IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 14, Issue 6 Ser. IV (June 2020), PP 47-58
www.iosrjournals.org

Contamination Levels of Polycyclic Aromatic Hydrocarbons in Soil at Uncontrolled Solid Waste Dumpsites in Port Harcourt City, Nigeria.

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Abstract
Backgound: *Households solid waste are dumped at any nearest dumpsites to the deposite. As a result of high temperature, These wastes are heated to generate Polycyclic Aromatic Hydrocarbons.This study is to show distintly and comparinly the Polycyclic aromatic hydrocarbons contermination level on soil at the solid waste dumpsites around the uncontrolled soild waste dumpsites clusters around market areas, semi- indusrial areas and residendial areas.*
Materials and Methods:*Each soil sample with corresponding control sample making a total of 30 soil samples were collected at depth 0 - 15 cm using an auger fromspecified different locations and analyzed at the Rivers State University, Institute of Pollution Studies Research Laboratory using Gas Chromatography.Data were analysed using descriptive statistics viz mean ± standard deviation as well as inferential statistics such as 2 sample T-test at 5% level of significance. Hierarchical Cluster Analysis (HCA) and Principal Components Analysis (PCA)where applied on the measured data to determine the sources of contamination as well as the level of pollution by comparing with the control sites.*
Results*:Each of the dumpsites has total ∑PAHs values greater than 1(>1) and are classified as "Heavily contaminated". The T- test results shows that there are level of significant of values varies between 0.008 to 0.047 respectivelywith control sites..Diobu location has four PAHs constituents above 2.8 and 4.2mg/kg while other locations show variation between 0.7 to 2.8mg/kg.*
Conclusion*: This study shows thatHigh Molecular weight (HMW) PAHs of 4 to 5 rings which are toxicologically relevant were detected in all the dumpsites with highest value of Chrysene and Dibenez(a,h)anthracene. Diobu area has more PAHs in high level and it is highly polluted compared to other waste dump sites.In-situ waste segregation and prompt evacuation of solid waste from all dumpsites in Portharcourt city areas.*
Key Words: *Polycyclic Aromatic Hydrocarbon, Solid Waste, Dumpsites, Contermination, Soil.*

Date of Submission: 12-06-2020 Date of Acceptance: 29-06-2020

I. Introduction

The first point of dumping household disused products which are known as solid waste in Port Harcourt city isdumpsites located nearer to the depositor. Polycyclic Aromatic Hydrocarbons (PAHs) areubiquitous environmental pollutants generated primarily during the incomplete combustion of organic materials (e.g. coal, oil, petrol, and wood). Different types of combustion yield different distributions of PAHs in both relative number of individual constituents and in which isomers are produced[2]. Natural source include release in forest fire and from volcanic eruptions. The study of this compounds is mainly due to their carcinogenic and widespread occurrence in environmental components, including surface soil[4]. However, most PAHs are introduced into the soil from atmospheric decomposition after local and long-range transport, which is supported by the presence of PAHs in soil of regions remote from any industrial activity[7]. Other potential sources of PAHs in environment include disposal from public sewage treatment, irrigation with coke oven effluent, leachate from bituminous coal storage sites, and use of soil compost and fertilizers[6]. Mammals can absorb PAHs by various routes e.g. inhalation, dermal contact and ingestion. Plant can absorb PAHs from soils through their roots and translocate them to other plant parts. Meanwhile, uptake rates are generally governed by concentration, water solubility and their physicochemical state as well as soil type. There is therefore need to carry out this research to generate more information and also evaluate the level and health risk effect of the Polycyclic Aromatic Hydrocarbons generated from household solid waste being dumped at the waste dumpsites areas nearer to human habitation.

