Universal Journal of Environmental Research and Technology
 **eISSN 2249 0256**
Available Online at: **www.environmentaljournal.org**
**Volume 3, Issue 4: 427-435**

**Open Access** **Research Article**

# Assessing the Impact of Waste Gasoline on the Physicochemical Properties of Soils at Selected Automobile Workshops in Obiaruku, Southern Nigeria

**[1]Ozulu G. U., [2]Usiobaifo O. B. and [3]Usman A. A.**

*[1]Department of Earth Sciences (Geology), Salem University, Lokoja, Nigeria.
[2]Department of Physical Sciences (Energy and Petroleum Studies), Novena University Ogume, Nigeria.
[3]Department of Chemical Sciences (Chemistry), Salem University, Lokoja, Nigeria.

*** Corresponding author: georgeozulu@yahoo.com, georgedquest@yahoo.com**

## Abstract:

**The dumping of used gasoline indiscriminately on soils poses a potential threat to the health status of the environment. Physiochemical analyses of the soil to study the impact of waste gasoline from five selected auto mechanic workshops and a control point in Obiaruku, Ukwuani Local Government Area of Delta state southern Nigeria, were carried out at depths of 0-15cm and 15-30cm respectively. The results obtained showed that the pH values varied from depth to depth for each sampled site. Results of metal concentrations were significantly higher than that at the control site (non auto-mechanic site), and had the following mean values: Pb- 10.70 mg/kg; Fe- 1326.35 mg/kg; Cu- 27.27 mg/kg; Zn- 70.47 mg/kg; Cd- 4.95 mg/kg. The metal levels at the control site shows Pb- 0.95 mg/kg; Fe- 999.88 mg/kg; Cu- 13.11 mg/kg; Zn- 23.11 mg/kg; Cd- 2.06 mg/kg. Profile of the heavy metals in the six sites was determined and the observed trend from most of the sites investigated showed that the top soil was more heavily loaded with heavy metals than the subsoil. However, the observed trend in the profile may also be influenced to varying factors such as age of site, type of soil formation and possibly the workload of automobile activities on the sites.** This research aimed at assessing the impact of waste gasoline in increasing the concentration level of selected heavy metals on the soils within mechanic workshops in Obiaruku. **The study shows that indiscriminate disposal of used gasoline oil on the soil for a long period may lead to increase in heavy metal concentration. Consequently, these metals may creep into our food chain through absorption by vegetation, become bioavailable and subsequently a threat to the ecosystem.**

**Keywords:** Automobile, Heavy Metals, Waste Gasoline, Workshops

## 1.0 Introduction:

Since the industrial revolution, the efforts to remove man-made pollutants from the natural environment have been unable to keep pace with the increasing amount of waste materials generated from anthropogenic sources. Waste gasoline oil from automobiles and machineries indiscriminately discarded on soils by artisans during the process of routine servicing of vehicles and machineries, lead to profuse contamination. (He, et al., 2004). Heavy metals are chemical elements found in all kinds of soils and mostly with density greater than $5gdm^{-3}$. The very low general level of their content in soils and plants as well as the biological roles of most of them make them microelements (Lacatusu, 1998). Heavy metal pollution refers to cases where the content of these elements in soils are higher than the maximum concentration, which has potential harmful effects on the soil.

Heavy metals may be poisonous at higher concentrations as they tend to undergo bioaccumulation in human bodies making them dangerous and thereby posing great health and environmental risk (Lenntech, 2005). They are naturally present in soils (Ojanuga, et al., 1996) but anthropogenic activities have resulted in high concentrations in the environment (He, et al., 2004). Heavy metals are considered serious pollutants because of their toxicity, persistence and non –

degradable conditions in the environment (Mohiuddin, et al., 2010). Motor vehicle servicing centres popularly called mechanic workshops are sources of automobile gasoline wastes specifically prone to contain heavy metals. In Obiaruku, a semi-urban area of Delta state in southern Nigeria, waste gasoline oil from automobiles are usually disposed off in workshops during mechanic maintenance and servicing; and these cause non–point source contamination.

According to Moller (1991), any undesirable change in the characteristic of the air, water, soil and food that can adversely affect the health, survival or activities of humans or other living organism is called pollution. Iwegbue, (2007) reported that the spilling of automobile wastes indiscriminately have created the problem of soil contamination in Nigeria. Onianwa (2001) specifically indicated that awareness on the effects of pollution due to anthropogenic activities in most mechanic workshops in Nigeria have not received enough attention. According to his analysis, these activities have been shown to produce petroleum based waste, leading to serious pollution problems. The objectives of this study were to determine the concentration level of specific heavy metals in soils from selected automobile workshops in the study area, ascertain if the soil samples were contaminated by these heavy metals and determine the relationship between the concentration level of these heavy metals and the age of the workshops or the depth of sampling. This research is aimed at assessing the impact of waste gasoline in increasing the concentration level of selected heavy metals on the soils within mechanic workshops in Obiaruku. This is with a view to determine the extent of these heavy metals contamination as this will provide impetus on awareness of the danger that lies in indiscriminate disposal of used engine and automobile oils.

