academicJournals

Vol. 8(26), pp. 3476-3482, 11 July, 2013
DOI: 10. 5897/AJAR2013.6753
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Impacts of automobile workshops on heavy metals concentrations of urban soils in Obio/Akpor LGA, Rivers State, Nigeria

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Accepted 1 July, 2013

This study investigated the impacts of automobile workshops on heavy metals concentrations in urban soils of Obio/Akpor Local Government Area (LGA), Rivers State, Nigeria. Thirty three soil samples were collected each at sites close in proximity to selected automobile workshops (experimental sites) and sites that are far from the workshop without the influence of automobile workshop (control sites). The levels of mercury (Hg), lead (Pb) and cadmium (Cd) were determined using atomic absorption spectrophotometer (AAS). Data interpretation involved the use of descriptive statistics and pairwise t-test for test of significance in the levels of heavy metals between the experimental sites and control sites. Findings revealed that heavy metals were generally higher in soils under the influence of automobile workshop than the areas farther but Pb was higher than Hg and Cd. The mean values of Hg, Pb and Cd were 3.07, 91.03 and 5.63 mg/kg respectively in soils under the influence of automobile workshops and 0.03, 60.25 and 1.79 mg/kg, respectively in soils farther from the automobile workshop. There were significant variations in the levels of heavy metals between the experimental sites and the control sites at 0.05 confidence level. It is recommended that mechanic villages should be sited far from residential areas, phyto-remediation of polluted soil using local plants should be encouraged and continuous education and training should be provided for the automobile workers, emphasizing on the environmental implications of their poor occupational waste management.

Key words: Automobile workshops, heavy metals, urban soils, Obio/Akpor.

INTRODUCTION

Motor servicing centers popularly known as mechanic workshops are sources of automobile waste in many urban areas in which Port Harcourt metropolis is not in exemption. In these land uses, fossil fuel products of different types are used leading to excess accumulation of heavy metals which are major constituents of the products in soils in and around these locations. These accumulations deteriorate vegetation that are nearby, accumulate in the plants tissues deteriorate surface runoff and percolate the water table causing non point pollution**.** The impacts of pollution from automobiles have reached a disturbing level. Environmental contaminants are widely distributed in the soil thereby having effect on the trophic chain, plants, animals and man (Campbell et al., 2005) and these pollutants can remain in the soil for a long time. Although trace metals are usually present in the biological world in accepted quantities, an increase of this through anthropogenic activities in the last century

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has been known to affect microbial growth, numbers, survival, biomass and abundance (Ogbonna and Okeke, 2010).

Automobile wastes which include solvents, paints, hydraulic fluids, lubricants and stripped oil sludge increase the amount of trace metals found in the soil. Automobile waste poured on the ground increases the level of heavy metals which drains into both surface waterways and ground water because of the connection between lands, air, water and soil. In a study on the physicochemical characterization of farmland affected by automobile waste in relation to heavy metals, Mbah and Ezeaku (2010) reported decreased Ca, K, Mg, cation exchange capacity (CEC) and increased levels of Zn, Pb, Cd, and Cu (above critical limits) in automobile waste affected farmland relative to the control. In another study on variation of heavy metal contents on roadside soils along a major expressway in South-east Nigeria, Mbah and Anikwe (2010) observed increased levels of Cu, Zn, Pb, Fe and Cd in soil nearer the road and this result according to Maynard and Turer (2003) is due to emissions from exhaust of automobile engines and contacts between metallic objects of machines.

Environmental pollution with petroleum products (complex mixture of hydrocarbon) has been recognized as a serious environmental problem especially as it is being spilled on large scale (Horsfall, 2001). They spread horizontally on the ground surface and continue to percolate into groundwater, soil pore space air and the surface of soil particles. The current interest in the environment stems from the concern that man is disrupting the natural processes and that the quality of life is being threatened. Automobile workshops are scattered all over the city of Port Harcourt and occupy almost every vacant plot especially along major roads, streets and markets. Wastes from these workshops are indiscriminately dumped on every available space thus, contaminating the soil by causing substantial alteration of the chemical composition and pH of the soil, hence may compromise efficient and quality plant growth. These wastes have a high level of heavy metal concentration that is hazardous to both plant and animals. In addition, microbes in the soil that are used in bioremediation are also destroyed**.** Since the water table in the Port Harcourt region is very close to the subsurface, very few people dig deep to source for potable water, thus the issue of water pollution is imminent through percolation and runoff. The consequence of water pollution as related to health is of great concern because two third of illness in Port Harcourt is reported to have been related to water-borne diseases through metal intoxification (Oyegun, 1999). Taking a good observation at both plants and soils around the automobile mechanic workshops, the soil colour of these sites is dark as a result of these wastes while the plants are brownish yellow as a result of lack of nutrients in the soil. In the literature, very few studies have investigated the effects of auto-mechanic workshops on the status of heavy metals in soils of an urban environment especially in Port Harcourt. This present study therefore examines the effects of heavy metal concentrations on urban soils of ObioAkpor Local Government Area (LGA), Rivers State, Nigeria.

