019). As shown in Fig. (4)

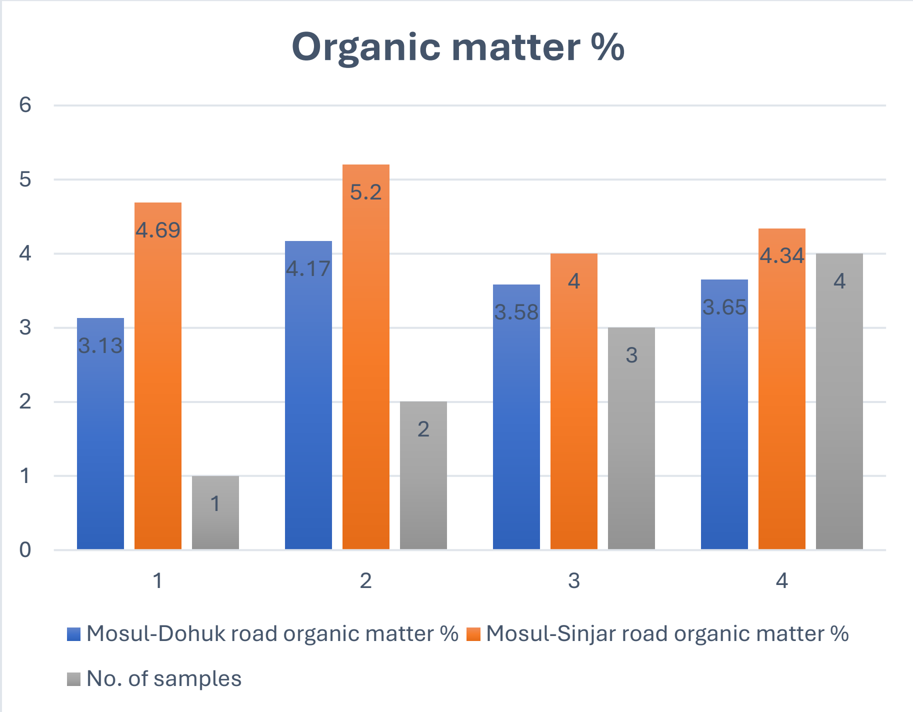


Fig. (4): Organic matter values in the study areas

The results of the statistical analysis in the table below showed that there were no significant differences between the two roads, as the average value of organic matter in the Mosul-Sinjar Road was (4.55%), and the average value of organic matter in the Mosul-Duhok Road was (3.63%). The results also showed that there were no significant differences between the study areas, and that the overlap between the study areas, agricultural areas, and industrial areas had a significant impact on the values of organic matter.

4- Estimation of heavy elements

a- Cadmium (Cd):

The results of the study showed that there was a difference in the rates of cadmium concentrations in the soils of the study areas, as the highest rate was (0.444) parts per million in sample No. (3) from the Mosul-Duhok road and the lowest rate was (0.351) parts per million in sample No. (2) from the Mosul-Duhok road, thus it did not exceed the permissible limits according to the World Health Organization (WHO, 2006) in all areas, and thus the soils of the study areas are considered not contaminated with cadmium, and these results are consistent with what was reached by (Al-Saadi *et al*., 2016). Fig. (5) shows an increase in cadmium concentrations in all industrial areas. This is due to the fact that surface soils are constantly exposed to pollutants resulting from car exhausts and waste burning operations, which increase its concentration in the atmosphere and are deposited in the soil due to rain. Cadmium usually remains in the top (15) cm of the soil, which tends to retain it. This was confirmed by (Al-Hashimi and Al-Shammari, 2020).

