

Evaluation and Characterisation of Some Heavy Metals in Soil Around Selected Automechanic Workshops in Minna, Niger State

ABUBAKAR, ILIYASU S.¹, ABDULHAMEED SALIHU², ISAH DANLAMI S.³, ABDULLAHI YAHAYA M.⁴, ISYAKU SALIHU⁵

^{1, 2, 3}Department of Physical Sciences Niger State Polytechnique Zungeru, Niger State

^{4, 5}Department of Biological Sciences Niger State Polytechnique Zungeru, Niger state

Abstract- Soil represents the most crucial components of the earth's crust, and their quality is of utmost importance, demanding serious consideration. This study aimed to evaluate the contamination of heavy metals in soil around selected auto mechanic workshop within Chanchaga local government Minna, Niger state. Soil samples were collected from the three auto mechanic workshops and control sample at Gurusu in non mechanic place as control undergoes pretreatment, digestion, and the concentration was determined using Microwave Plasma Atomic Emission Spectrophotometer (MP-AES). The concentrations of the samples were, Fe (751.94±41.12 mg/kg), at Eastern by-pass quadrant one (EB1), Mn(6.76±0.01 mg/kg) Keteren Gwari quadrant one(KG1) Pb (5.70±0.02 mg/kg) Keteren Gwari quadrant four (KG4) with high values. While, Ni (0.21±0.03 mg/kg) at Eastern bye pass quadrant one (EB1), and Cr (0.18±0.01 mg/kg) indicated the lowest values. The finding revealed that the concentrations of all investigated metals were higher in the workshops than in control sites, indicating the influence of anthropogenic activities associated with auto mechanic operations. However, the concentration remained below permissible limits recommended by the world health organization, suggesting that the area is not yet significantly polluted.

Keywords- Soils, Evaluation, Heavy Metals, Pollution, Contamination, Auto-Mechanics.

I. INTRODUCTION

Over the years, soil pollutants and contaminants have been described as substances that present a threat to the existence of man, plant and animals. They occur in various degrees, forms and quantity. Some of these contaminants include used oils which are generally seen in mechanic workshops, where automobiles are serviced and repaired. Heavy metals are considered serious pollutants because of their toxicity, persistence

and non-biodegradable in the environment; thereby constituting a threat to human beings and other forms of biological life, chronic exposure to toxic metals in humans may result in plumbs, anaemia, nephropathy, gastrointestinal colic, and central nervous system symptoms (Duru *et al.*, 2021).

The regular use of petroleum-based products like gasoline, diesel, fuel, engine oil, Other activities that may result to elevated levels of heavy metals in the soil of mechanic workshops include, panel beating, welding and car battery maintenance, most often results in extensive and inevitable spillage of most of these products into the environment. These categories of wastes in addition to those from oil filters, scrap metal parts, lead batteries, and abandoned vehicles which are indiscriminately disposed of are often resistant to biodegradation, most of these environmental pollutants often results in the buildup of heavy metals in the soil which may finally find their way into the plant tissues (Azorji *et al.*, 2021). Pollution effects of mechanic site activities in Nigeria have received limited attention even though these activities deposited harmful wastes. There is need for accurate information on the soil around human habitations as they are generally semi natural ecosystems constructed by man in landscape suitable for activities is important for life (Akinlola *et al.*, 2025).The increasing rate indiscriminate sitting of auto mechanic workshops within residential areas in Minna Niger state, especially at Keteren Gwari, Eastern byepass and western byepass are large considering the number of auto mobile repaired on a daily basis exacerbates environmental pollution caused by these activities. Despite the significant of heavy metals released into the environment in these

areas, little attention has been given to examining the potential health effects of exposure to heavy metals through land pollution. Therefore is need to assess the concentrations of heavy metals and other pollutants in the study sites, for allowing future planning of suitable site-specific management by the decision makers, is an important task in preventing risk to natural life and public health. This study aims to evaluate and investigate levels of some selected heavy in soils; iron (Fe), lead (Pb), nickel (Ni), manganese (Mn) and chromium (Cr) concentrations around auto mechanic workshops at Keteren Gwari, Eastern bye pass and western bye pass in Minna, Niger state, Nigeria.

II. LITERATURE REVIEW

Soil represents the most crucial components in the earth's crust and their quality is of utmost importance, demanding serious consideration. A soil is an excellent media to monitor the concentration of heavy metal pollution because anthropogenic heavy metals are usually deposited in the soils. A study were carried out in Ilesa western Nigeria which examines heavy metal pollution and associated health risks in soil and ground water at mechanic workshops and heavy metals analyses (Pb, Fe, Cu, Cr, Co, Ni, Zn, As) were quantified using absorption spectrophotometer. Soil concentrations exceeded target values for most metals (Akinola, *et al.*, 2025).