Study area

The study was carried out in Obio/Akpor LGA of Rivers State, Nigeria. It is located between latitudes 4°45'N and 4°60'N and longitudes 6°50'E and 8°00'E in the Niger Delta of Nigeria (Figure 1). The study area enjoys tropical hot monsoon climate due to its latitudinal position. The tropical monsoon climate is characterized by heavy rainfall from April to October ranging from 2000 to 2500 mm with high temperature all the year round and a relatively constant high humidity. The relief is generally lowland which has an average of elevation between 20 and 30 m above mean sea level. Generally, the land surface slope is gentle (3°-5° on the average) in the NW-SE direction. The geology of the area comprises basically of alluvial sedimentary basin and basement complex. The vegetation found in this area includes raffia palms, thick mangrove forest and light rain forest. The study area is well drained with both fresh and salt water. The salt water is caused by the intrusion of sea water inland, thereby making the water slightly salty. The soil is usually sandy or sandy loam underlain by a layer of impervious pan and is always leached due to the heavy rainfall experienced in this area. They are often soils formed from older sediments and younger quaternary and recent alluvium. The study area is influenced by urbanization or urban sprawl whereby smaller communities have merged together and form megacity. The reason is due to high influx of people that resulted to rapid growth of the population in the study area. This in turn is largely due to the expansion of the oil and allied industries which have also attracted many varied manufacturing industries. The industries include food manufacturing, oil servicing, oil and gas, and construction, entertainment as there are media houses around and marine industries. The automobile mechanic workshops fall under industries and they scatter all over the study area. The occupation of the people in the area also includes fishing and subsistence farming.

MATERIALS AND METHODS

A total of fifty eight (58) auto-mechanic workshop was identified and mapped with the use of Global Positioning Systems (GPS), out of which thirty three (33) were randomly selected for analysis (Figure 2 and Table 1). Soil samples were collected from the top soil (0-15 cm) close to each of the auto-mechanics as the experimental site since it was reported that maximum contamination of heavy metals takes place in the top layer of the soil (Elbassam and Verlagerung, 1977; Mohr, 1971). Soil samples were also collected at the control sites which were observed not to be under the influence of auto-mechanic workshops and there was no existence of any activity that can dispose effluents. Soil auger was used to collect the soil into well-labelled polythene bags to prevent loss of moisture and