### *1.1 Location of the Study Area:*

Obiaruku is a town in Ukwuani Local Government Area of Delta State southern Nigeria. It is located in the northern region of the State. It is flanked from the north by $N05^{o}51^{1}18.1^{11}$ from the east by $E006^{o}09^{1}53.7^{11}$ from the west by $E006^{o}08^{1}31.8^{11}$ and from the south by $N05^{o}49^{1}33.2^{11}$. It has common boundaries in the North with Ika South and Aniocha South Local Government Areas. Obiaruku has remarkably high population due to their nearness to flowing water which is part of their settlement. It is flanked by the early stage of the fast flowing north – south fresh water river Ethiope. The soil is reddish brown in colour and the topography shows a gentle slope which makes a u-shape towards river Ethiope.

## 2.0 Materials and Methods:

The study area is within Obiaruku, the headquarters of Ukwuani Local Government Area of Delta State, southern Nigeria (Fig. 2). Five mechanic workshops were selected within the metropolis and a non-mechanic workshop used as a control point. The sites were chosen because of their high volume of automobile mechanic activities and information as regards their ages were obtained by personal communication with the artisans working on these sites. The sites were well coded for easy identification: L1- Okanga Mechanic Workshop (30yrs), L2- Okowa Mechanic Workshop (3yrs), L3- Hitler Mechanic Workshop (18yrs), L4- Oyoyo Lucky Mechanic Workshop (9yrs), L5- Chinedu Mechanic Workshop (7yrs), and L6- Local Government Secretariat (LGA) Secretariat (Control Point).

At each site, two different points were systematically chosen for sampling. Two soil samples per points were collected at depths 0-15cm and 15–30cm using standard soil (Hand) Auger. Ten (10) of the samples were taken from automobile waste affected soils while the remaining two (2), were from a nearby unaffected land used as the control point. The collected soil samples were transferred into black polythene bags which were properly labeled and sealed immediately to inhibit air from entering the bags before transporting them to the laboratory. Soil samples from the different locations were dried at a temperature of $80\pm10^{o}C$, for a period of ten (10) hours in hot air oven. They were then homogenized and sieved.

The procedure for the analyses and precautionary measures followed the ASTM Guidelines (2011). 10g of dried and ground soil samples were placed inside a crucible and ignited in a Muffle Furnace at $500^{o}C$ for a period of three (3) hours. The ignited masses were cooled inside a crucible and were later transferred into a 100ml beaker. Inside the beaker, 10ml concentrated HCl was then added and the mixture, which formed a suspension, was stirred. The suspension was kept inside a thermostatic controlled water-bath at a temperature range of 70-$80^{o}C$ for an hour. The supernatant was decanted and kept inside a 100ml volumetric flask. This contains mostly alkaline earth metals. To the residue in the beakers, 10ml each of HCl (concentrated) and $HClO_4$ (concentrated, 70% pure), and few porous beads were added and evaporated to dryness over a hot plate. This whole process was repeated, when necessary and the dried residues were dissolved completely by using minimum amount of concentrated HCl. This solution was then transferred to the same volumetric flasks, where previous extracts containing alkaline earth metals were stored. The flask was then made up to the mark by adding distilled water and this was then stored in a refrigerator. These extracts were then analyzed for the required metals. Atomic Absorption Spectrometer (AAS) Buck Scientific Model 210, was used for the heavy metal analyses using element specific hollow cathode lamps in default condition by flame absorption mode. This was used to approximate the metal concentration within the sample.