Heavy metals such as cadmium (Cd), copper (Cu), chromium (Cr), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn) which is often contained as additives in some lubricants and gasoline are non-degradable in the soil. Demand for personal vehicles, most of which are used "Tokunbo" vehicles. They have contributed evidently to the problem of soil contamination in most cities. An assessment of heavy metal contamination in soils within auto-mechanic workshops at IkareAkoko showed remarkably high levels of all the metals such as nickel (Ni), copper (Cu), iron (Fe), chromium (Cr), and Cd above background concentrations (Ojedokun and Bello, 2022). Metals elements such as Cd, Hg, As and Pb are non-essential elements and therefore have toxic effects on living organisms such as damage to the renal and nervous systems especially Lead (Pb) is toxic even at low concentration. It can accumulate in the brain,

which may lead to poisoning or even death. Mercury poisoning symptoms are blindness, deafness, brain damage, digestive problems, kidney damage, lack of coordination and mental retardation. The most prominent chronic manifestations of Arsenic (As) involve the skin, lungs, liver and blood systems (Ogunkolu *et al.*, 2021).

III. METHODOLOGY

3.1 Description of study area

The study focuses on three auto mechanic workshops randomly selected within Minna metropolis. The workshops includes; Keteren Gwari along hospital road before high court, Western bye pass along PDP secretariat before city gate and Eastern bye pass along grave yard before Eid praying ground Minna, Niger state. The sampling site was selected with consideration for large number of vehicles been repaired on daily basis, anthropogenic activities and compliance of the people in the study area.

3.2 Samples and sampling (Collection of soils sample)

Soils samples from three selected auto mechanic workshops were collected from KeterenGwari, Western bypass, and Eastern bypass. Each site was divided into four (4) quadrants and four (4) samples for each were taken randomly 20 metres away from one another. Soil samples were collected to a depth of 0-15 cm³, using a clean soil auger and the total of the sample were 48. Soils samples were placed in the labeled polythene bags and transported to the laboratory prior to preparation. They were bulked down to 12 samples and then composited to one (1) for each quadrant as representative. Also six (6) soil samples were collected at Gurusu community far away from auto mechanic activities and were mixed properly as one (1) composite representative.

3.3 Soil sample preparation and pre-treatment

After collection, soil samples were air-dried in the laboratory at room temperature (0C) for seven days, coarse, pebbles, stones, debris and other dirt particles were removed. To obtain homogenous samples, the soil sample was grounded using a clean porcelain mortar and pestle and then sieved to obtain a finely ground soil sample, using a 2 mm sieve. Finally, the

samples were stored in desiccators in black polythene bags prior to digestion.

3.4 Heavy metal concentrations (Digestion of soil samples using wet acid digestion)

Soil samples were digested using the procedure (Obasi *et al.*, 2022). To a sterilised beaker 1g of a homogenized soil sample was weighed and 10 cm³ of freshly prepared aqua regia (HCl: HNO₃, 1:3) was added. The beaker was covered and the contents heated for 1h at 150 °C on a hot plate. The mixture was allowed to cool and then filtered through a Whatman No. 42 filter paper into a 50 cm³ volumetric flask and

made up to the mark with de-ionized distilled water. The filtrate was transferred into clean 50 cm³ plastic bottles and stored in a refrigerator prior to analysis.

3.4 Statistical analysis

Statistical analysis of collected data in soil samples from Auto mechanic Workshops was performed using Statistical program for Social Science (SPSS) version, 21(P < 0.05) for the estimation of mean value ± standard deviation.

IV. RESULT AND DISCUSSION

Table 1: Concentrations of selected heavy metals (mg / kg) in soils from auto mechanic workshops and control sites

