Industrial Chemistry
ISSN: 2469-9764
Editorial Open Access

Evaluating the Levels of Heavy Metals in Auto-Mechanic Waste Disposal Sites Across Makurdi Metropolis

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Abstract

This study aimed to evaluate the contamination of heavy metals in auto-mechanic dumpsites located in the Makurdi metropolis, specifically in Kanshio (K), Northbank (NB), and Wadata (W) areas. The heavy metal concentrations (Cd, Cu, Pb, and Zn) were determined using an atomic absorption spectrophotometer (PG990). The mean concentrations of these heavy metals were found to exceed their respective reference permissible levels in the soil, as defined by World Health Organization (WHO), United States Environmental Protection Agency (USEPA), Mean Shale Concentration (MSC), and World Surface Rock Average (WSRA) guidelines. This indicates a significant level of pollution in the area, possibly attributed to activities such as welding, lead battery repairs, and coatings. Geo-accumulation index, contamination factor, and pollution load index were employed to assess the extent of contamination.

Keywords: Heavy metals; Auto-mechanic dumpsites; Geo-accumulation index

Introduction

Recent research has focused on heavy metal contamination, defining heavy metals as metals with densities at least five times greater than water and exhibiting toxicity at low concentrations. These metals, with atomic numbers above 20 and densities exceeding 5 g/cm^3, are a considerable source of environmental contamination in Nigeria, particularly from auto mechanic activities. These workshops, which encompass various repairs and maintenance tasks, contribute to heavy metal pollution. The proliferation of heavy metals in the environment has become a growing concern, particularly in areas where auto-mechanic activities are prevalent. Heavy metals, defined by their high densities and toxicity even at low concentrations, pose significant risks to both ecosystems and human health. Auto-mechanic workshops, while crucial for vehicle maintenance and repair, inadvertently contribute to the release of heavy metals into the environment through various processes such as welding, battery repairs, and coatings. This study focuses on assessing the concentration of heavy metals in auto-mechanic dumpsites within the context of the Makurdi metropolis, shedding light on the potential implications for environmental contamination and the well-being of local populations [1]. By investigating heavy metal levels and employing established assessment methods, this research aims to provide valuable insights into the extent of pollution in these dumpsites and the necessity for effective mitigation strategies.

Methods

Sample collection and preparation

Three auto-mechanic dumpsites were selected within the Makurdi metropolis: Kanshio (K), Northbank (NB), and Wadata (W). Soil samples were collected from each site at a uniform depth ranging between 5.5 and 10 cm. The samples were air-dried and then subjected to further drying in an oven until complete dryness. After sieving the samples through a 0.5 mm particle size mesh, the finely-ground soil was treated with an acid mixture (H2SO4, HCl, and HNO3) for digestion. This process was carried out to ensure the release of heavy metals from the soil matrix [2].

Assessment of heavy metal contamination

The study employed various assessment methods to determine the extent of heavy metal contamination in the auto-mechanic dumpsites:

Geo-accumulation Index (Igeo)

The geo-accumulation index was calculated to quantitatively assess the contamination of heavy metals in the soil sediments. By comparing current concentrations to pre-industrial levels, this index provided insights into the degree of metal pollution. The Igeo values were categorized into enrichment classes based on numerical thresholds.

Contamination factor (CF)

The contamination factor was utilized to gauge the level of contamination in the soil. This factor compared the concentration of the metal of interest to a background concentration, indicating the degree of contamination by that metal.

Pollution load index (PLI)

The pollution load index was calculated to determine the overall pollution level in the environment. By combining the contamination factors for different heavy metals, the PLI provided a comprehensive view of the contamination status within each dumpsite [3].

Discussion

The analysis of heavy metal concentrations in the auto-mechanic dumpsites revealed significant insights into the pollution levels and potential sources of contamination. The concentration of heavy metals, including cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn), varied among the studied sites. The highest concentrations were observed in the Kanshio dumpsite, indicating a more pronounced pollution level in comparison to the Northbank and Wadata sites.

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Received: 03-July-2023, Manuscript No. ico-23-110978; **Editor assigned:** 05-July-2023, PreQC No. ico-23-110978 (PQ); **Reviewed:** 19-July-2023, QC No. ico-23-110978; **Revised:** 24-July-2023, Manuscript No. ico-23-110978 (R); **Published:** 31-July-2023, DOI: 10.4172/2469-9764.1000239

Citation: Brown T (2023) Evaluating the Levels of Heavy Metals in Auto-Mechanic Waste Disposal Sites Across Makurdi Metropolis. Ind Chem, 9: 239.

The results from the geo-accumulation index (Igeo), contamination factor (CF), and pollution load index (PLI) corroborated the observed contamination patterns. The Igeo values for Cd and Pb demonstrated strong pollution potential in all three sites, while Cu and Zn indicated varying degrees of contamination [4]. The CF values confirmed the considerable contamination of Cd and Pb, with Cu and Zn showing moderate levels of contamination.

Overall, this study highlights the substantial presence of heavy metals in auto-mechanic dumpsites, posing potential risks to the environment and human health. The accumulation of heavy metals in the soil indicates the need for effective waste management strategies in these areas to mitigate the adverse effects of contamination. Additionally, the assessment methods employed provide valuable tools for evaluating pollution levels and guiding future environmental management decisions. The study revealed that auto-mechanic waste dumps in Kanshio, Northbank, and WA data are significant sources of heavy metal pollution in the soil [5-9]. This contamination poses potential health and environmental risks. Most heavy metal concentrations exceeded reference limits, and contamination assessment indices confirmed high pollution levels. Effective legislation is crucial to mitigate human exposure and environmental impact associated with heavy metal contamination in these dumpsites. The investigation into heavy metal concentrations within auto-mechanic dumpsites in the Makurdi metropolis has unveiled critical insights into the severity of environmental contamination stemming from these activities. The comprehensive methods employed to assess contamination levels have shed light on the potential risks posed to both the ecosystem and human well-being .

Conclusion

The varying heavy metal concentrations across the studied dumpsites, with Kanshio exhibiting the highest levels, underscore the significance of localized pollution sources. The observed presence of cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) beyond permissible limits indicates the urgent need for addressing the environmental impact of auto-mechanic activities. The utilization of assessment methods such as the geo-accumulation index (Igeo), contamination factor (CF), and pollution load index (PLI) has provided a robust framework for quantifying and categorizing contamination levels. These methods not only confirmed the contamination trends observed in heavy metal concentrations but also furnished a holistic perspective on the extent of pollution across dumpsites.

The study's findings emphasize the importance of implementing effective waste management and pollution control measures in auto-mechanic dumpsites. Proactive interventions are crucial to curbing the release of heavy metals into the environment, thereby safeguarding ecosystems and the health of local communities. Furthermore, the methods utilized in this study offer valuable tools for future assessments and informed decision-making regarding environmental management strategies. This research serves as a clarion call for heightened awareness and remedial actions in mitigating heavy metal pollution arising from auto-mechanic activities. The collaborative efforts of policymakers, environmental agencies, and stakeholders are essential to ensure sustainable practices and a healthier environment for present and future generations.

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