



**ASSESSMENT OF SOIL CONTAMINATION BY AUTO-MOBILE WASTE IN
GWAGWALADA, FCT**

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Abstract

This study investigated soil contamination by auto-mobile waste in Gwagwalada, FCT. Thirty soil samples were collected each at sites within selected automobile workshops and sites that are far from the workshop without the influence of workshop activities (control sites). The levels of eight heavy metals (Mn, Cu, Fe, Zn, Pb, Cr, Co and Cd) were determined using atomic absorption spectrophotometer (AAS). Data interpretation involved the use of descriptive statistics and mean to test for the levels of heavy metals between the workshop sites and control sites. Findings revealed that heavy metals were generally higher in soils under the influence of automobile workshop activities than the areas farther. The mean values of Mn, Cu, Fe, Zn, Pb, Cr, Co and Cd were 59.77, 10.24, 180.04, 45.74, 13.10, 0.02, 1.72 and 1.69 mg/kg respectively in soils under the influence of automobile workshop activities, 44.56, 7.74, 96.81, 22.02, 9.99, 0.00, 1.19 and 1.61 mg/kg at upstream location and 32.59, 3.53, 49.38, 17.71, 6.34, 0.01, 0.96 and 2.01 at downstream location, respectively in soils farther from the automobile workshop. There were significant variations in the levels of heavy metals between the automobile workshops and the control sites. Soils at these mechanic shops sites should be occasionally be sampled for laboratory analysis to know the heavy metal status of the soil and also to monitor for healthy soils.

KEY WORDS: automobile workshop, automobile waste, soil contamination, heavy metals.

INTRODUCTION

The emergence of auto mechanic workshops enables vehicle repairs and servicing that create and discharge automobile wastes into the environment (soil, water bodies and air), leading to environmental pollution if not properly disposed of and managed. Operators of automobile

workshops get rid of fluid waste (used-motor oil, contaminated petrol and diesel) by pouring them on the ground, which either penetrate into the soil or washed by rainstorm into drains.

Soils become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition (Wuana and Okieimen, 2011). The ability of soil to immobilize introduced chemicals like heavy metals depends on sorption properties of the soil (soil texture, pH, moisture content and cation exchange capacity (Joseph, Titilope, Oguntimehin and Lajide, 2017). The role of soil organisms in soil formation is crucial to the formation of soil in terms of organic matter accumulation, biochemical weathering, profile mixing, nutrient cycling and aggregate stability through the activities of organisms in the soil (Abaje, 2017). All these processes that soil undergoes makes up a good soil structure, texture and composition that would determine the kind of use it will be put into. Taking note on the constituents of the generated automobile waste such as petrol, diesel, solvents, grease and lubricants coming from the auto-mechanic repair and servicing workshop, mostly contain heavy metals such as lead, nickel, cadmium, zinc, copper, chromium and manganese (EPC, 2017 and Tayo and Briggs 2018). Heavy metals are chemical elements found in all kinds of soils mostly with density greater than 5g dm^{-3} (Lacatusu, 2008). These heavy metals contaminates both urban and agricultural soils which have grave consequences on an organism's position in the food chain and poisons soil micro-organisms due to bioaccumulation (Rabe, Agbaji, Zakka, Muhammed and Rabe, 2018).

In Nigeria, soil pollution problems associated with automobile wastes has been reported by Adewoyin, Hassan and Aladesida, (2013), Pam, Sha'ato, and Offem (2013), Adelekan and Abegunde (2011) and Rabe, *et al* (2018) Okoro, Chukwuma, Chukwuma and Ugwu (2015) and Utang, Eludoyin and Ijekeye (2013) in their experiments studied the effects of auto-mechanic workshops on soil with respect to the accumulation of heavy metals. Generally, the heavy metals concentrations were higher in the soils close to the mechanic workshops than the control sites. However, there is a need to check the level of these heavy metals in mechanic workshop soil so as

to provide useful environmental information and data for future monitoring to avoid alarming concentrations of these heavy metals in the soil environment.

The objectives of this study were to assess the level of heavy metals from auto-mechanic workshops in the soil of informal automobile workshops and analyze the effects of auto-mobile waste generation on the soil of Gwagwalada. This will provide knowledge on the level of heavy metals from auto-mechanic workshops and the effects on the soil.