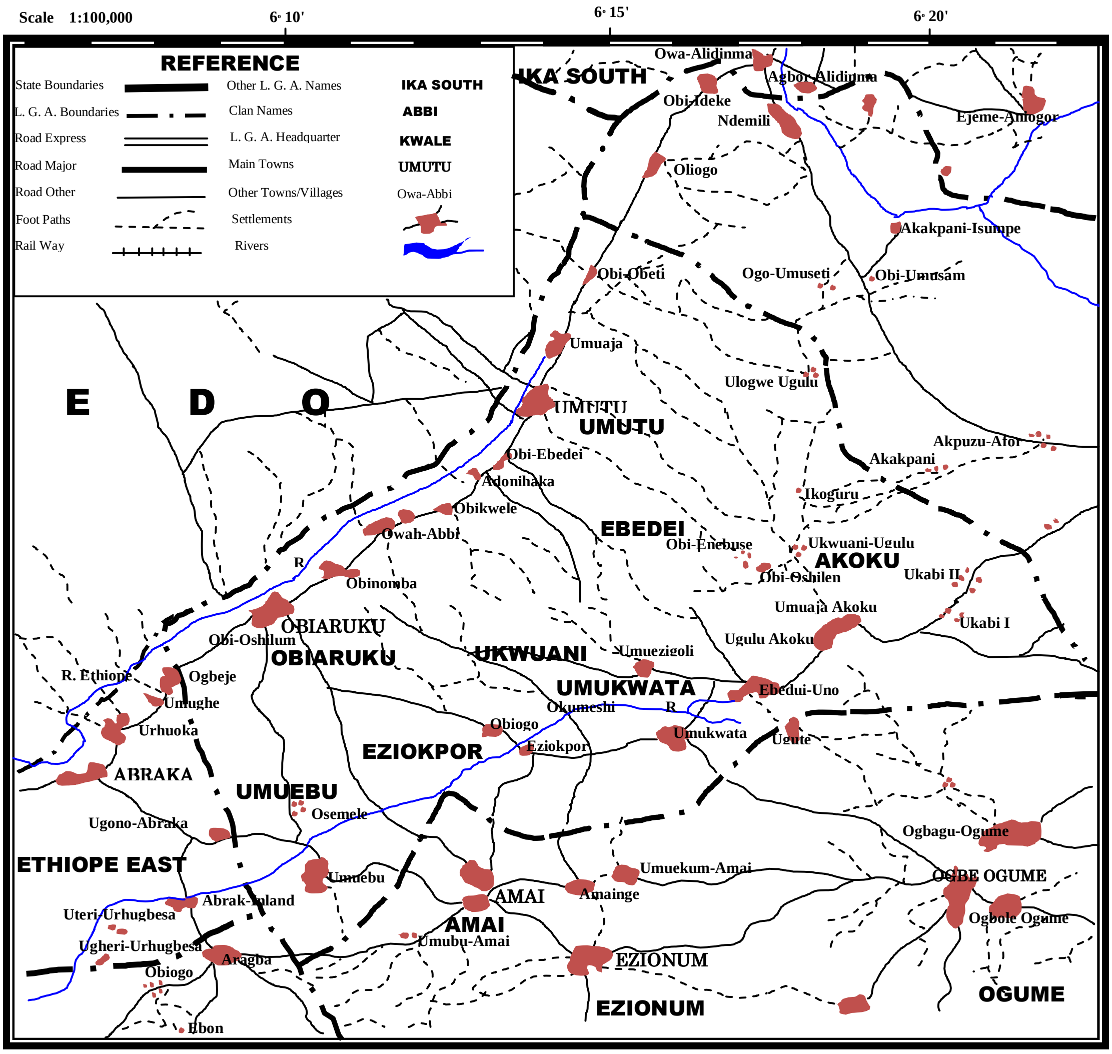
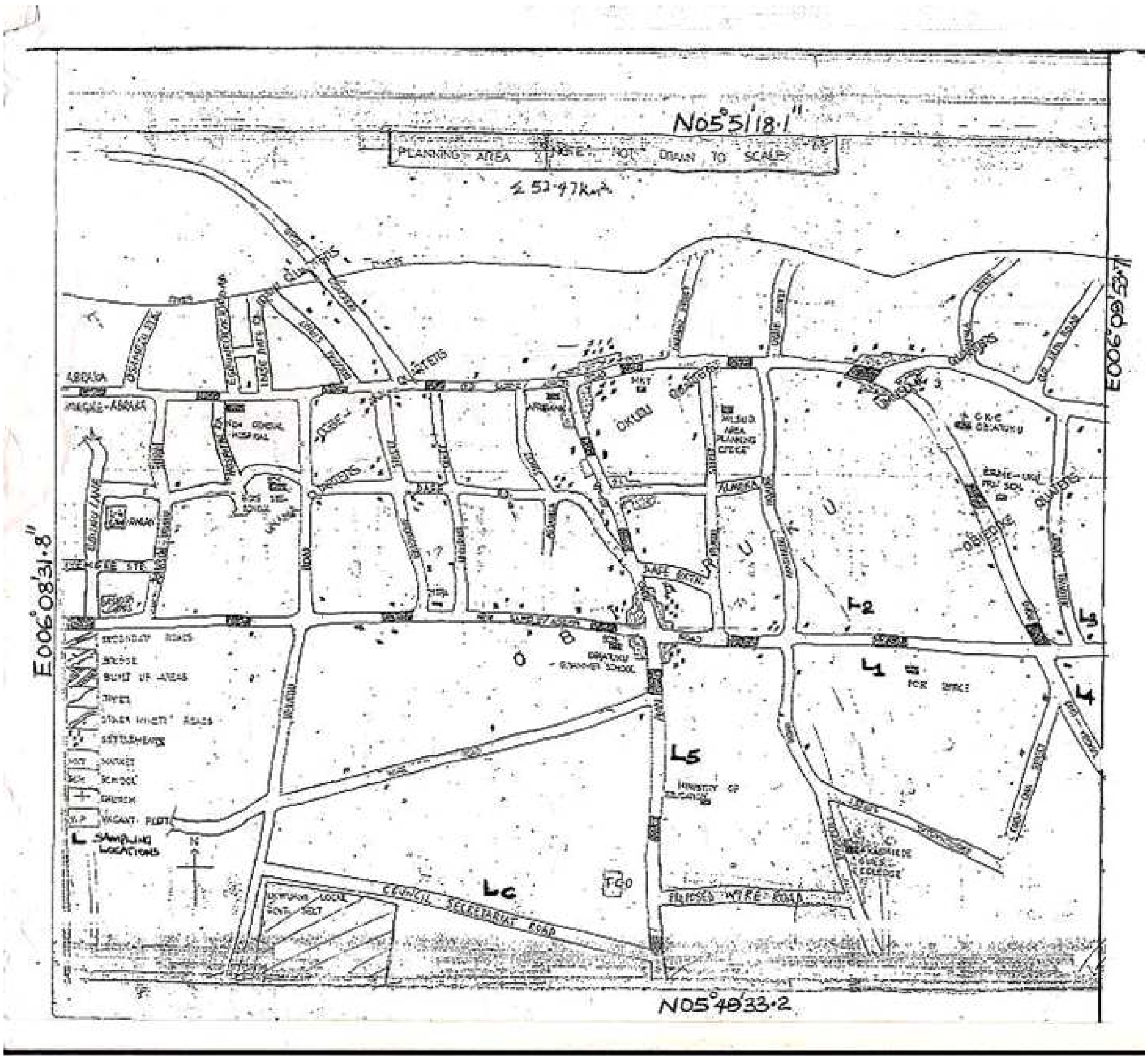