The following three types: pyrogenic, petrogenic, and biological are the major PAH sources to the environment. In a process called pyrolysis, Pyrogenic PAHs are formed whenever organic substances are exposed to high temperatures under low oxygen or no oxygen conditions. The temperatures at which the pyrogenic processes occur are ranging from about (350 °C to more than 1200 °C). Pyrogenic PAHs are generally found in greater concentrations in urban areas and in locations close to major sources of PAHs. In addition, PAHs can also be formed at lower temperatures. It is worth mentioning that crude oils contain PAHs that formed over millions of years at temperatures as low as (100–150 °C). In this respect, PAHs formed during crude oil maturation and similar processes are called petrogenic. Such petrogenic PAHs are common due to the widespread transportation, storage, and use of crude oil and crude oil products. PAHs may also be produced biologically. For example, they can be synthesized by certain plants and bacteria or formed during the degradation of vegetative matter.

Edori[1] work on concentration of Polycyclic Aromatic Hydrocarbons at three dumpsites (Chakiricha, Psychiatric and Rumuokwuta) in Portharcourt showed that there was heavy presence of PAHs in the dumpsites. The total concentrations of PAHs in the dumpsites were in the order; Rumuokwuta>Chakiricha> Psychiatric with values of 60.958, 30.036 and 21.987mg/Kg respectively. There was the predominance of 2-3 membered ring PAHs in Rumuokwuta and Psychiatric dumpsites while at the Chakiricha dumpsite, it was the 4 membered rings that dominated. The diagnostic and source identification of PAHs in the dumpsites showed multiple sources but dominated by pyrogenic sources

Godson[3], studies determined, in comparison with guideline limits, the levels of Polycyclic Aromatic Hydrocarbons (PAH) in the soils at Eleme (highly industrialized) and Ahoada East (less industrialized) communities in the Niger Delta Area. At Eleme, the highest concentration of phenol (1.04 ± 0.85%) was observed in samples at Ekporo. The highest levels of Benzo(a)pyrene (BaP) (1.54 x 10^5ng/kg) were recorded at Onne. Soil samples close to the Petroleum Refinery at Alesa recorded the highest total PAH concentration (2.30 x10^6ng/kg) even though this was slightly lower than the EPA guideline value of 2.5 x 10^6 ng/kg. The highest total PAH levels (3.67 x 10^5ng/kg) were recorded at Odiabidi and this was lower than the levels at Eleme and EPA guideline limits ($P < 0.05$). The mean level of total PAHs at Eleme which recorded the highest number of individual components was 7-fold higher than that recorded at Ahoada East with only 3 components. Also, at Eleme four locations compared to none at Ahoada East were classified as high risk sites. The study showed that the communities at Eleme when compared to Ahoada East may be more vulnerable to hazards associated with increased exposure to Soil PAH.

II. Materials And Methods

Port Harcourt is the capital and largest city of Rivers State, Nigeria. It lies along the Bonny River and is located in the Niger Delta. As of 2016, the Port Harcourt urban area has an estimated population of 1,865,000 inhabitants, up from 1,382,592 as of 2006. The urban area (Port Harcourt metropolis), on the other hand, is made up of the local government area itself and parts of Obio-Akpor and Eleme accordingly. Port Harcourt, which is the current capital of Rivers State, is highly congested as it is the only major city of the state.The area of study is in Port Harcourt metropolis, Rivers State. The area is bounded geographically by latitudes 4°46'N to 5°00'N and longitudes 6°55' E to 7°03' E. Open dump sites are the most common waste disposal methods in Port Harcourt and many cities in Nigeria. Open dump sites are found in several residential, Markets and semi – industrial locations around the city, for example, Rukpokwu village, Rumuokoro, Rumuomasi, Diobu, Marine base, and Borokiri, to mention a few. The dumpsites within the study area and the locations of all the sampling points were recorded with the aid of a garmin Global Positioning System (GPS).