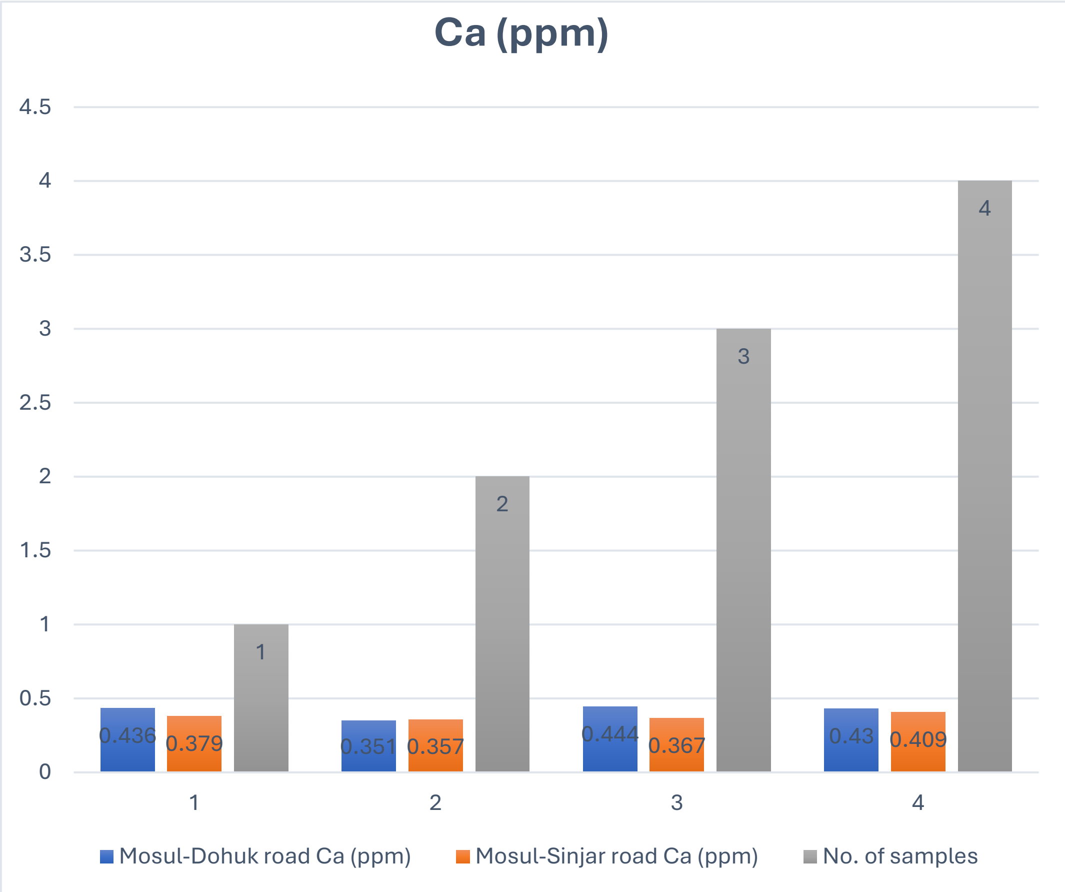


Fig. 5: Cadmium metals values in the study areas

The statistical analysis table indicates that there are no significant differences between the two roads, as the average concentration of the element in the Mosul-Duhok Road was (0.415) and the average concentration of the element in the Mosul-Sinjar Road was (0.378), and this indicates that there is a very small difference between the two roads.

b- Zinc (Zn):

The results of the laboratory analysis in Fig. (6) show that the concentration rates of zinc did not exceed the globally permissible limits. Through a study, the highest value of zinc was (20.5) parts per million in sample No. (1) from the Mosul-Sinjar road, and this may be due to the fact that these areas are industrial and contain fuel combustion waste and municipal waste, in addition to containing places for irregular oil refining, and the amount of zinc in the soil is affected by factors such as soil formation, weathering, organic matter and acidity (-Al-Hashimi and Al Shammari, 2020) The lowest value was (0.692) in sample No. (3) from the Mosul-Sinjar road.