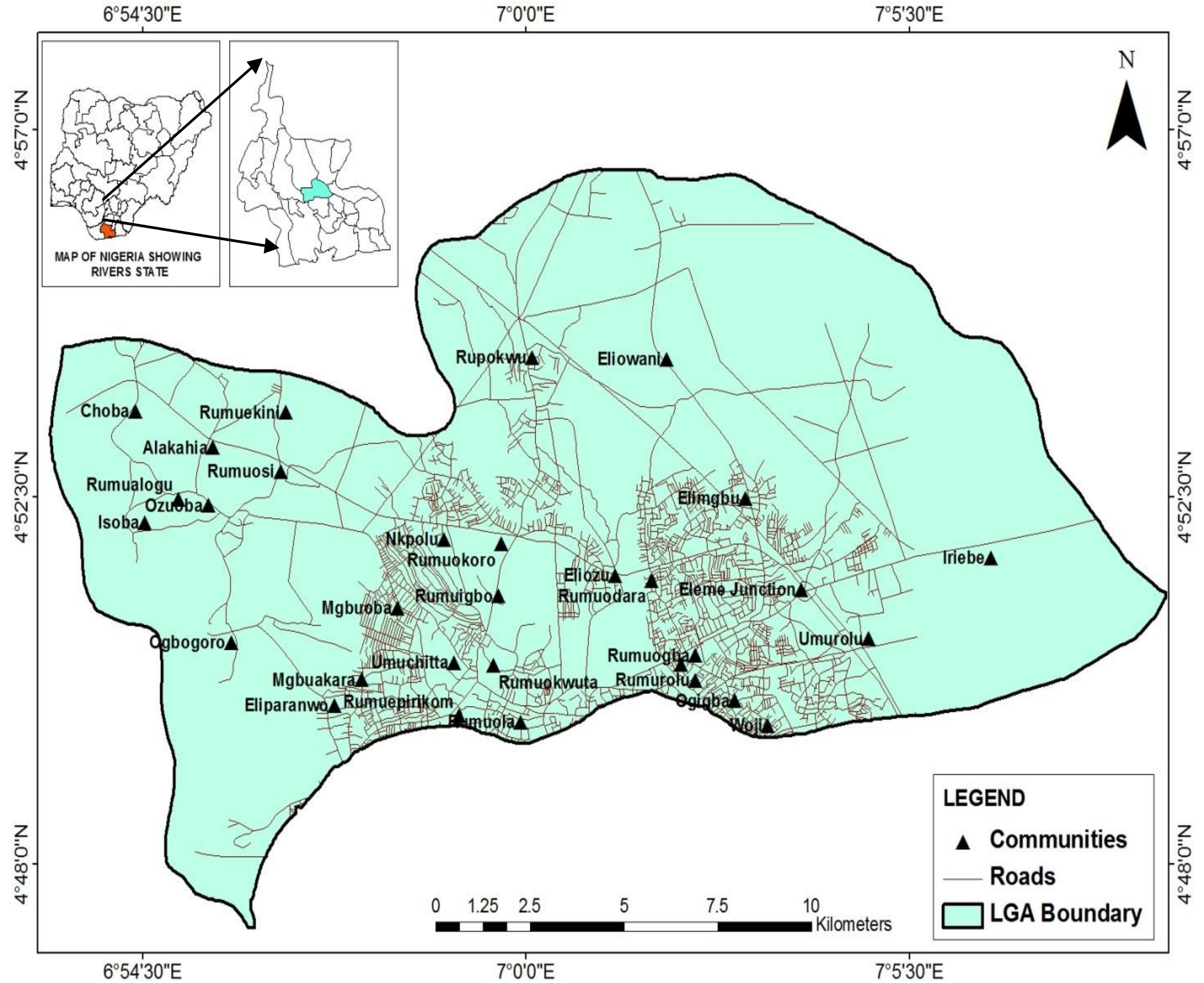

Figure 1. Obio/Akpor LGA.

brought to laboratory for various analyses. The soil samples were air-dried and passed through 2 mm diameter mesh size sieve. Mercury (Hg), lead (Pb) and cadmium (Cd)} in soil samples were extracted by leaching into 0.1 N EDTA (Aweto and Oyenuga, 2000) and analyzed using Atomic Absorption Spectrum (AAS) (Ogbonna and Okeke, 2010). Data analyses were done using descriptive statistics and Pairwise T-test was applied to test the significant difference in the levels of heavy metals in soils between mechanic workshops and control sites. All the analyses were carried out using Statistical Package for Social Sciences (SPSS) 17.0 version and Microsoft Excel 2007 version.

RESULTS AND DISCUSSION

Effects of auto-mechanic workshops on soil heavy metals

Table 2 presents the result of the analysis of the levels of heavy metals in the soils of the study area. The result of the analysis showed that the mean concentration of Hg in soils close to mechanic workshops ranged between 0.50 and 6.00 mg/kg with a mean value of 3.07 mg/kg, while the Hg ranged between 0.01 and 0.20 mg/kg in the control sites with a mean of 0.03 mg/kg. Pb had the highest concentration of all the heavy metals considered for this study. The mean value of Pb was 91.03 mg/kg ranging between 4.90 and 205.50 mg/kg at the experimental site while the mean concentration was 60.25 mg/kg ranging from 2.90 to 98.30 mg/kg. The mean value of Cd was 5.63 mg/kg in soils close to the auto-mechanic shops while the mean value in soils in control site was 1.79 mg/kg with a range of 0.10 to 6.40 mg/kg. Generally, the heavy metals concentrations were higher in the soils close to the mechanic workshops than the control sites (Figure 3) justifying the effects of auto-