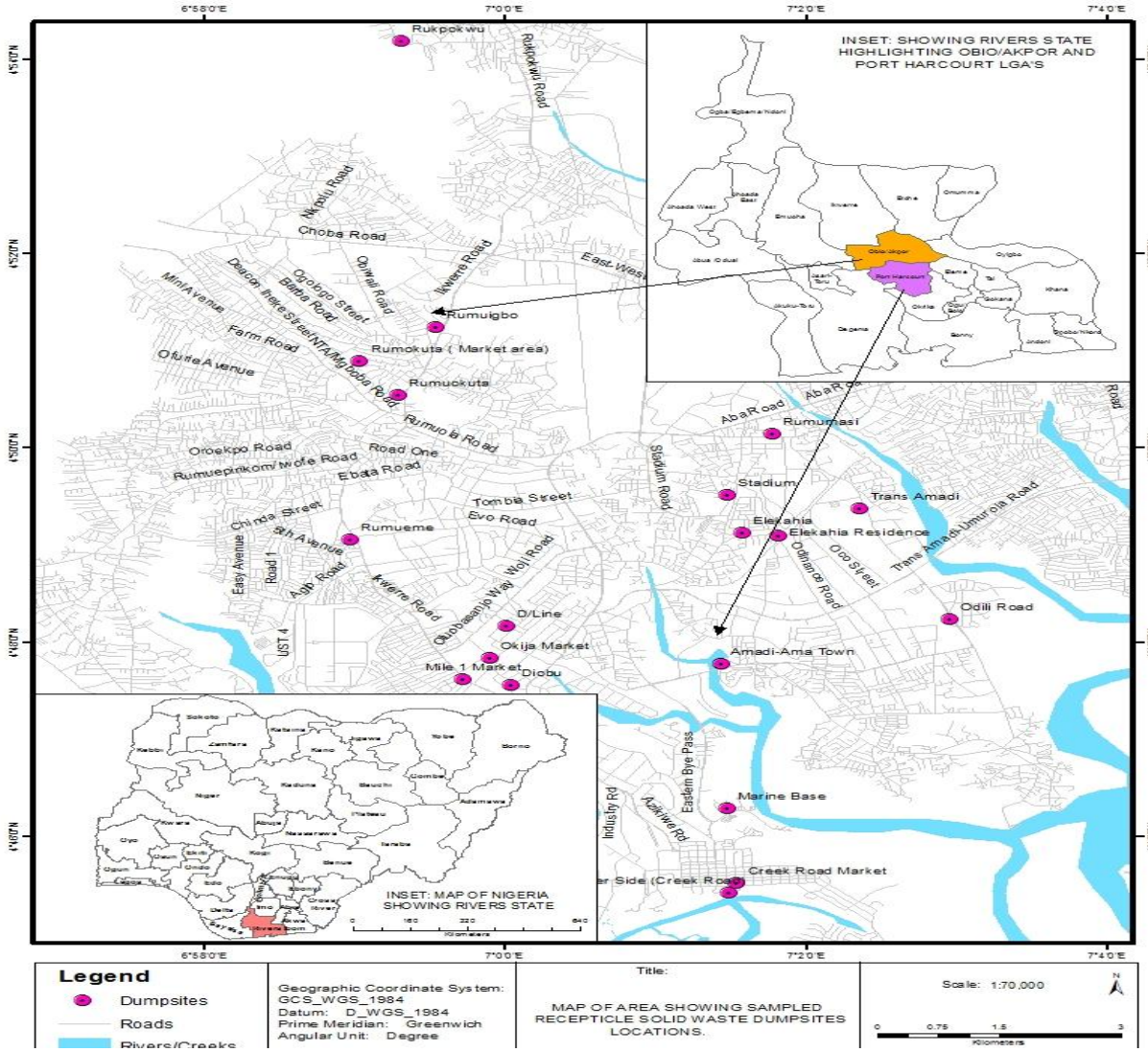

Fig 1: Map of study area. Port Harcourt. Nigeria

Soil samples for PAH determination were collected in aluminum foil from the various dumpsites. Auger was used for collection of soil samples at shallow depth of about 1 - 15cm. For each sampling point, three samples were taken from the same area and mixed thoroughly to form a composite homogenous sample. Sampling tools were washed with water and dried before the next sample was collected. About 1 kg of soil sample was collected at each sampling site in order to ensure that enough fine-grained material would be available for analysis. Fifteen (15)nain soil and fifteen control samples were collected, each from a different dumpsite. Samples were labeled properly including date of collection, location and code number of soil samples.