**Figure 1: Map of Ukwuani Local Government Area Showing the Study Location (Source: Delta State Ministry of Housing)**




**Source: Delta State Planning Office, Obiaruku**

**Figure 2: Map the study location Obiaruku showing the sampling points**

## *2.1 Determination of Contamination/Pollution (C/P) Index Values:*

In this study, comparisons of the heavy metals load in soils were made by using the method adopted by Lacatusu, (1998) in measuring the total heavy metals in soils. A distinction between soil contamination and pollution range, was established by means of the contamination/pollution index (C/P). To explain the heavy metal profile on the sites, an appraising method by calculating the C/P index values for each metal in each site was calculated.

$$\text{C/P Value} = \frac{\text{actual measurement of metal concentration in soil}}{\text{Target value from reference table}}$$

Statistical analyses for mean pH and mean concentration Level for Heavy Metals (mg/kg) was computed using: $\Sigma x/n$, where $\Sigma x$= Summation of obtained values and n= Total number of values

**Table 1. Significance of Intervals of Contamination/ Pollution Index (C/P) Values.**

| C/P | Significance | Symbols |
|---|---|---|
| < 0.1 | Very slight contamination | Vsc |
| 0.10- 0.25 | Slight contamination | Sc |
| 0.26 - 0.50 | Moderate contamination | Mc |
| 0.51 – 0.75 | Severe contamination | Sc |
| 0.76 – 1.0 | Very severe contamination | Vsc |
| 1.1 – 2.0 | Slight pollution | Sp |
| 2.1 – 4.0 | Moderate pollution | Mp |
| 4.1 – 8.0 | Severe pollution | Sp |
| 8.1 – 16.0 | Very severe pollution | VSP |
| >16.0 | Excessive pollution | EP |

Source: Lacatusu, 1998.

