

Assessment of Heavy Metals Concentration in Soils Around an Auto-Mechanic Workshop at Airport Road Warri Delta State

Yusuf Adamu Datti, Uka Miracle, Ochai Enemona Johnson

Environmental Science and Management Technology Department, Petroleum Training Institute,
Effurun, Delta State, Nigeria

DOI: <https://doi.org/10.51584/IJRIAS.2026.11090017>

Received: 06 December 2025; Accepted: 11 December 2025; Published: 01 October 2026

ABSTRACT

The study assessed the concentration of selected heavy metals (Pb, Ni, Cd, and Cr) in soil samples collected from three auto-mechanic workshops and a control site in Effurun, Delta State. Soil samples were digested and analyzed using Atomic Absorption Spectrophotometry (AAS). To evaluate contamination levels, the Geo-accumulation Index (Igeo) was applied. And the results showed that Pb ranged from **2.88 – 23.85 mg/kg**, Ni from **27.89 – 35.21 mg/kg**, Cd from **2.58 – 2.88 mg/kg**, and Cr from **23.08 – 31.25 mg/kg**, all of which were above background levels. The calculated Igeo indicated moderate to heavy contamination for Ni and Cr, while Pb and Cd showed lower levels of contamination. These findings suggest significant anthropogenic input from auto-mechanic activities such as used oil disposal, battery dumping, and metal scrap corrosion. It is recommended that designated mechanical workshop zones be established with appropriate waste management facilities. Regular monitoring of soil quality should be enforced, and environmental awareness programs for mechanics introduced to reduce the risks of heavy metal pollution to soil, groundwater, and public health.

Keyword: Heavy metals, Automobiles, Soil, Public Health, Geo-accumulation index

INTRODUCTION

Environmental pollution is said to occur when there is an introduction of any material into the environment in more than its natural concentration and which has net detrimental effect on the environment or something of value in the environment (Okonkwo and Eboatu, 1999). Global industrialization and various urban activities are taking their toll on the natural environment and ecosystem. It has been predicted that environmental change induced by anthropogenic activity will first be experienced in Africa, especially in heavily polluted nations like Nigeria (Mwambaambi, 2010). In Nigeria, auto-mechanic activities have induced large-scale environmental deterioration. Isaac (2014) stated that it is due to ever-increasing demand for personal vehicles. This increase in the number of automobiles has resulted in an increased citing of auto mechanic workshops for their repairs, which have contributed markedly to the problem of soil contamination in most cities. These workshops comprise of auto-mechanic units such as auto-welding unit, auto-electrician unit and auto-painting unit amongst others (Pam, Sha'Ato and Offem, 2013). Such automobile repair activities include dumping of metal scraps, used batteries, spent lubricants, condemned batteries, packaging materials and worn-out components from automobiles which poses a serious threat to soil and groundwater resources since they are composed of organic and inorganic constituents including heavy metals (Ogunkolo, Moses, Oyetunji and Abdullahi, 2019). Orji, Ikechukwu, Nwaogo and Nwagu (2015), reported that petroleum and derivative waste products (from auto-mechanic service station) are discharged on soils within the service stations within 2m distance on a daily basis. Motor oil tends to accumulate metals as it comes into contact with the adjoining parts of the engine as it runs. These oils are most time deliberately or accidentally discharged into the soil during servicing of the vehicle thus creating a pathway through which metals go into the surrounding (Shinggu et al., 2010). Heavy metals are amongst the most widespread environmental pollutants and their occurrence in the soil indicates the existence of anthropogenic sources (Pravin et al., 2012)

Heavy metals are naturally occurring, environmentally stable, non-biodegradable and can be injurious to the wellbeing of living organisms (Huang, Liu, Zhao and Zheng, 2020). Heavy metals such as cadmium (Cd), copper

(Cu), chromium (Cr), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn) are often contained as additives in some lubricants and gasoline and are non-degradable in the soil after contamination. One of the biggest health concerns in the world is the pollution caused by heavy metals, even at low levels, and the long-term cumulative health impacts that occur (Huton and Symon, 1986). Their propensity to bio accumulates, go up the food chain, and harm soil microorganisms, as well as their permanence in the soil, increase the level of worry (Udousoro et al., 2010). Auto mechanic work is one of the main causes of the rise in heavy metal concentrations in Nigerian ecosystems (Adewole and Uchegbu, 2011). According to Nwachukwu et al. (2011), these auto maintenance shops are located in groups of open land plots close to cities and urban centers. Some pollution and soil contamination result from this unhealthy method of getting rid of such dangerous auto-mechanic workshop waste. Their propensity to bio accumulates, go up the food chain, and harm soil microorganisms, as well as their permanence in the soil, increase the level of worry (Udousoro et al., 2010).