2g samples were weighed into a clean extraction container. 20 ml of extraction solvent (hexane) was added into the sample, mixed thoroughly and allowed to settle. The mixture was carefully filtered into solvent-rinsed extraction bottles using filter paper fitted into Buchner funnels. The extracts were concentrated to 2 ml and then transferred for clean-up/separation.1cm of moderately packed glass wool was placed at the bottom of 10 mm I.D (internal diameter) x 250 mm long (GC) Gas Chromatographic column. Slurry of 2 g activated silica in 10ml dichloromethane was prepared and placed into the chromatographic column. To the top of the column was added 0.5 cm of sodium sulphate. The column was rinsed with additional 10 ml of dichloromethane. The column was pre-eluted with 20 ml of hexane. This was allowed to flow through the column at the rate of about 2 minutes until the liquid in the column was just above the sodium sulphate layer. Immediately, 1 ml of the extracted sample was transferred into the column. The extraction bottle was rinsed with 1 ml of hexane and the dissolved extract was added to the column as well. The stop cork of the column was opened, and the effluent was collected in a 10 ml graduated measuring cylinder. Just prior to exposure of the sodium sulphate layer to air, hexane was added to the column in 1 – 2 ml increments. Accurately measured volume of 8 – 10 ml of the volatile aromatics (BTEX) as applicable.

Gas Chromatographic analysis: The concentrated aliphatic or aromatic fractions were transferred into labelled glass vials with Teflon or rubber crimp caps for GC (Gas Chromatographic) analysis. 1 ml of the concentrated sample was injected by means of a hypodermic syringe through a rubber septum into the column. Separation occurs as the vapour constituent partitions between the gas and liquid phases. The sample was automatically detected as it emerged from the column by the FID (Flame Ionisation detector) whose response is dependent upon the composition of the vapour.

III. Results

Table 1a: Results Showing PAH Concentration (mg/kg) at Dumpsites(8) Locations

PAHs Constituents	Okija Market	Creek Road Market	Rumokuta (Market area)	Water side (Creek road)	Mile 1 Market	Trans Amadi	Stadium Road	Odili Road
Naphthalene (2 rings)	0.0050	0.0550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Acenaphthylene(3 rings)	0.0390	0.0190	0.0030	0.0030	0.0000	0.0000	0.0790	0.0000
Acenaphthene(3 rings)	0.2090	0.0260	0.0130	0.0010	0.0090	0.0170	0.0140	0.0020
Fluorene(3 rings)	0.1200	0.0070	0.0090	0.0040	0.0070	0.0190	0.0930	0.0020
Phenanthrene(3 rings)	0.0420	0.0070	0.0130	0.0070	0.0130	0.2290	0.0750	0.0100
Anthracene(3 rings)	0.0150	0.0100	0.0070	0.0020	0.0120	0.0360	0.2740	0.0090
Fluoranthene(4 rings)	0.0100	0.0230	0.0250	0.0230	0.0110	0.0360	0.3790	0.0180
Pyrene(4 rings)	0.1130	0.0070	0.0110	0.0010	0.0040	0.0030	0.0220	0.0020
Benz(a)anthracene(4 rings)	0.0090	0.0060	0.0310	0.0060	0.0030	0.0100	0.0320	0.0040
Chrysene (4 rings)	0.1410	0.2120	0.6410	0.3650	0.7410	0.2960	0.0540	0.4340
Benzo(b)Fluoranthene(5 rings)	0.1560	0.2680	0.4200	0.0780	0.1800	0.1650	0.1800	0.2160
Benzo(k)fluoranthene(5 rings)	0.0900	0.1450	0.0720	0.0830	0.0450	0.0790	0.0330	0.0090
Indeno(1,2,3-cd)Pyrene(6 rings)	0.3710	0.2240	0.3600	0.3210	0.2650	0.2120	0.1050	0.0050
Dibenez(a,h)anthracene(5 rings)	0.5520	0.5310	0.2830	0.2430	0.2640	0.3690	0.1890	0.1800
Minimum value	0.0050	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum value	0.5520	0.5310	0.6410	0.3650	0.7410	0.3690	0.3790	0.4340
Total PAHs	1.8720	1.5400	1.8880	1.1370	1.5540	1.4710	1.5290	0.8910