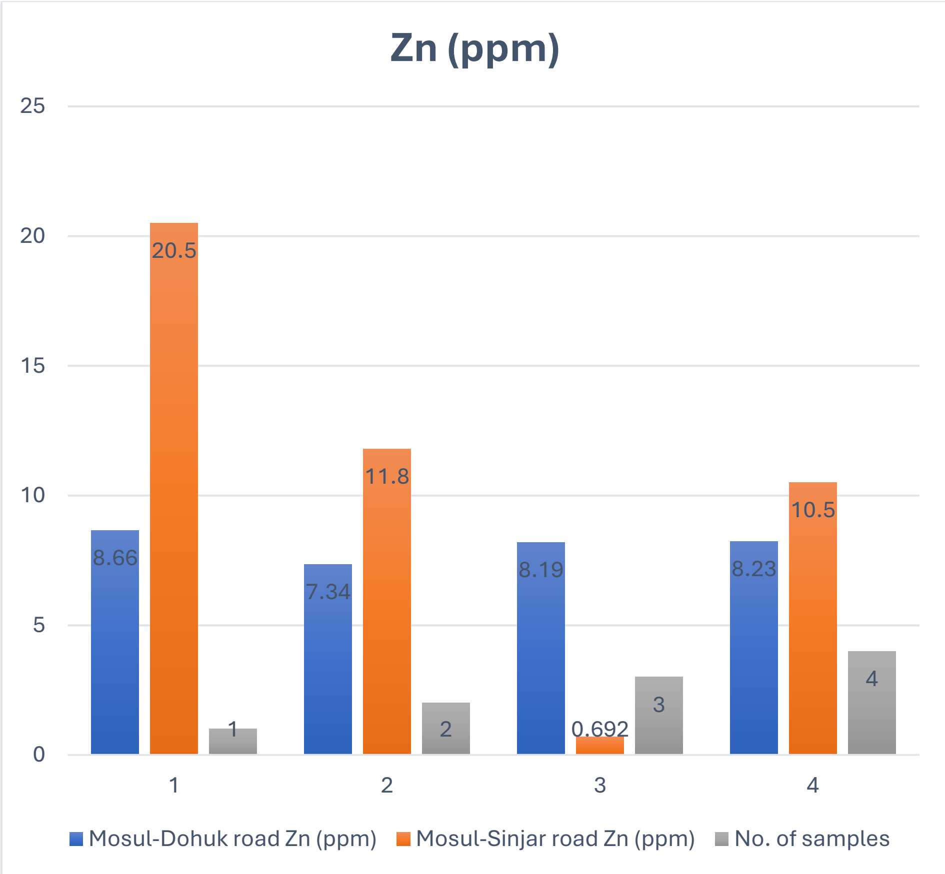


Fig. 6: Zinc element values in the study areas

The results of the statistical analysis in the figure below showed that there is a difference between the two roads, as the average concentration of the element in the Mosul-Sinjar road is higher than the average concentration of the Mosul-Duhok road by (2.765%), as the highest value of the element was recorded during the study in an industrial area and the lowest value in an agricultural area,(Gunadasa *et al*, 2023) and the reason for that is the use of the zinc element by the plant and the absence of petroleum waste in those areas.

c- Chromium (Cr):

The results of the study showed that there is a difference in the concentration rates of chromium in the soils of the study areas, as the highest rate was (0.657) parts per million in sample No. (4) from the Mosul-Duhok road and the lowest rate was (0.104) parts per million in sample No. (2) from the Mosul-Sinjar road, thus it did not exceed the permissible limits according to the World Health Organization (2006 WHO) in all areas, and thus the soils of the study areas are considered not contaminated with chromium, and these results are consistent with what was reached by (Al-Saadi *et al*, 2016). As shown in Fig. (7).