Sample Sites	Concentration (mg / kg)				
	Fe	Ni	Pb	Mn	Cr
KG1	240.37±37.67	1.17±0.01	4.61±0.04	6.76±0.01	0.23±0.01
KG2	237.4±18.14	0.97±0.01	4.87±0.06	4.51±0.01	0.28±0.01
KG3	371.67±46.55	1.72±0.01	4.60±0.02	6.14±0.03	0.34±0.01
KG4	370.23±89.21	2.72±0.01	5.70±0.02	5.44±0.03	0.32±0.01
WB1	617.96±9.74	2.64±0.01	3.60±0.02	6.30±0.01	0.59±0.01
WB2	526.76±18.49	2.10±0.01	0.95±0.01	4.67±0.01	0.44±0.01
WB3	310.11±5.76	1.17±0.01	0.51±0.01	3.80±0.01	0.44±0.01
WB4	358.45±8.24	1.55±0.01	2.27±0.01	5.04±0.01	0.38±0.01
EB1	751.94±41.12	4.16±0.02	3.44±0.01	6.27±0.03	0.62±0.01
EB2	455.82±33.89	1.18±0.01	2.54±0.01	5.47±0.04	0.22±0.01
EB3	248.41±14.46	0.21±0.03	0.89±0.01	3.39±0.02	0.18±0.01
EB4	419.18±11.51	2.67±0.01	2.11±0.02	4.07±0.01	0.36±0.01
MIN	240.37±37.67	0.21±0.03	0.51±0.01	3.39±0.02	0.18±0.01
MAX	751.94±41.12	4.16±0.02	5.70±0.02	6.76±0.01	0.62±0.01
CNT	223.19±0.76	0.84±0.07	0.06±0.01	3.94±0.01	0.16±0.01
WHO	50,000	80	100	500	50-200

Keys: MIN= Minimum, MAX= Maximum, CNT = Control site, KG = KeterenGwari, WB = Western by-pass, EB = Eastern by-pass, WHO = World health organization

Heavy metal distributions at the three study areas and control sites are showed in Table 1. The concentrations of The concentrations of Fe, Pb, Mn, Ni, Cr in soils collected from auto mechanic workshops and control site are presented in Table 1. The results revealed variations in metal concentrations across the sample

locations, indicating the influence of automobile repair activities on soil quality. Iron was the most abundant metal detected in soil samples, with concentrations ranging from 204.37±37.67 mg/kg at KG1 to 751.94±41.12 mg/kg atEB1. The highest iron concentration was recorded at EB1, while the control site contained 223.19±0.76 mg/kg. Although Fe levels in all workshop soils were higher than the control value, they remained far below the WHO permissible limit of 50.000 mg/kg, suggesting no immediate risk of Fe contamination. The elevated Fe concentrations

at the mechanic workshops may be attributed to corrosion of vehicle parts, disposal of metal scraps, engine wear, and other automobile maintenance activities as reported by (Bisht, *et al.*, 2022).

Nickel concentration varied between 0.21 ± 0.03 mg/kg at EB3 and 4.16 ± 0.02 mg/kg at EB1. The control soil contained 0.84 ± 0.07 mg/kg, indicating enrichment of Ni in several workshops locations, particularly at EB1, KG4, WB1, and EB4. Despite this increase, all values were significantly below the WHO guideline value of 80 mg/kg. Nickel contamination in mechanic workshop soils is commonly associated with lubricating oils, batteries, metal alloys, and vehicular emissions (Belcik, *et al.*, 2023).

Lead concentrations ranged from 0.51 ± 0.01 mg/kg at WB3 to 5.70 ± 0.02 mg/kg at KG4. The control site recorded a very low concentration of 0.06 ± 0.01 mg/kg, indicating substantial Pb accumulation in workshop soils compared to the background level. Although the detected concentrations were well below the WHO permissible limit of 100 mg/kg, the enrichment observed may result from improper disposal of used batteries, lead containing automobile components, paints, and lubricants (Prasad *et al.*, 2021). The relatively high lead (Pb) levels at KG4, KG2, KG1, and KG3 suggest greater anthropogenic inputs at these locations.

Manganese concentrations ranged from 3.39 ± 0.02 mg/kg at EB3 to 6.76 ± 0.01 mg/kg at KG1. The control soil contained 3.94 ± 0.01 mg/kg, and most workshop samples showed slightly elevated Mn concentrations. Nevertheless, all measured values were considerably lower than the WHO permissible limit of 500 mg/kg. Presence of Mn in workshop soils may be linked to engine wear, steel components, welding activities, and the disposal of automotive wastes (Muze, *et al.*, 2022).

Chromium concentrations varied from 0.18 ± 0.01 mg/kg at EB3 to 0.62 ± 0.01 mg/kg at EB1, with control site recording 0.16 ± 0.01 mg/kg. Similar to the other metals, Cr were higher in workshop soils than in the control but remained well below the WHO permissible range of 50-200 mg/kg. Chromium contamination may originate from metal plating, vehicle parts, paints, and lubricants commonly handle in automobile repair

workshops (Bisht, *et al.*, 2022). Overall, the mean concentrations of the investigated metals followed the order: Fe > Mn > Pb > Ni > Cr across the studied mechanic workshop soils. The elevated concentrations observed in workshop locations relative to the control site confirm the contribution of automobile repair activities to heavy metal accumulation in soils. However, all measured concentrations were below the corresponding WHO permissible limits, indicating that the soils are currently not heavily contaminated. Nonetheless the enrichment of Fe, Mn, Pb, Ni, and Cr above background levels suggest ongoing anthropogenic inputs, and continuous monitoring is recommended to prevent future accumulation that could pose environmental and public health risks.