## 3.0 Results and Discussion:

**Table 2. pH of Soils and Total Concentration of Metals (kg/mg) in Dry Soil Samples of Six Sites.**

| CODE OR SITE | SITE NAME | DEPTH (cm) | pH | Pb | Fe | Cu | Zn | Cd |
|---|---|---|---|---|---|---|---|---|
| L1 | Okanga Mechanic Workshop(30yrs) | 0-15 | 7.20 | 8.16 | 1021.35 | 40.56 | 121.84 | 2.56 |
| | | 15-30 | 7.15 | 19.80 | 1254.22 | 15.22 | 30.26 | 0.89 |
| L2 | Okowa Mechanic Workshop(3yrs) | 0-15 | 7.40 | 21.50 | 1154.21 | 58.66 | 154.88 | 5.87 |
| | | 15-30 | 6.90 | 11.20 | 987.54 | 21.55 | 54.32 | 3.11 |
| L3 | Hitler Mechanic Workshop(18yrs) | 0-15 | 8.30 | 1.33 | 875.66 | 23.87 | 27.24 | 1.84 |
| | | 15-30 | 8.00 | 7.45 | 2014.24 | 11.09 | 47.89 | 2.45 |
| L4 | Oyoyo Lucky Mechanic Workshop (9yrs) | 0-15 | 8.60 | 3.54 | 1547.54 | 34.56 | 144.21 | 15.46 |
| | | 15-30 | 8.30 | 12.60 | 1412.33 | 14.86 | 33.67 | 3.87 |
| L5 | Chinedu Mechanic Workshop (7yrs) | 0-15 | 7.80 | 10.90 | 1522.21 | 30.68 | 41.71 | 8.26 |
| | | 15-30 | 7.20 | 10.50 | 1474.21 | 21.68 | 48.71 | 5.14 |
| L6 | LGA Secretariat (Control) | 0-15 | 6.80 | 1.35 | 987.21 | 12.34 | 20.54 | 2.14 |
| | | 15-30 | 6.76 | 0.54 | 1012.55 | 13.87 | 25.67 | 1.98 |

**Table 3. Mean Concentration Level for Heavy Metals (mg/kg) and pH in the Six Sites**

| Sampling Site | pH | Pb | Fe | Cu | Zn | Cd |
|---|---|---|---|---|---|---|
| L1 | 7.18 | 13.98 | 1137.79 | 27.89 | 76.05 | 1.73 |
| L2 | 7.15 | 16.35 | 1070.88 | 40.11 | 104.60 | 4.49 |
| L3 | 8.15 | 4.39 | 1444.95 | 17.48 | 37.57 | 2.15 |
| L4 | 8.45 | 8.07 | 1479.94 | 24.71 | 88.94 | 9.67 |
| L5 | 7.50 | 10.70 | 1498.21 | 26.18 | 45.21 | 6.70 |
| L6 | 6.80 | 0.95 | 999.88 | 13.11 | 23.11 | 2.06 |

**Table 4. Mean Concentration Level for Heavy Metals (mg/kg) and pH in the Automobile Workshops compared with the Control Site**

| Sampling Site | pH | Pb | Fe | Cu | Zn | Cd |
|---|---|---|---|---|---|---|
| L1-L5 | 7.69 | 10.70 | 1326.35 | 27.27 | 70.47 | 4.95 |
| L6 (Control) | 6.80 | 0.95 | 999.88 | 13.11 | 23.11 | 2.06 |

**Table 5. Heavy Metals Contamination Profile Showing Total Contamination by Site and Depth**

| Depth/ Site | L1 (30yrs) | L2 (3yrs) | L3 (18yrs) | L4 (9yrs) | L5 (7yrs) | L6 (Control) |
|---|---|---|---|---|---|---|
| 0-15 | 0.66 | 0.92 | 0.21 | 0.75 | 0.35 | 0.14 |
| 15-30 | 0.26 | 0.34 | 0.30 | 0.25 | 0.33 | 0.16 |