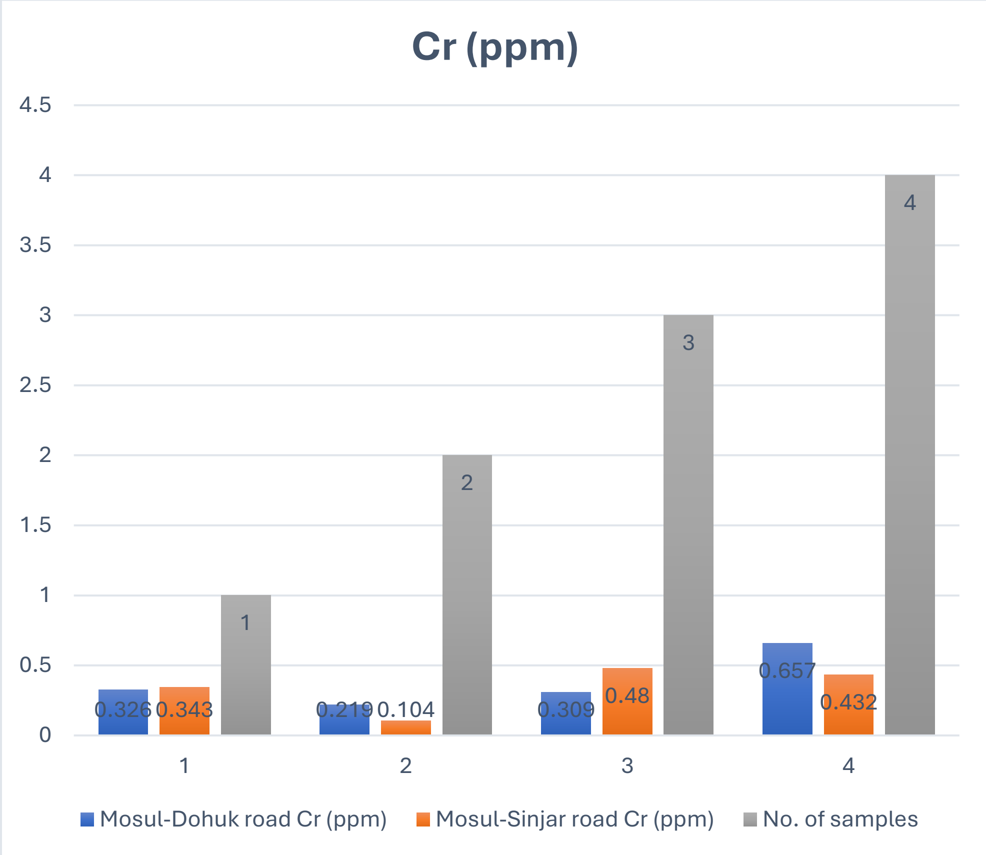


Fig. 7: Chromium element values in the study areas

The statistical analysis table indicates that there are no significant differences between the study areas, as shown in the table below.

d- Lead (Pb):

Fig. (8) shows the results of lead concentration rates in the study areas. It can be noted that all areas did not exceed the limits permitted by the World Health Organization (2006, WHO), and thus the soil of all areas is considered not contaminated with lead, as the highest concentration was recorded in sample No. (2) from the Mosul-Duhok road, and it was at a concentration of (8.45) parts per million, and its lowest concentration was (1.33) parts per million in sample No. (4) from the Mosul-Sinjar road. The reason for the high concentrations of lead is attributed to the presence of industrial waste, car repair and painting workshops, in addition to the heavy movement of various means of transportation. This is consistent with what was stated by (Muslim *et al*., 2019)