V. CONCLUSSION AND RECOMMENDATIONS

This study evaluated the concentrations of Fe, Mn, Pb, Ni, and Cr in soils around auto mechanic workshops and compared them with control samples and permissible standards. The finding revealed that the concentrations of all investigated metals were higher in the workshops than in control sites, indicating the influence of anthropogenic activities associated with automechanic operations. However, the concentration remained below permissible limits recommended by the world health organization, suggesting that the area is not yet significantly polluted. Nevertheless the elevated metal levels relative to the control sample indicate gradual accumulation of heavy metals in the soil, which may becomes harmful with prolonged exposure and continuous deposition. Therefore, regular monitoring, proper waste disposal practices, and environmental management strategies are recommended to prevent future contamination and environmental quality

Contribution to the knowledge

This study provides baseline information on heavy metal contamination in soils around auto mechanic workshops in Chanchaga local government Area, Minna, Niger State. It confirms that auto mechanic activities increase heavy metal concentrations in surrounding soils relative to control sites, although the concentrations remain within world health organization permissible limits. The findings contribute to the environmental pollution monitoring,

support future risk assessment studies, and provide data for developing effective environmental management in auto mechanic workshops.

REFERENCES

- [1] Akinola Ayoola E. Akpan Benjamin M. Toheeb Ayodeji S. Love David A. Amalachukwu Eukorah, Miracle Oladeyin O. (2025). Carcinogenic and non-carcinogenic risk assessment of selected heavy metals in soil and ground water at mechanic workshops GSC Advanced Research and Reviews, 2025, 22(01), 169-181.
- [2] Azorji, J., Okechukwu, R., Udebuani, C., & Duru, M. (2021). Evaluation of Physicochemical Properties and Heavy Metal Levels in Soils from Selected Auto Mechanic Workshops in Imo State, Nigeria. *Asian Journal of Advances in Research*, 19-29.
- [3] Bełcik, M., Grzegorzek, M., Canales, F. A., Struk-Sokołowska, J., & Kaźmierczak, B. (2023). Examination of interactions between heavy metals and benzotriazoles in rainwater runoff and snowmelt in an urban catchment in Poland. *Water Resources and Industry*, 100236.
- [4] Bisht, L., Gupta, V., Singh, A., Gautam, A. S., & Gautam, S. (2022). Heavy metal concentration and its distribution analysis in urban road dust: A case study from most populated city of Indian state of Uttarakhand. *Spatial and Spatio-temporal Epidemiology*, 40, 100470.
- [5] Daniel D.O. Udofla I.M. Agwo M.U. Aslwe T.N (2025). Evaluation of heavy metals contamination from automobile workshops Environ. Sci., 16(1), 102-111
- [6] Duru, C. E., Enyoh, C. E., Enedoh, M. C., Duru, I. A., Ibe, F. C., Verla, A. W., & I siuku, B. O. (2021). Assessment of Heavy Metals in Soils from Reclaimed Section of Nekede Mechanic Village, Owerri, Southeastern, Nigeria. *Chemistry Africa*, 4(2), 429-441.
- [7] Muze, N. E., Opara, A. I., Ibe, F. C., & Njoku, O. C. (2022). Assessment of the geo-environmental effects of activities of auto-mechanic workshops at Alaoji Aba 6(2), 17-19
- [8] Obasi, P. C. (2022). Factors affecting Agricultural productivity among arable crop farmers in Imo State, Nigeria. *American Journal of Experimental Agriculture*, 3(2), 443-454.
- [9] Ogunkolu, A. B., Moses, O., Oyetunji, A. B., & Abudllahi, A. (2021). Assessment of heavy metal contamination of soil around auto mechanic workshops in Anyigba, Kogi State. *Confluence Journal of Environmental Studies*, 13(1), 79-89.
- [10] Ojedokun, A. T., & Bello, O. S. (2022). Sequestering heavy metals from wastewater using cow dung. *Water Resources and Industry*, 13, 7-13.
- [11] Prasad, S., Yadav, K., Kumar, S., Gupta, N., Cabral-Pinto, M., Rezanian, S., Radwan, N. & Alam, J, (2021). Chromium contamination and effect on environmental health and its remediation: A sustainable approaches. *Journal of Environmental Management*, 285, p.112174.