MATERIALS AND METHODS

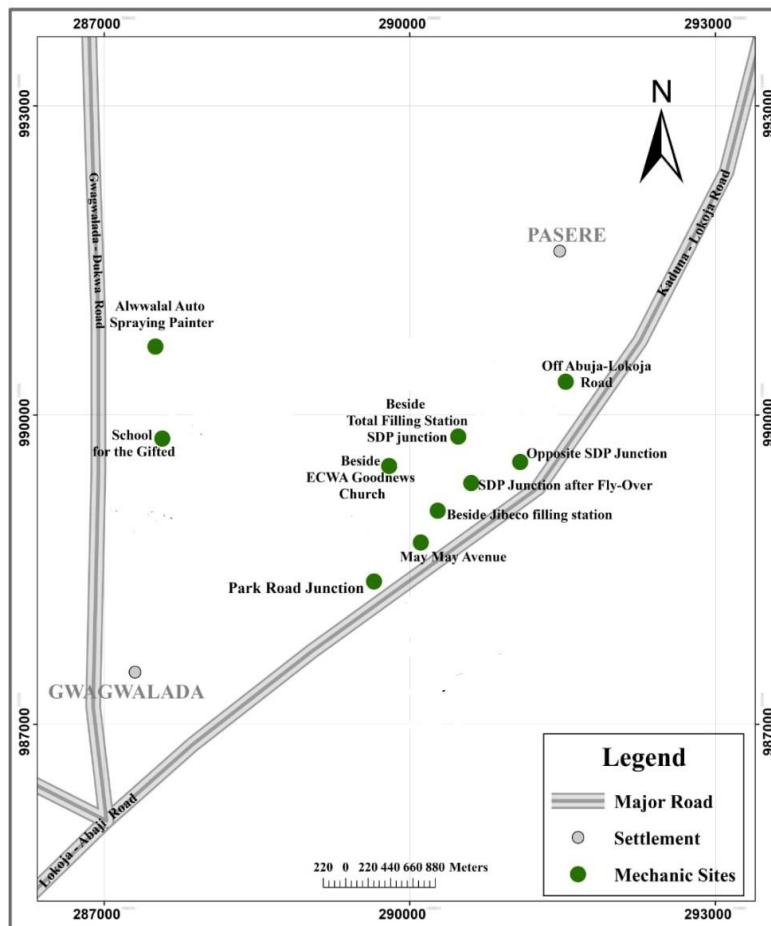
Study Area

Gwagwalada area covers 1,043 km² and is located between latitude 8° 55' N and 9° 00' N of the equator and longitude 7° 00' E and 7° 05' E of Greenwich meridian at a height of 205 meters and at extreme southwest near the flood plain of river Gurara which traverses the territory from North to South at an elevation of 70m above sea level. It is located at about 55km South-West of the Abuja city center (Abdulsalam and Ologe, 2013). Gwagwalada has a tropical climate, with the rainy season from May-October and dry season from November -April and with an average annual temperature of 34.15°C and about 806mm of precipitation annually. The duration of sunshine hours ranges from 5 to 10 hours per day and it has a relative humidity of 68.7% (Weather Atlas, 2021).

Sample Collection

There were eighteen (18) locations of automobile workshop identified using Global Position System (GPS), out of which ten (10) of the locations were randomly selected. Soil samples were collected at random from three different locations at each automobile workshop location at 0-10cm depth which were then mixed up to obtain a composite soil sample and control samples were collected from two locations which were the upstream and downstream locations at the distance 100 meters from the mechanic which were put in polythene bags and sent to the laboratory for various analysis. These samples were air dried, grinded using mortar and pestle and sieved with 2mm mesh size. 2g of each of the soil samples was accurately weighed and treated with 10 ml aliquots of high purity concentrated HNO₃. The mixture was heated on a hot plate until the sample was almost dry and then cooled. This procedure was repeated with another 10ml of concentrated HNO₃ followed by 10 ml of 2M HCl to re-dissolve the residue. The extracts were

then filtered through Whatman filter paper into 50ml capacity bottle and brought up to volume with doubled distilled water. Heavy metal concentrations (Cadmium, Cd; Chromium, Cr; Zinc, Zn; Manganese, Mn; Iron, Fe; Copper, Cu; Cobalt, Co and Lead, Pb) were determined using Atomic Absorption Spectrophotometer.