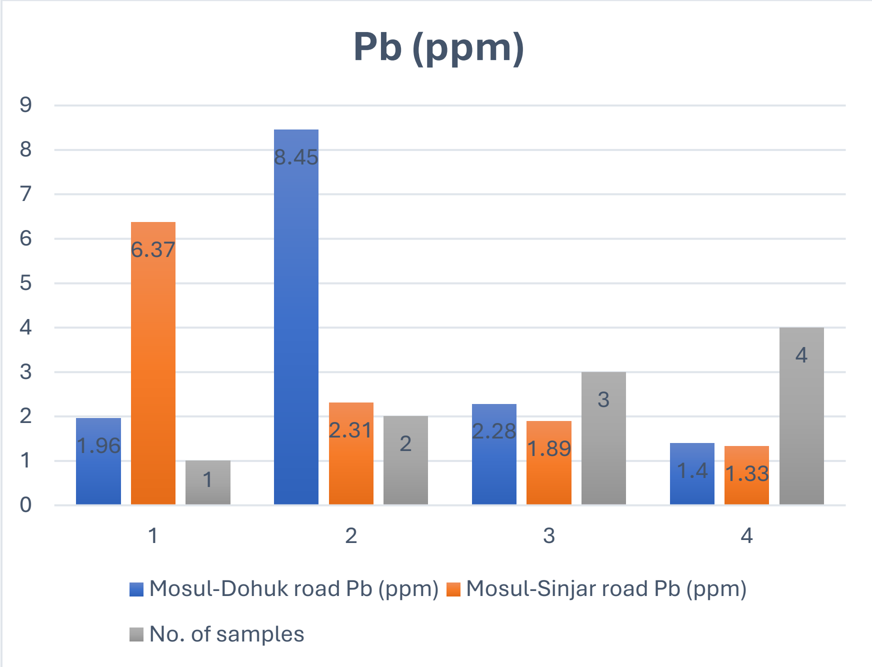


Fig. 8: Lead element values in the study areas

The results of the analysis indicate that there is a slight significant effect between the rate of the Mosul-Sinjar Road and the Mosul-Duhok Road on the element value, as the rate of the element value in the Mosul-Duhok Road was slightly higher than the rate of the element value in the Mosul-Sinjar Road by a percentage of (0.54%) as in the table (1) below.

Table (1): WHO recommended maximum of heavy metals (ppm) as following:

WHO recommended maximum (ppm)	The highest recorded value of a metal from the studied areas (ppm)	Heavy metals
8.45	100-300	Pb
0.444	0.5-3	Cd
20.5	300-700	Zn
0.65	100-150	Cr

Potential sources of heavy metals, focusing on pollution mechanisms, associated metals, and their environmental and health impacts are diesel and vehicle combustion, pollution mechanism includes. Diesel fuel contains small amounts of heavy metals or metal-containing additives, the combustion process produces fine particulate matter (PM2.5, PM10) laden with heavy metals, which is released into the air and subsequently deposited in soil and water (Wuana and Okieimen, 2011).

pollution mechanism includes industries such as mining, paint, battery manufacturing, electronics manufacturing, and leather tanning release wastes rich in heavy metals into water or air, improper disposal of industrial wastewater leads to metal leaching into soil and groundwater (Sharma, et al., 2007). Cadmium (Cd) associated with Battery manufacturing, electroplating while mercury (Hg) paper manufacturing, chlorine, medical devices, chromium (Cr) leather tanning and coating but lead (Pb) paint and pipe manufacturing (He, *et al*., 2005).

The factors that may influence the variations in heavy metals concentrations between samples was variation in contamination sources, different soil properties, and sample collection or preservation methods or localized human impacts and temporal or seasonal variation (Salem and Al-Walid, 2019).

CONCLUSIONS

The research included measuring the physical and chemical properties controlling the distribution of heavy elements in the soil and comparing them with global determinants, and observing the impact of industrial and human pollution sources that are thrown into the soil without treatment, Physical examinations of the soil texture showed that it ranges between mixed, mixed sand, mixed sandy clay). The results of the chemical examinations showed that the acidity function of the soil was neutral to alkaline, as its rates varied between (7.5-7.9), The results of soil sample analysis showed that all industrial areas were polluted with zinc, cadmium, chromium and lead in different rate.

REFERENCE

Ahmed, N. B. (2019). Impact of using Aldanfeeli Valley water on the pollution of soils with heavy metals. Tikrit *J. Agr. Sci.*, **19** (2), 8-18. DOI.org/10.25130/tjas.19.2.2

Al-Ameri, H. A. (2023). Estimation of phenyl alanine ammonialyase (PAL) and some phytoalexins in *Vicia faba* plants infected with spot disease caused by *Alternaria alternata*. *J. App. Nat. Sci.*, **15**(4), 1499 - 1504. DOI.org/10.31018/jans.v15i4.4811.

Al-Azzawi, M. Z. I. (2020). Soil pollution with heavy and radioactive elements in selected areas of Mosul city. Master's Thesis, College of Environmental Sciences and Technology/ University of Mosul-Iraq.

Al-Hashimi, Ab. M.; Al-Shammari, A. K. H. (2020). Environmental assessment of urban soil pollution with heavy elements in wasit province using pollution standards (CF, PLI, I, geo). Proceedings of the First Virtual International Conference on Social Sciences/ College of Basic Education/ Mustansiriya University.