The citing of auto-mechanic workshop in Delta State is currently increasing and presenting increased risk to residents due to its citing around local gardens and residential areas (Nwachukwu, Feng and Alinnor, 2011). It is therefore important that heavy metal in soil is assessed. Due to the pollution associated with heavy metal at elevated concentration to human lives and soils in the environment. The aim of the study is to assess heavy metals concentration in soils within some auto-mechanic workshop along airport road Warri. This study will help to further bring to the fore the impact on public health. This study will also help to facilitate adequate monitoring of the environment by planners, auto-mechanics and the public.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out at selected automobile mechanic workshops located along Airport Road, Warri, Delta State, Nigeria. The area is characterized by vehicular repair activities including engine servicing, panel beating, welding, spray painting, and surface finishing. These activities are potential sources of soil contamination as they involve the use of lubricating oils, paints, solvents, and metallic components that can release heavy metals into the environment. The workshops are unpaved and open, with soil serving as the primary surface for most mechanical operations. Wastes such as used engine oil, spent batteries, metallic scraps, and paint residues are often discarded directly on the ground without proper disposal. The workshops are situated close to residential areas and local businesses, raising environmental and public health concerns due to the possibility of soil contamination spreading to surrounding land. A nearby uncontaminated site, located away from mechanical activities, was used as a control sample location for comparison.

Table 1. Sampling Co-Ordinates

S/No	Workshop	Coordinates
1	Elchris Ventures Auto Repair	Lat. 5.5414 ⁰ N Lon. 5.76159E
2	Peace Mass Transit workshop	Lat. 5.5378 ⁰ N Lon. 5.76050E
3	Forte Oil Auto Repair workshop	Lat. 5.5414 ⁰ N Lon. 5.76159E

Collection of Sample/ Preparation

Soil samples were collected from auto-mechanic workshop using a soil auger in a randomized method at 5m interval from three points at different auto-mechanic workshops. These sampling locations were coded samples A, B, and C, while an unpolluted location was sampled as a control. At each sampling location, auger-boring instrument was used to bore holes of depths 10cm, 15cm and 30 cm. The samples were homogenized in a clean plastic bucket, poured into a polythene bag, labeled adequately and transported to the laboratory immediately for analysis.

Soil Analysis

A composite sample was drawn from each polythene bag. The composite samples were air-dried and allowed to pass through a 2mm sieve prior to analysis.

2.0g of 2mm sieved air-dried soil was weighed into a 300cm³ conical flask and 1ml of concentrated HClO₄, 3ml of HNO₃ and 1ml of concentrated HF was added to the soil in a conical flask under a fume hood.

The mixture was heated until dense white films appeared, after which heating continued for an additional 30 seconds. The flask was cooled and 40-50ml of distilled water was added. The solution was filtered into a volumetric flask for further analysis.

The atomic absorption spectrophotometer was calibrated with various standard solutions of the selected heavy metal. The specific wavelength for each heavy metal was selected. 15mL of the soil extract samples were measured into a conical flask and a conveyor hose pipe dipped into the samples. The conveyor hose pipe then sucked up the sample into the flame at a specific wavelength of the parameters to be measured, given the concentration of parameters of interest.

Geo-Accumulation Index

Result level was calculated using the formula below:

$$I_{geo} = \log_2 \left(\frac{C_n}{1.5 \times B_n} \right)$$

Where: C_n is the concentration of the heavy metal in the polluted sample and B_n is the concentration of the metal in the unpolluted (control) samples. Factor 1.5 is introduced to minimize the effect of the possible variations in the background or control values which may be attributed to lithogenic variations in the soil.