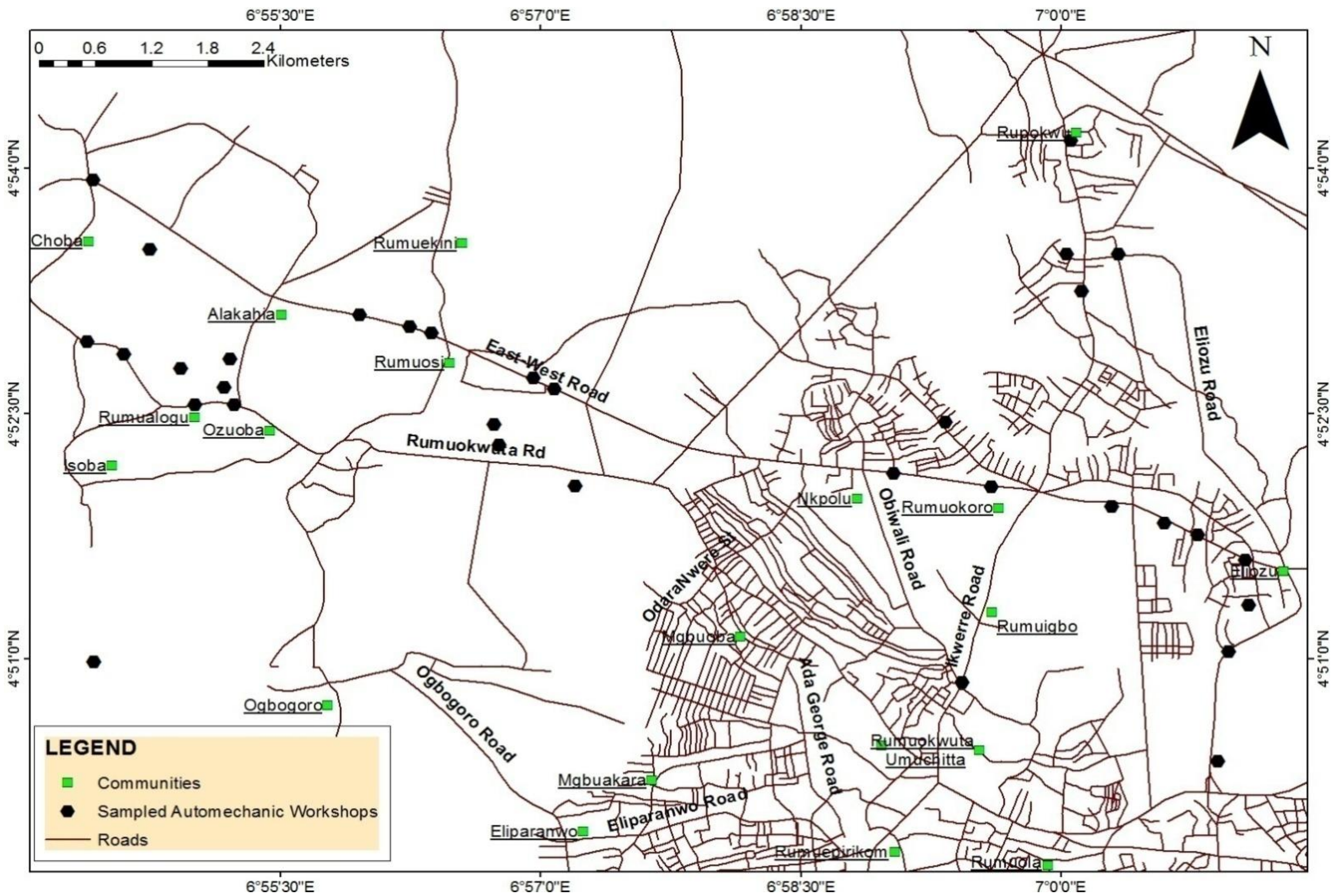

Figure 2. Map showing zones and sampled automobile workshops.

Table 1. Total Selected auto-mechanics shops in the study area.

Zone	Total distribution of mechanic workshops	Total selected auto mechanics shops
Eliozu	13	7
Rumuokoro	17	9
Rumuosi	9	3
Choba	19	14
Total	58	33

Table 2. Heavy metal variations in soils from the study area and control sites.