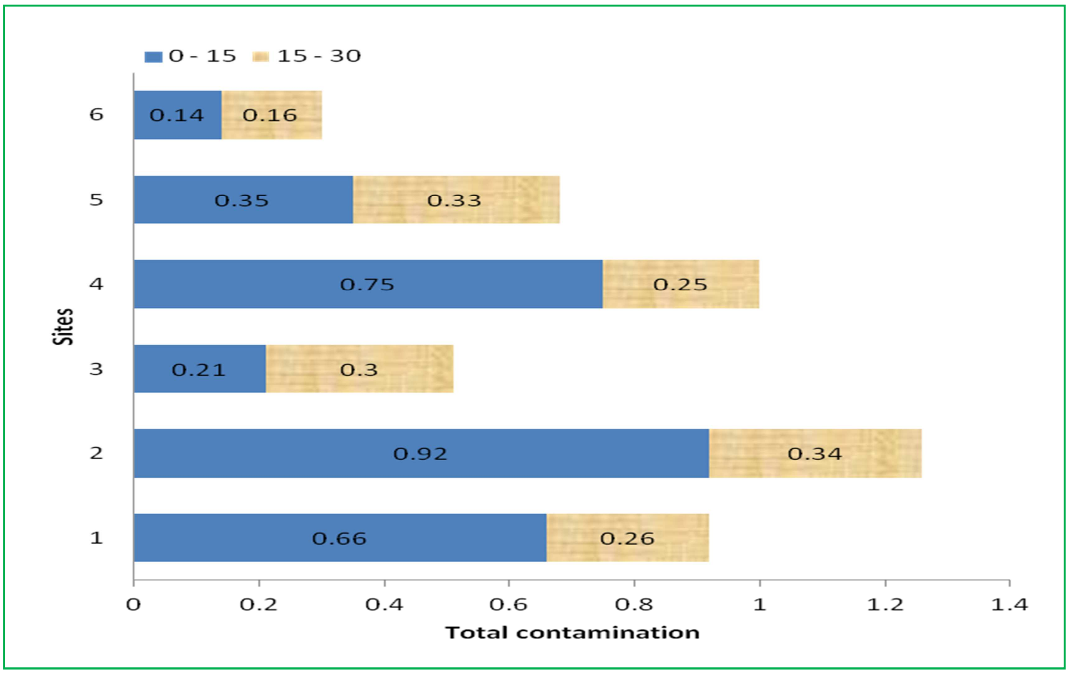



**Figure 3: Heavy Metal Contamination Profile Showing Total Contamination by Sites and Depths**

## *3.1 Data Analysis:*

It was expected that the ages of the mechanic workshops visited, should have direct relationship with the concentration of the total heavy metals status for each site. However, this was not exactly the case. For instance, site $L_2$ which had the lowest age of establishment (3yrs), was ranked the most contaminated site instead of site $L_1$ which had the highest age (30years) to be ranked the most contaminated site. The possible interpretation for this could be due to the amount of waste gasoline disposal, the soil type and the rate of percolation with time. Site $L_3$ of age 18years was ranked as the least contaminated (see **figure 3)**. This implies that other factors not determined in this study like volume of work done on each site and type of soil might be important factors for consideration.

Generally, the levels of heavy metals at the contaminated sites were found to be higher than at the control site. The difference in values suggested soil contamination. The general trend of dispersion of metal contamination within the soil profile is Fe>Zn>Cu>Pb>Cd. This is similar to the trend of Fe>Pb>Co>Cd observed for metals analyzed in soils of automobile workshops in Osogbo, western Nigeria (Olayiwola 2011).

Also observed, is the fact that iron (Fe) and zinc (Zn) are predominantly present in all the sites. The abundance of these two metals might be due to their relative abundance in soils, or the anthropogenic source from the metal junkyards found in many of the auto-mechanic sites. Used oils that sinks into the ground as leachates contain high proportion of these metals: copper (Cu) and lead (Pb) from Babbitt metal brushings, copper (Cu) and tin (Sn) from metal bearing wears, nickel (Ni) and iron (Fe) from crank shafts wears and engine body damage. Next in abundance to iron (Fe) and zinc (Zn), is lead (Pb) and copper (Cu). Lead (Pb) usually has the highest concentration value as a heavy metal in waste oil. Generally lead added to gasoline in tetra-ethyl, form an anti-knock agent; and can be deposited from exhaust pipes in automobiles (Jensen, 1992). Just like iron (Fe) and zinc (Zn), lead (Pb) distribution also followed an irregular pattern of increase down the depth and decrease in some instances for all the sites. This is due to the variable mineralogical composition of soils in the site. For example, clay alluvial horizons can be wrongly interpreted as the migration of an anthropogenic component. In addition, minor accumulation of anthropogenic lead (Pb) may be ignored in deeper soil horizons because of the predominant occurrence of endogenous lead (Pb) at these depths. Similar study carried out on Mechanic workshops in Onitsha, Eastern Nigeria revealed that values of Pb was very high in all the soil samples analyzed (Ojiako and Okonkwo 2013). Also, Abii (2012) in his work observed that Pb had the highest concentration in soils of automobile workshop followed by Cr and then Cadmium.