Map of Gwagwalada town showing points of sample collection

RESULTS AND DISCUSSION

Heavy Metals Concentration

The result showed that heavy metals concentrations in the soil samples were higher in the auto-mechanic workshops than the upstream and downstream locations which were used as control points. A similar result was reported (Uba, Uzairu, Harrison, Balarabe, and Okunola, 2008) from Okigwe, and Nekede mechanic villages in Imo State Nigeria, and by (Ajiwe, Nnibuikwe, Onochie, and Ajibola, 2000) from auto mechanic villages in Ibadan, Nigeria. These high levels observed may be connected with the large amounts of waste engine oil and other chemical fluids discharged in the vicinity of the auto mechanic workshop villages. Iron, Manganese, Zinc, Lead and Copper had the highest concentration in the values of the heavy metals analyzed from the mechanic sites. This is an indication that these heavy metals are the primary contaminant in the auto-mechanic workshops soil which was also reflected in the low level of these heavy metals obtained in comparison with those obtained from the upstream and downstream locations. Cadmium and Cobalt had lower concentration in the values of heavy metals analyzed and Chromium had the lowest value in a few locations and non was detected in majority of locations.

Table 1: Mean Concentration of Heavy Metals in Soil Samples from Mechanic Sites, Upstream locations and downstream locations.

Location	Metal Concentration (mg/kg)							
	Mn	Cu	Fe	Zn	Pb	Cr	Co	Cd
Mechanic site	59.77	10.24	180.04	45.74	13.10	0.02	1.72	1.69
Upstream	44.56	7.74	96.81	22.02	9.99	0.00	1.19	1.61
Dwnstream	32.59	3.53	49.38	17.71	6.34	0.01	0.96	2.01

Figure 4: Mean concentration of heavy metals

Manganese (Mn)

In Table 1 the concentrations of Mn were found to be very high in mechanic site at a mean average of 59.7 in comparison to the upstream and downstream locations of mean average of 44.56 and 32.59 respectively. This metal may not be regarded as a primary contaminant in the study area, but it is reflected in its accumulation factors which primarily determine its extent of contamination. However there is no soil quality criteria established for Mn for now (Kimberly and William, 1999 and Karen, 2005). Nevertheless, increase in the concentration of Mn in the mechanic sites may be attributed to the metal scraps dumped around the sites before sold out to scavengers which is in support of the findings by Idugboe, Tawari-Fufeyin & Midonu (2014) and Olayinka, Akande and Adetunji (2017). While the decrease in concentration at the upstream can be attributed to it naturally occurring Mn and that of the downstream is as a result of obstructed and diverted metals during the downwards movement from the mechanic site. Mn is an essential micronutrients in most organisms, though in acidic soil it tends to be in high concentration which can be toxic to plants (Millaleo, Reyes-Diaz, Ivanov, Mora and Alberdi, 2010). In this study, the Mn concentration is below maximum permissible limit prescribed by World Health Organization (WHO) of 2000 mg/kg which may not be intoxicating to soil, thereby can support plant growth.

Copper (Cu)

Copper was present in all the soil samples investigated in the mechanic workshop sites. The values of Cu are higher in the mechanic site at a mean average of 10.24 in comparison to upstream and downstream locations that ranged 7.74 and 3.53 respectively (Table 1). The higher value at the mechanic site can be attributed to automobile wastes containing electrical and electronic parts, such as copper wires, electrodes and copper pipes and alloys from corroding vehicle scraps which have littered the vicinity for a long time just as suggested by Pam *et al* (2013). The concentration of Cu seems to be lowest at the downstream due to the loss of some amount of it during movement than that of the upstream that is the source point of the naturally occurring Cu. Cu is known to be very toxic to micro organisms, as it has significantly decreased the amount of microbial biomass and exert toxic effects on the decrease size of the biomass when compared to certain metals as Pb (El-Ghamry, Subhani, Mohd, Changyong and Zhengmiao, 2000). Thus this may have attributed to the inhibition of plant growth within the mechanic site. This study

revealed that mechanic site, upstream and downstream locations have the concentration of Cu below maximum permissible limit of 100mg/kg as prescribed by WHO and not toxic to the soil quality for now and does not require any remediation.