Heavy metals (mg/kg)	Mechanic workshops		Control site		T-Test (P = 0.05)
	Range	Mean±SD	Range	Mean ± SD	
Hg	0.50-6.00	3.07±1.61	0.01-0.20	0.03±0.03	10.92*
Pb	4.90-205.50	91.03±47.62	2.90-98.30	60.25±25.36	6.10*
Cd	1.10-14.00	5.63±3.69	0.10-6.40	1.79±1.43	7.95*

*Significant at 0.05 confidence level.

waste discharges on soil. There were significant variations in the concentrations of heavy metals between the soils under the influence of auto-mechanics and the control site at 0.05 confidence level of pairwise t-test.

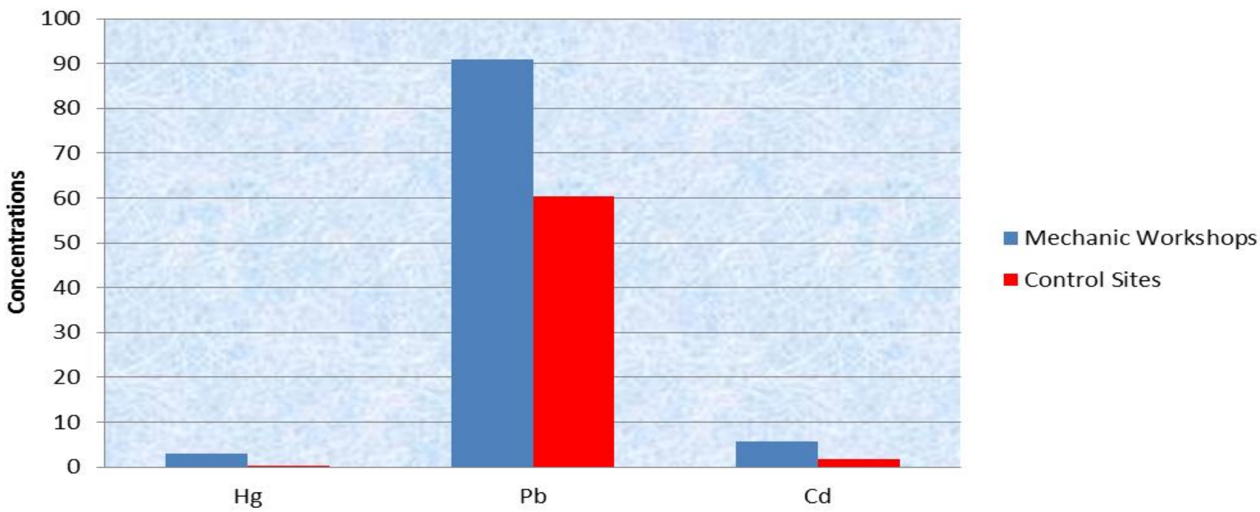

Figure 3. Heavy metal concentrations in soils of the study area.

Table 3. Critical loads for heavy metals in soil of selected countries.

Heavy metals	Critical limits	
	Hungary	Denmark
Hg	0.01-5	0.0033-1
Pb	15-30	22
Cd	0.01-2	0.0035-0.27

Sources: Bak and Jenson (1998), Sipos and Roka (2000).

Comparison of the levels of heavy metals in the study area with the critical loads of the heavy metals adopted in Hungary and Denmark (Table 3), it was observed that the all heavy metals in soil sample from both the mechanic workshops plot and the control plot exceeded the critical limits of these countries, suggesting that the soil of the area was precipitated with heavy metals. However, similar to the situation of the status of heavy metals in the study area, the Pb critical load limit was observed as the highest in soils of the both countries. Furthermore, it was observed that there were variations in the concentrations of heavy metals in soils under mechanic workshop and control sites (Figures 3 to 5) but the Hg concentration was discovered to be very low. Hg levels in soils across the sampled locations in the control site are presented in Figure 6.

Significant differences were observed between the levels of heavy metals sample sites close to the mechanic workshops and the control sites farther from the mechanic workshops. This may be attributed to the deliberate dumping of waste products containing the metals, and through storm water runoff (Gbadegesin and Olabode, 1999).