The pH values varied from depth to depth in each sampled site and within the sampled sites as well. The pH value obtained from DPR standard, range between 6.80 - 8.45. The highest pH was obtained in location $L_4$ with a value of 8.45 and the lowest value obtained from location $L_2$ was 7.15. The closeness of the pH values obtained for the soils may suggest an indication that pH effect on the availability of the metals is minimal and so do not affect site characterization. Abechi et al. (2010) stated that mobility of metals depends not just on the pH but also on the organic matter and granulometric composition of the soil. It is worth noting that in site $L_1$ and $L_2$, the lower pH values might be responsible for the higher concentration of some heavy metals between the depths of 15-30cm (Table 2). The profile of the heavy metals in the six sites was determined. To obtain a profile, the total pollution range, defined by multiple pollution found from contribution from each metal contamination and pollution status, was used. The observed trend from site $L_1$, $L_2$, $L_4$, and $L_5$; showed that the top soil was heavily loaded with heavy metals than the subsoil. In contrast, location $L_3$ profile showed that the subsoil is heavily loaded than the top soil. It was observed that site $L_2$ had the highest total contribution of contamination by heavy metals followed by $L_4$, $L_1$, $L_5$ and then $L_3$, which was the least. Due to multiple contaminations, the entire site was characterized as severely contaminated with respect to the five (5) heavy metals. A similar study conducted by Ameh et al (2011) to analyse the distribution of metals in soils from mechanic workshops around Zaria, Northern Nigeria indicated that there was an increase in the metal content to the extent that some of the metals were above recommended limits. It is the opinion of the authors, however, that the observed trend in the profile may also be subject to varying factors such as age of site, type of soil formation and possibly the workload of automobile activities on the sites.

## 4.0 Conclusion:

Automobile wastes are becoming a visible problem especially in developing countries like Nigeria. Therefore, the act of improper disposal of these wastes by humans, most especially from mechanic workshops, now demands attention in order to protect the soil for agricultural purposes. The study locations in which automobile mechanic workshops within Obiaruku metropolis, where improper disposal of these wastes are dumped pose a serious environmental risk due to possible groundwater contamination in Obiaruku and its environs. Mechanic workshops situated within the Obiaruku metropolis, like most developing rural or urban areas, are anthropogenic sources of heavy metals to the soil. They are, therefore, prone to pose serious threats to the underground water which will in turn affect public health.

From the discussion made in this work, the following are recommended:

1. Automobile/mechanic workshops should be located to a confined area or environment where the use of land for farming is limited.
2. There is need for constant monitoring of these heavy metal concentrations in soils where automobile activities are carried out in order to limit improper disposal of harmful substances.
3. Indiscriminate disposal of spoilt and used gasoline should be avoided or limited. Disposable carcass of vehicles should be taken to the nearby Delta Steel Company for proper recycling.
4. Stricter environmental laws should be enacted in this regard to curb the menace of individuals or organizations involved in the use of auto-mechanic workshops and indiscriminately disposing waste gasoline oil leading to heavy metal contamination in the soil.
5. To be safe however, proper drainages should be constructed at auto-mechanic workshops to allow for proper disposal of these used oils, lubricants and gasoline.

## 5.0 Acknowledgement:

The authors sincerely acknowledge the assistance offered by the following agencies of Delta State Government of Nigeria:

1. Delta State Ministry of Housing, Asaba.
2. Delta State Ministry of Housing, Area Planning Office- Ukwuani Local Government Area, Obiaruku.