Al-Qaysi, M. R.; Al Obaidy, A. H. M. ; Rahi, M. A. (2014). Assessment of toxic levels for lead in soil of Al-Waziriya Region, Baghdad. *Eng. Tech. J.*, **32**(13), 3157-3165. DOI: 10.30684/etj.32.13A.7

Al-Saadi, N. Ab.; Nada, Kamal B.; Naji, A. M. (2016). Geochemical distribution of heavy elements in the soil of Wasit Governorate. *Al- Anbar J. Agr. Sci.*, **41**(2). DOI.org/10.25130/tjas.19.2.2.

Al-Sarraj, E. S.; Jankeer, M.H.; Al-Rawi, S. M. (2019). Estimation of the concentrations of some heavy metals in water and sediments of Tigris River in Mosul city. *Raf. J. Sci.*, **28** (1),1-10. DOI:10.33899/rjs.2019.159401

Al-Sarraj, E. S.; Jankeer, M. H.; Al-Rawi, S. M. (2018). Bioaccumulation of zinc in four tissues of local fishes collected from Tigris River in Mosul city. *Raf. J. Sci.*, **27** (4),15-22. DOI:10.33899/rjs.2018.159379

Al-Tamimi, M. H.; Kadhim, H. H.; Al-Hello, A. Z. A. (2022). Assessment of environmental pollution by heavy elements in the sedimentary at Abu Al-Kahsib River in Basrah province-southern Iraq. *Marsh Bulletin*, **17**(2). DOI: 10.33899/earth.2023.142140.1117.

Antar, S. H.; Al-Waka, A. H. (2017). "Statistical Analysis of Agricultural Experiments Using SAS Software," University of Diyala, First Edition. (In Arabic).

Communication Team ICARDA. (2003). Aleppo, Syrian Arab Republic: International Center for Agricultural Research in the Dry Areas (ICARDA).

Gunadasa, S. G.; Tighe, M. K.; Wilson, S. C. (2023). Arsenic and cadmium leaching in co-contaminated agronomic soil and the influence of high rainfall and amendments. *Env. Poll.*, **316**, 120591. **DOI:** 10.1016/j.envint.2022.107533

Hammam, A. A.; Mohamed, W. S.; Sayed, S. E. E.; Kucher, D. E.; Mohamed, E. S. (2022). Assessment of soil contamination using gis and multi-variate analysis: A case study in El-Minia Governorate, Egy. *Agr.*, **12**(5), 1197. DOI:10.3390/agronomy12051197

He, Z. L.; Yang, X. E.; Stoffella, P. J. (2005). Trace elements in agroecosystems and impacts on the environment. *J. Tra. Elem. Med. Bio*., **19**(2–3), 125–140. DOI:10.1016/j.jtemb.2005.02.010

Ismael, Gh. R. S. (2022). The Impact of Traffic Movement on Air and Soil Pollution Levels in Selected Areas of Mosul City. Master's Thesis, College of Environmental Sciences and Technology, University of Mosul-Iraq.

Jankeer, M. H.; Al-Chalabi, K. (2001). Effect of cadmium, copper and zinc on the total protein content for free living Ciliata *Tetrahymena pyriformis* (Ehrenberg,1830). *Raf. J. Sci*.,**12** (2).26-41. DOI:10.1023/A:1002957830704

Muslim, R. L.; Issa, M. J.; AL-Obaidi, B. S. (2019). Environmental assessment of heavy metals concentration and distribution in surface soils of Wasit Governorate/Iraq. *Iraqi J. Sci.*, 60(4), 803-818. DOI: 8ad92844-cnvj-42d1-98e1-ab93764a97b0

Salem, M. A. S.; Al-Walid, S. M. (2019). Evaluation of some physicochemical properties and concentration of some heavy metals in agriculturally fertilized soil with chemical fertilizers throughout the seasons for a long period in the brak agricultural project, Libya, at the third annual conference on theories and applications of basic and vital sciences, September 7.