The levels of Pb across the study sites in soils of both the mechanic workshops and control sites was the highest among the three heavy metals and this could be due to the immobilization of Pb at the top soil. The higher concentration of Pb in this study is similar to the concentration of Pb in Ogbonna and Okeke (2010) whereby Pb was observed to be higher in concentration than Cd and Zinc (Zn). According to Ogbonna and Okeke (2010), the high concentration of Pb could be associated with lead-acid batteries that are among the constituents of the wastes. Pb contamination in soils leads to the decrease in the activities of soil microorganism and soil fertility deterioration (John et al., 2009).

The concentration of Cd in soil may be attributed to large quantities of battery dumped at the study area since batteries are good sources of several elements including Pb, Cd and Ni (Chrysanthus, 1996 in Ogbonna and Okeke, 2010). The presence of heavy metals in the study area could have deleterious impact on the health of individuals and animals. As heavy metals are toxic and non-biodegradable pollutants, the unexpected rapid mobilization could also result in environmental catastrophes through water and food poisoning (Iwegbue et al., 2006). Exposure to heavy metals is normally chronic (exposure over a longer period of time), due to food chain transfer. According to Isirimah et al. (1989), persons exposed to oil films are prone to headaches,

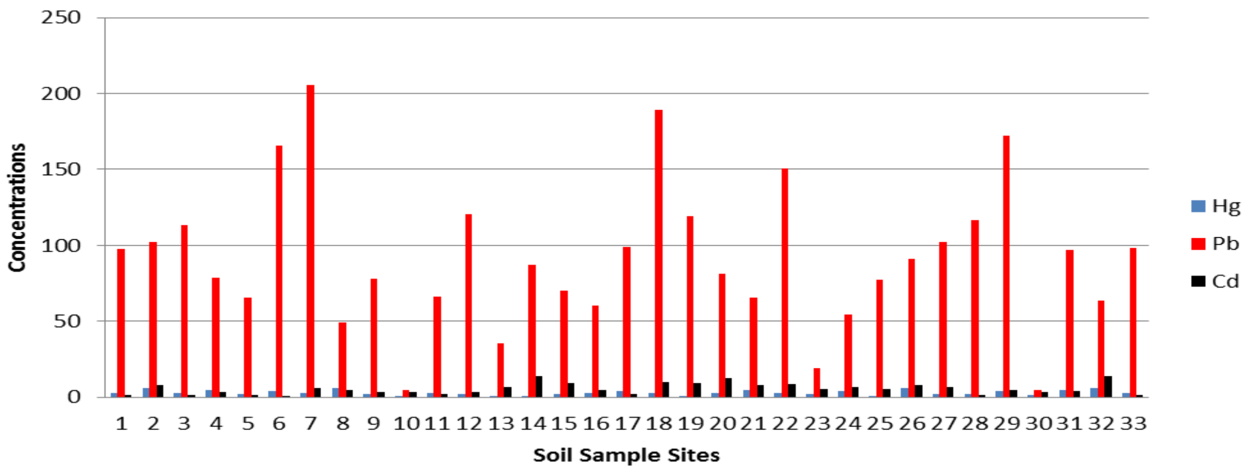

Figure 4. Heavy metal concentrations at each soil sample location close to mechanic workshop.