Table 2. Seven Classes of Geo-accumulation index

Class	Value of Soil Quality
Unpolluted	< 0
Unpolluted to moderately polluted	0 – 1
Moderately polluted	1 – 2
Moderately polluted too highly polluted	2 – 3
Highly polluted	3 – 4
Highly polluted to very highly polluted	4 – 5
Very highly polluted	> 5

RESULTS AND DISCUSSION

Results obtained from laboratory analysis of soil samples from three different sampling sites are tabulated the samples collected.

Table 3. Heavy Metal Concentration in Soil Samples

S/N	Parameters	Unit	Sample 1	Sample 2	Sample 3	Control Sample
1	Lead (Pb ²⁺)	Mg/kg	23.85	2.88	3.85	1.00
2	Nickel (Ni)	Mg/kg	27.89	3.25	3.85	1.50
3	Cadmium (Cd ²⁺)	Mg/kg	2.88	2.88	2.88	0.50
4	Chromium (Cr)	Mg/kg	23.08	8.35	31.25	2.00

Table 4. Geo-accumulation Index (I_{geo}) Results

Parameter	Sample A Igeo	Level Classification	Sample B Igeo	Level Classification	Sample C Igeo	Level Classification
Lead (Pb)	3.991	Highly polluted	0.941	Unpolluted to moderately polluted	1.360	Moderately polluted

Nickel (Ni)	3.632	Highly polluted	0.531	Unpolluted to moderately polluted	0.775	Unpolluted to moderately polluted
Cadmium (Cd)	1.941	Moderately polluted	1.941	Moderately polluted	1.941	Moderately polluted
Chromium (Cr)	2.944	Moderately → Highly polluted	1.477	Moderately polluted	3.381	Highly polluted