Sanayei, Y.; Ismail, N.; Talebi, S. M. (2009), Determination of heavy metals in Zayandeh Rood river, Isfahan-Iran. *Wor. App. Sci. J.*, **6**(9), 1209-1214. ISSN 1818-4952

Shannon T.; Ahler S.; Mathers, A.; Ziter C.; Dugan, H. (2020). Road salt impact on soil electrical conductivity across an urban landscape. *J. Urb. Eco.*, **6**(1). DOI.org/10.1093/jue/juaa006

Sharma, R. K.; Agrawal, M.; Marshall, F. M. (2007). Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India. *Eco. Env. Safety J*, **66**(2), 258–266. DOI:10.1016/j.ecoenv.2005.11.007

Wuana, R. A.; Okieimen, F. E. (2011). "Heavy metals in contaminated soils: a review of sources, chemistry, risks and best available strategies for remediation." ISRN Ecology, Volume 2011, Article ID 402647.DOI 10.1080/00207231.2019.1694337

Zhou, H.; Ouyang, T.; Guo, Y.; Peng, S.; He, C.; Zhu, Z. (2022). Assessment of soil heavy metal pollution and its ecological risk for city parks, vicinity of a landfill, and an industrial area within Guangzhou, South China. *App. Sci. J*, **12**(18), 9345. DOI:10.3390/app12189345

تقييم العناصر الثقيلة في الترب المختلفة الملوثة بالديزل من مناطق متعددة في محافظة نينوى/العراق

فيصل قاسم حجي هديل احمد العامري

قسم علوم الحياة/ كلية العلوم/ جامعة الموصل

الملخص

تضمنت الدراسة تقييم تلوث التربة ببعض العناصر الثقيلة وتحليلها إحصائيا في الطريق الرابط بين الموصل وسنجار والطريق الرابط بين الموصل ودهوك ضمن محافظة نينوى في موسم خريف عام 2024، وتم اختيار 8 عينات من الطريقين على عمق (0–15) سم للتربة السطحية، وتم قياس الخواص الفيزيائية والكيميائية المتحكمة في توزيع العناصر الثقيلة في التربة ومقارنتها بالمحددات العالمية، وأظهرت الفحوصات الفيزيائية لقوام التربة أنها تتراوح بين (التربة المزيجية والرملية المزيجية والرملية الطينية) أظهرت نتائج الفحوصات الكيميائية أن التربة كانت متعادلة إلى القلوية، حيث تراوحت معدلاتها بين (7.5 – 7.9)، وكانت أعلى قيمة لها في العينة رقم 2 على الطريق الرابط بين الموصل وسنجار، وتراوحت معدلات قيم التوصيل الكهربائي للتربة بين (1.8 – 17.7) ميكروسيمنز/ سم بالإضافة إلى معدلات قيم المادة العضوية التي تراوحت بين (3.13 – 5.2).

أظهرت نتائج تحليل عينات التربة أن جميع المناطق الصناعية ملوثة بعنصر الزنك، حيث بلغ متوسط تركيز العنصر (9.489) جزء في المليون، وكانت العينة رقم 1 هي أكثر المناطق تلوثاً بالعنصر. أما عنصر الكروم فقد تراوحت معدلات التركيز بين (0.104 – 0.657). وأظهرت النتائج أن عنصر الكادميوم تراوحت معدلات تركيزه بين (0.357 – 0.444) جزء في المليون. وأظهرت نتائج الدراسة وجود اختلاف في معدلات تراكيز الكادميوم في ترب مناطق الدراسة، إذ بلغت أعلى نسبة (0.444) جزء في المليون في العينة رقم (3) من طريق الموصل – دهوك، بينما بلغت أعلى قيمة للزنك (20.5) جزء في المليون في العينة رقم (1) من طريق الموصل – سنجار. هناك اختلاف في معدلات تركيز الكروم في ترب مناطق الدراسة، إذ بلغ أعلى معدل (0.657) جزء في المليون في العينة رقم (4) من طريق الموصل – دهوك.

الكلمات الدالة: المعادن الثقيلة، الديزل، تلوث التربة، التوصلية الكهربائية.