Iron (Fe)

The study revealed that the value of iron content is high within the mechanic site with the mean average of 180.04 (Table 1) in comparison to the concentration in upstream and downstream locations with the mean average of 96.81 and 49.38 respectively (Table 1). Although Fe concentration in this study was below maximum permissible limit prescribed by WHO. Hoyt (2021) opined that the iron content in soil typically depends on its pH level, measuring the acidity of soils rated on a scale from 1 to 14. Thus soils below a pH level of 7 are acidic and generally contain more iron. Possibly one of the factors that have attributed to the value of iron recorded at the mechanic site may be as a result of the fact that some of the disposed waste contain high level of iron and its pH level that is slightly acidic. Also the pH level of the upstream is slightly acidic which may have contributed to the higher concentration of Fe than the downstream that has a pH that is slightly alkaline. The high concentration of iron in soils relative to other metals have also been reported in various studies, confirming that natural soils contain significant levels of iron (Dara, 2006; Ademoroti, 1996; Aluko and Oluwande, 2003; Oguntimehin and Ipinmoroti, 2008, and Joseph, Titilope, Oguntimehin and Lajide, 2017). Fe is significant for the successful production of crops through nitrogen fixation as well as the condition of human health when such crops are consumed (Irmak, Surucu and Aydin, 2008). However, the concentration of Fe within mechanic site, upstream and downstream locations are below maximum permissible limit of 50000 as prescribed by WHO. Though due to the slight acidic nature of soil at mechanic site, there is the tendency of higher retention of Fe in the soil that could lead to toxicity when not monitored.

Zinc (Zn)

The ability of Zinc to conduct heat has made it possible for it to be used as break lining that is released during mechanical abrasion of vehicles, combustion of engine oil and wear and tear of tyres which are emitted into the environment as particles during deposition (Akande and Ajayi, 2017). In this study, Zn has a mean average of 45.74 at the mechanic site which is higher

than those at the upstream and downstream locations of 22.02 and 17.71 respectively. This suggest that, there is anthropogenic contribution at the mechanic site. Therefore, the concentration of Zn in mechanic site, upstream and downstream locations are below maximum permissible limit of 300 as prescribed by WHO. When large quantities of Zn are found in the soil, animals can absorb concentration that is damaging to their health and also plants can have an uptake that their system cannot handle. Water soluble zinc in the soil can contaminate ground water (Lenntech, 2022). The low concentration of Zn in the soil of the study area does not signify any damaging effect as a result, the available quantity can support plant growth and development, particularly for protein synthesis, hormone regulation, and disease resistance and will not warrant absorption by animals.

Lead (Pb)

Lead concentration in the soil is likely to have derived from vehicle exhaust fumes containing lead-rich aerosols (Zakir, Sultana and Akter, 2014). Studies carried out by Ostas and Sibel (2002), Akbar, Hale, Headley and Arther (2006), Onder, Dursun, Gezgin and Damirbas (2007), Sharma and Parasade (2010) showed that the use of tetraethyl lead as an antiknocking agent in gasoline gives rise to its release during emissions from automobiles and fossil fuel combustion. In this study table 4.8 showed that the mean average mechanic site is 13.10. The higher concentration of lead in mechanic site in comparison to upstream and downstream locations of the mean average of 9.99 and 6.34 respectively (Table 1), indicates that the activities carried out at the workshop sites to have contributed to it. Lead accumulates in the soil, particularly soil with a high organic content (Greene, 2014). It could be said that the low concentration of lead in the soil at the downstream location is as a result of its low organic content. Pb accumulate in the bodies of water and soil organisms. However, the concentration of Pb in mechanic workshop sites is below maximum permissible limit of 100mg/kg as prescribed by WHO. Generally, Pb concentration in the study area is low and does not pose any potential risk to the soil, thus can support plant growth. However Pb can alter soil structure, reduces its porosity and permeability. Also reduces water infiltration rates, thereby making it harder for plants to access water. Furthermore, it can contribute to soil degradation and acidification by reducing the soil's pH and potentially harming microorganisms and plants and disrupting nutrient balances in soil by reducing the availability of essential nutrients like nitrogen, phosphorus, and potassium.