## Reference:

1) Abechi, E. S; Okunola, O. J; Zubairu S. J; Usman A. A. and Apene, E. (2010). Evaluation of heavy metals in street soils of Jos Metropolis, Northern Nigeria. Journal of Environmental Chemistry and Ecotoxicology Vol. 2(6), pp. 98-102.
2) Abii, T. A. (2012). Levels of Heavy Metals (Cr, Pb, Cd) Available for Plants within Abandoned Mechanic Workshop in Umuahia Metropolis. Reearch Journal of Chemical Sciences. Vol. 2 (2); 79 – 82.
3) Ameh, A. O; Mohammed-Dabo, I. A; Ibrahim, S; Ameh, J. B; and Odengie, J. O. (2011). ). Heavy metal Contamination of soil in mechanic workshops. International Journal of Biological and Chemical Sciences,Vol 5, No 5.
4) Annual Book of American Society for Testing and Materials (ASTM) standards, (1998): ASTM USA, Vol. 05, p.4, retrieved from: www.astm.org.18/6/2011.
5) Department of Petroleum Resource (DPR) (1991): Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, Revised Edition 2002, P. 53-57.
6) Egboh, S. H. O., Nwajei, G. E., and Adaikpoh, E. O. (2000): Heavy Metals Concentration of Sediments from Science and Environment, Vol. 2, p. 107-195.
7) Environmental Protection Agency (EPA) (2002): Risk Assessment Technical Background Information, Available online from: http://www.epa.gov/reg, updated 23.03.2009.
8) He, Z. L., Zhang, M. K., Calvert, D. V. (2004): Transport of Heavy Metals in Surface Runoff from Vegetable and Citrus Fields, Soil Science Society, America, 68, p.1662-1669.
9) Iwegbue, C. M. (2007): Metal Fractionation in Soil Profiles at Automobile Mechanic Waste Dumps Around Port-Hacourt, Wastes Management. Resources, 25 (6): p. 585-593.
10) Jensen, H. (1992). Lead in Household Dust, Total Environment Journal, 114: p. 1-6.
11) Kabata, A., and Pendias, A. (1995): Agricultural Problems Related to Excessive Trace Metal Content in Soils, New York, London, Tokyo, p. 3 - 18.
12) Kadem, D. E., Rached, O. D., and Gheribi, Z. (2004): Statistical Analysis of Vegetation Incidence on Contamination of Soils by Heavy Metals (Pb, Ni and Zn) in the Vicinity of an Iron Steel Industrial Plant in Algeria. Environmetrics, 15: p. 447- 462.
13) Lacatusu, R. (1998): Appraising Levels of Soil Contamination and Pollution with Heavy Metals In: Land Information System for Planning the Sustainable Use of Land Resources, European Communities, Luxembourg, p. 393-402.
14) Lee, M. (1989): Alice Human Lecture on Lead and Human Health: Background Findings. Science of the Total Environment, 356: p. 45-61.
15) Lenntech, A. (2004): Lenntech Water Treatment and Air Purification Facts Sheet. Netherlands, p. 20-25. Retrieved from: http://www.environmental- expert.com.
16) Levine, E. (2006): Effects of Heavy Metals in Soils, Soil Science Society of Nigeria, p. 22- 40
17) Mattigod, S. V., and A. L. (1981): Factors Affecting the Solubility of Trace Metals in Soils in D.E Baker (Editor.), Chemistry in the Soil

Environment, American Society for Agronomy, (ASA), Madison, USA, Special Publication No 40. 101. p. 99-105.
18) Mohiuddin, K. M., Zakir, O. K., Sharmin, D. (2010): Geochemical Distribution of Trace Metal Pollutants in Water and Sediments of Downstream of an Urban River. Int. J. Environ, SciTech. 7(1), p. 17-28.
19) Moller, G. T. (1991): Environmental Science Sustaining the Earth, Belmont, CA: Wadsworth Publishers, Environmental Research, 97: p. 229-235.
20) Nwachukwu, M. A., Feng, H., and Alinnor, J. (2010): Assessment of Heavy Metals Pollution in Soils and their Implications within and Around Mechanic Villages: Int. J. Environ. Sci. tech. 7(2): p. 347- 358.
21) Olade, M. A., (1976): On the Genesis of Lead-Zinc Deposits in Nigeria's Benue Rift. Nig.J. Min.Geol., 13, p. 20-27.
22) Olayiwola, O. A. (2011). Levels of Pb, Fe, Cd and Co in soils of Automobile Workshops in Osun State, Nigeria. J. Appl. Sci. Environ. Manage. Vol 15 (2) 279-282.
23) Ojanuga, A. G., Lakwa, G., Okusami, T. A. (1996): Distribution, Classification and Potential of Wetland Soils of Nigeria Monograph No 2, Soil Science Society of Nigeria. p. 1-24.
24) Ojiako, E. N and Okonkwo, M. N. (2013). Analysis of Heavy Metals in Soils of Mechanic Workshops in Onitsha Metropolis. Advances in Applied Science Research. 4 (1): 79 – 81.
25) Onianwa, P. C., Jaiyeola, O. M., Egekenze, R. N. (2001): Heavy Metals Contamination of Top Soil in the Vicinities of Auto- Repair Workshops, Gas Stations and Motor parks in Nigeria City, Toxicol Environmental Chemistry, Vol. 84, p.33-39.
26) Perkins, R. A., Florence, T. M., and Staauber, J. L. (2000): Toxicity of Nickel Ores to Marine Organisms. Journals of Environmental Science 148: p.136-140.
27) Pidwirny, M. (2010): Different Soil Horizons, Wikimedia Commons Publication, 2.p. 2-12.
28) Robert, R. K., and Johnson, M. S. (2005): Disposal of Heavy Metals from Abandoned Mine Working and their Transference through Terrestrial Food Chain, Environmental Pollution 16 (4): p. 293-300.
29) Shuman, L. M. (1991): Chemical Forms of Micronutrient in Soils, in J.J. Mortvedt, 4$^{th}$ Edition, Micronutrients in Agricultural Soils, Soc. Amer. Book series #4. Soil Science. p. 45-50.
30) USEPA (1985): Nickel Poisoning and Carcinogenesis in Rates Exposed to Nickel, Cabony Arch. Ind. Health, 20:30.