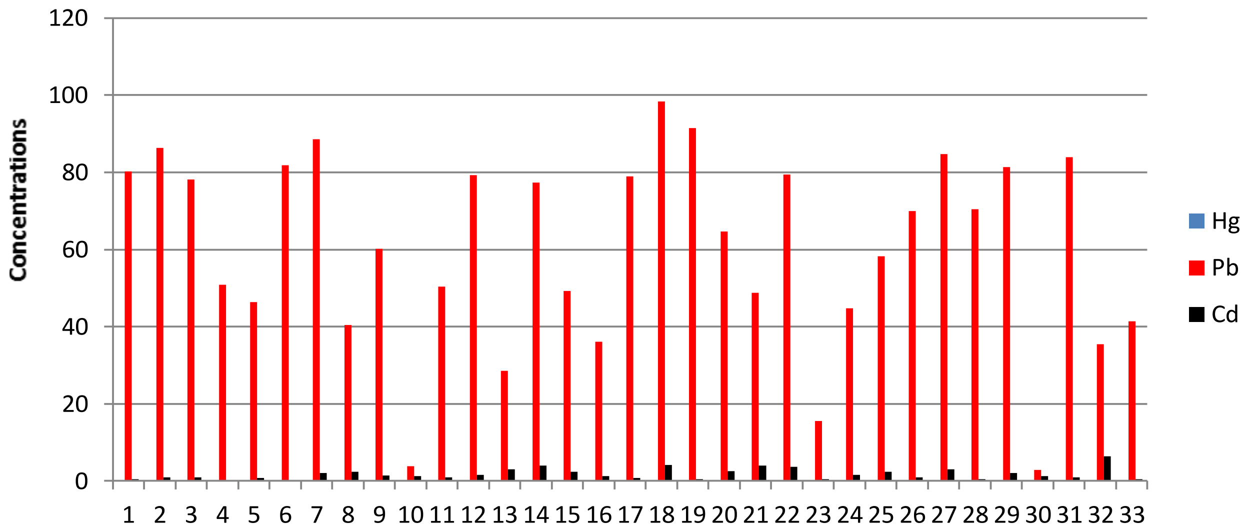

Figure 5. Heavy metal concentrations at each soil sample location in the control sites.

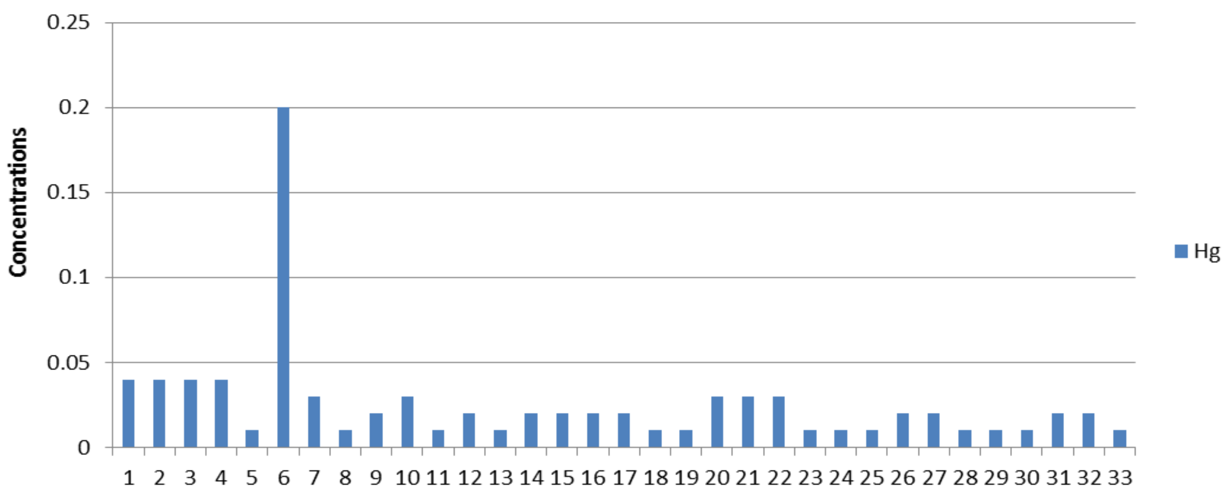

Figure 6. Mercury (Hg) concentrations across the sample locations in the control site.

dizziness, nausea, vomiting, and abdominal pains. Therefore, environments contaminated with heavy metals pose health risk to man and other organisms when metal concentration is in excess. The lower concentration of Cd could be attributed to the high mobilization of the metal and strongly acidic nature of soil (Meers et al., 2007 in Beesley et al., 2009). Clemente et al. (2008) also noted that a large proportion of soil Cd could be found soluble in pore water at 30 cm depth in a study on a contaminated urban woodland soil. Heavy metals demonstrate different mobility characteristics in soil and thus, Cd is more mobile than Hg and Pb and more importantly, Cd percolates faster than Hg and Pb.

CONCLUSION AND RECOMMENDATIONS

The present study investigated the impacts of mechanic workshops on the levels of heavy metals (Hg, Pb 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. It is therefore recommended that, mechanic villages should be sited far from residential and farmland areas to avoid the transfer of these metals into the food chain and ground and surface water systems. Bioremediation can be used to clean up the already polluted soil to avoid further transfer of these heavy metals. In addition, the study recommended that the waste effluents from workshops should be recycled and more importantly, environmental education should be encouraged.

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