Chromium (Cr)

This result showed in Table 1 that the mean average of Cr at mechanic site is 0.02 while the upstream and downstream locations are 0.00 and 0.01 respectively. Similar range of value at the mechanic site was reported by Joseph *et al.* (2017). Cr was not present in the upstream location of study. This element have been introduced into the soil through the activities carried out at the mechanic site. However, the result of the downstream suggests that a major fraction of Cr in soil might have leached and percolated to deeper layer which causes contamination of groundwater and subsequently highly prone to mobilization to the surrounding water layers as well as available to biota. Similarly, the concentration has decreased with the increase in distance between the mechanic site and the downstream location sampling point just as reported in a similar study by Mandal, Vankayala, and Kumar (2011). Cr in the soil attaches itself to soil particles which can lead to soil degradation, reducing its fertility and structure while in water it's absorbed on sediment and becomes immobile. Crops contain systems that enables Cr uptake to be low enough not to cause any harm. Furthermore, the low concentration in the mechanic site and downstream location is indicative that it has little or no impact on plant growth as crops are made up of systems for low Cr uptake. Cr can alter soil structure, reducing its porosity, permeability and water infiltration rates thereby making it harder for plants to access water.

Cobalt (Co)

The mean average Cobalt concentration in the mechanic site is 1.72 while upstream and downstream locations are of 1.19 and 0.96 values respectively (Table 1). The low concentration of cobalt could be related to the dilution effect as opined by Chapman (2021). In the study of Oladeji and Saeed (2015), affirms that soil cobalt concentration during the dry season was higher compared to that of the rainy season. Thus, this could be reason for a low concentration of cobalt in this study, as samples were collected during the rainy season. Co mobilizes under acidic conditions but mostly ends up in soil and sediments. However, the low concentration of Co at the downstream is indicative of the alkalinity of the soil, as it reduces the element mobility. The amount of Co uptake by plants and animals depends on the concentration of Co present in the soil (Lenntech, 2022). Toxic levels of Co leads to detrimental physiological behaviors in biological systems such as structural aberration, reduced photosynthetic activity, interference with

chlorophyll synthesis and induction of oxidative stress (Banerjee & Bhattacharya, 2021). Unfortunately, there has been no record by WHO on Co maximum permissible limit.

Cobalt can improve soil fertility by increasing the availability of other nutrients, like nitrogen and phosphorus which is essential for plant growth, particularly for nitrogen-fixing bacteria in legumes. Also it can stimulate microbial growth and activity, thereby promoting soil biota and ecosystem services.

Cadmium (Cd)

Cadmium is part of many additives found in lubricating oil. According to Jaradat and Momani (2003), cadmium level in car tires is in the range of 20 to 90 µg/g. The levels of Cd could be due to lubricating oils and/or old tires that are frequently used as convoy belt in machine and other associated wastes which corroborate the suggestion by Iwegbue, Basset, Tesi, Nwajei, and Tsafe (2013).

In this study, the mean average cadmium in the mechanic site is 1.69 while the upstream and downstream locations are of the value 1.61 and 2.01 respectively (Table 1). All of these falls within the non-contaminated level Alloway (2012) and WHO allowable permissible limit of 3. The presence of Cd has posed a potential threat to biota due to its non-metabolic, mobility and bioavailability in the environment. Though it is toxic to humans at lower concentrations than that of plants (Singh and McLaughlin, 2022). The low concentration of Cd in the soil of this study area is not at toxicity level, thereby can support plant growth.

Cd can alter soil structure, reducing its porosity, permeability and water infiltration rates, making it harder for plants to access water. It can also disrupt nutrient balances in soil, reducing the availability of essential nutrients like nitrogen, phosphorus, and potassium and soil acidification by reducing the soil's pH and potentially harming microorganisms and plants.

Conclusion and Recommendation

The present study investigated soil contamination by auto-mobile waste (Mn, Cu, Fe, Zn, Pb, Cr, Co and Cd) in soil and it can be concluded that automobile wastes from mechanic workshops accumulated in soils. The study also revealed significant variations in heavy metal levels in soils

that were closer to the automobile workshops than the control sites. The usual improper disposal of these wastes now demands attention in order to protect the soil as they render farmlands unfit for agriculture as well as pollute the ground and surface water systems. The study recommends that the artisans at auto-mechanic workshops need to be educated on the ripple effects of their activities on the soil and the environment when they improperly dispose fuels, engine oils, acid in car batteries, metal scraps and old tires on the soils when servicing vehicles.

Farmers should be advised to avoid cultivating crops close to auto-mechanic sites due to possible soil contamination. Soils at these mechanic shops sites should be occasionally be sampled for laboratory analysis to know the heavy metal status of the soil and also to monitor for healthy soils.

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