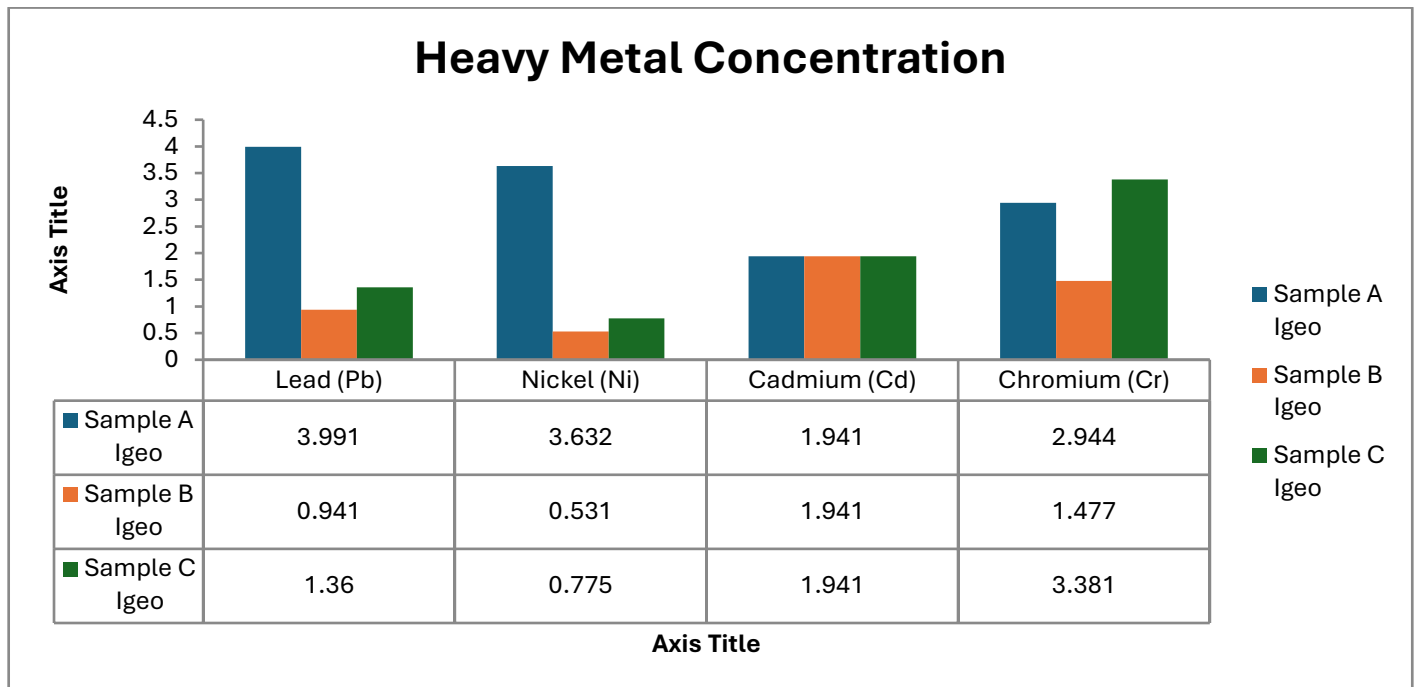


Fig 1. Heavy Metal Concentration

DISCUSSION OF RESULTS

Fig. 2 shows the variation in heavy metal concentrations (Pb, Ni, Cd, and Cr) across the three sampled workshops.

Sample A recorded the highest concentrations of Ni (27.89 mg/kg) and Pb (23.85 mg/kg), indicating strong contamination linked to frequent disposal of lubricants, batteries, and metallic wastes.

Sample B had comparatively lower values for most metals, with Pb (2.88 mg/kg) and Ni (3.25 mg/kg) showing the least accumulation, suggesting less intense contamination activities at this site.

Sample C exhibited elevated Cr (31.25 mg/kg) and moderate levels of other metals, reflecting contamination associated with welding, spray painting, and corrosion-related wastes.

The concentrations of Pb, Ni, Cd, and Cr in soil samples from the three auto-mechanic workshops were notably higher than the background (control) values, confirming anthropogenic contributions from mechanic activities.

Sample A recorded the highest Pb concentration (23.85 mg/kg) with an Igeo value of 3.991, indicating heavy pollution. This aligns with findings by Ogunkolo et al. (2019), who reported elevated Pb levels in soils around mechanical workshops due to discarded batteries, lubricants, and lead-based paints. Sample B showed an Igeo of 0.941 (polluted to moderately polluted), while Sample C had an Igeo of 1.360 (moderately polluted).

Ni levels were highest in Sample A (27.89 mg/kg, Igeo = 3.632), classed as heavily polluted. Similar studies by Akan et al. (2013) found elevated Ni in soils from workshop areas due to corrosion of metallic parts and use of

Ni-based alloys. Samples B and C showed lower Igeo values (0.531 and 0.775), indicating unpolluted to moderately polluted status.

Cd concentrations were constant across all samples (2.88 mg/kg) with Igeo values of 1.941, placing them in the moderately polluted category. These results are consistent with Iwegbue (2007), who identified Cd contamination in workshop soils from brake linings, lubricants, and tyre wear.

Cr levels were highest in Sample C (31.25 mg/kg, Igeo = 3.381), indicating heavy pollution, likely due to use of Cr-based paints and anti-corrosion coatings. Sample A (23.08 mg/kg, Igeo = 2.944) was moderately to heavily polluted, while Sample B (8.35 mg/kg, Igeo = 1.477) was moderately polluted. This trend aligns with Adejumo et al. (2018), who observed similar Cr contamination in urban mechanic sites.

Overall, the high Igeo values in Sample A suggest more intense mechanical activities and poor waste handling compared to other sites. The consistent Cd levels across all samples may indicate a common contamination source.

CONCLUSION AND RECOMMENDATIONS

The study revealed that soils around the investigated auto-mechanic workshops contained elevated levels of Pb, Ni, Cd, and Cr compared to the control sample. Geo-accumulation index analysis classified most metals in Samples A and C as heavily or moderately polluted, confirming significant anthropogenic impact. Pb and Ni showed the highest pollution severity, especially in Sample A, while Cd contamination was uniform across sites.

These findings underscore the need for environmental monitoring and improved waste management practices in auto-mechanic workshops to prevent further heavy metal accumulation in soils, which could threaten soil quality, groundwater safety, and public health.

Recommendation

In the light of the above findings, the study recommended.

1. Regular monitoring of soils around auto-mechanic workshops should be carried out by environmental agencies to ensure heavy metal levels remain safe.
2. Workshops should adopt proper waste disposal methods such as recycling used oils, batteries, and metal scraps instead of indiscriminate dumping.
3. Mechanics and apprentices need to be educated through awareness programs on the dangers of heavy metals and trained on safe waste handling practices.
4. Highly polluted soils should be treated using remediation techniques such as phytoremediation or soil washing.
5. Local authorities must enforce environmental regulations and apply strict penalties for non-compliance.
6. Establishing designated mechanic villages with proper waste management systems will help reduce scattered pollution in residential areas.
7. Further research should be encouraged on the transfer of heavy metals from contaminated soil to crops and groundwater to safeguard human health and the environment.

REFERENCES

1. Adejumo R. O., Adagunodo T. A., Bility H., Lukman A. F., & Isibor P. O (2018). Physicochemical constituents of groundwater and pits quantity in crystalline bedrock in Nigeria. *International journal of civil engineering and technology* 9(8)887 - 903
2. Adewole, M. B., & Uchegbu, L. U. (2010). Properties of soils and plant uptake within the vicinity of selected automobile workshops in Ile-Ife, Southwestern Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 3(3), 31–35.

3. Akan J. C., Kolo B. G., Yikola B. G & Chellube Z. M (2013). Level os some agricultural pollutants in soil samples from Biu LGA of Borno State Nigeria. Merit Research Journal of Environmental Sciences and Toxicology 1(3) 071 – 081
4. Huang, Z., Liu, C., Zhao, X., &Zheng, B. (2020). Risk assessment of heavy metals in the surface sediments at the drinking water source of the Xiangjiang River in South China. Environmental Sciences Europe, 32(23), 1–10.
5. Hutton M. & Symon C. (1986). The quantities of Cadmium, Lead, Mercury and Arsenic entering the United Kingdom environment from activities. Science of the total environment 57, 129 - 150
6. Isaac, O. A. (2014). An assessment of heavy-metal contamination in soils within auto-mechanic workshops using enrichment and contamination factors with geo-accumulation indexes. Journal of Environmental Protection, 5(1), 970–982.
7. Iwegbue C. N. A (2007). Metal fractionation in soil profiles at automobile mechanic waste dumps. Waste management research 25: 585 - 593
8. Mwambazambi, K. (2010). Environmental problems in Africa: A theological response. Ethiopian Journal of Environmental Studies and Management, 3(2), 23–34.
9. Nwachukwu, A. M., Feng, H., & Achilike, K. (2010). Integrated study for automobile wastes management and environmentally friendly mechanic villages in the Imo River Basin, Nigeria. African Journal of Environmental Science and Technology, 4(4), 234–294.
10. Nwachukwu, M. A., Feng, H., & Alinnor, J. (2011). Trace metal deposition in soil from auto-mechanic village to urban residential areas in Owerri, Nigeria. Procedia Environmental Sciences, 4(1), 310–322.
11. Ogunkolo, A. B., Moses, O., Oyetunji, A. B., &Abdullahi, A. (2019). Assessment of heavy metal contamination of soil around auto-mechanic workshops in Anyigba, Kogi State. Confluence Journal of Environmental Studies, 13(1), 79–89.
12. Okonkwo, E. M and Eboatu, A. N (1999). Environmental Pollution and Degradation. Onis Excel Creation Ltd 2, 6 – 8
13. Orji M. Uy., Ikechukwu O., Nwoagu M. C & Nwagu T. N. T., (2015). Dynamics of microbial population in petroleum impacted soils in automobile mechanic workshops in Awka Nigeria. International journal of research and innovation in earth science 2(4) 122 – 126
14. Pam, A. A., Sha’Ato, R., & Offem, J. O. (2013). Contributions of automobile mechanic sites to heavy metals in soil: A case study of North Bank Mechanic Village Makurdi, Benue State, Central Nigeria. Journal of Chemical, Biological and Physical Sciences, 3(3), 2337–2347.
15. Pravin U. S., Manisha P. T and Ravindra M. (2012). Sediment heavy metal contamination in Vasai Creek of Mumbai: Pollution impacts. American journal of chemistry 2(3) 171 – 180
16. Shinggu D. Y., Ogugbuaja V. O Toma I and Barminas J. T (2010). Determination of heavy metal pollutants in street dust of Yola, Adamawa State Nigeria. African journal of pure and applied chemistry 4(1) 017 – 021
17. Udousoro I. L., Umoren I. U and Asuquo E. D (2010). Survey of some heavy metals concentration in selected soils in South Eastern parts of Nigeria. World Journal of applied sciences and technology 2(2) 139 – 149