Table 1b: : Results Showing PAH Concentration (mg/kg) at the remaining Dumpsites 7 Locations)

PAHs Constituents	Elekohia (industrial)	D/Line	Borokiri	Marine Base	Elekohia (residential)	Diobu	Rukpokwu village
Naphthalene (2 rings)	0.0000	0.0480	0.0000	0.0000	0.0000	0.0000	0.0010
Acenaphthylene(3 rings)	0.0000	0.0060	0.0000	0.0000	0.0120	0.0000	0.0260
Acenaphthene(3 rings)	0.0040	0.0070	0.0030	0.0070	0.0030	0.0040	0.0050
Fluorene(3 rings)	0.0080	0.0050	0.0080	0.0020	0.0050	0.0050	0.0050
Phenanthrene(3 rings)	0.0110	0.0120	0.0060	0.0110	0.0190	0.0040	0.0070
Anthracene(3 rings)	0.0090	0.0240	0.0050	0.0070	0.0120	0.0040	0.0030
Fluoranthene(4 rings)	0.0140	0.0440	0.0090	0.0270	0.0160	0.0100	0.0110
Pyrene(4 rings)	0.0050	0.0240	0.0020	0.0020	0.0100	0.0180	0.0010
Benz(a)anthracene(4 rings)	0.0040	0.0140	0.0020	0.0090	0.0160	0.1060	0.0090
Chrysene (4 rings)	0.7750	0.4550	0.6780	0.6560	0.7650	2.8390	0.4180
Benzo(b)Fluoranthene(5 rings)	0.0650	0.2380	0.3420	0.1560	0.2650	0.2350	0.0350
Benzo(k)fluoranthene(5 rings)	0.0580	0.0760	0.0730	0.1090	0.0940	0.1440	0.0920
Indeno(1,2,3-cd)Pyrene(6 rings)	0.0700	0.1850	0.4480	0.4580	0.2670	0.1560	0.1720

Dibenez(a,h)anthracene(5 rings)	0.0890	0.3770	0.3810	0.2340	0.3970	1.1000	0.8100
Minimum value	0.0000	0.0050	0.0000	0.0000	0.0000	0.0000	0.0010
Maximum value	0.7750	0.4550	0.6780	0.6560	0.7650	2.8390	0.8100
Total PAHs	1.1120	1.5150	1.9570	1.6780	1.8810	4.6250	1.5950

Table 2 : Average Concentration (mg/kg) of PAHs constituents for control sites (non- impacted sites)

PAHs Constituent	PAHs (mg/kg)
Naphthalene (two Rings)	0.000000
Acenaphthylene (Three rings)	0.000000
Acenaphthene (Three Rings)	0.000000
Fluorene (Three rings)	0.000000
Phenanthrene (Three Rings)	0.000000
Anthracene (Three Rings)	0.000426
Fluoranthene (FourRings)	0.000412
Pyrene (Four Rings)	0.000272
Benz(a)anthracene(Four Rings)	0.000127
Chrysene (Four Rings)	0.001924
Benzo(b)Fluoranthene (Five rings)	0.010485
Benzo(k)fluoranthene (Five Rings)	0.026372
Indeno(1,2,3-cd)Pyrene (Six Rings)	0.003708
Dibenez(a,h)anthracene (Five Rings)	0.008282
Total	0.052000

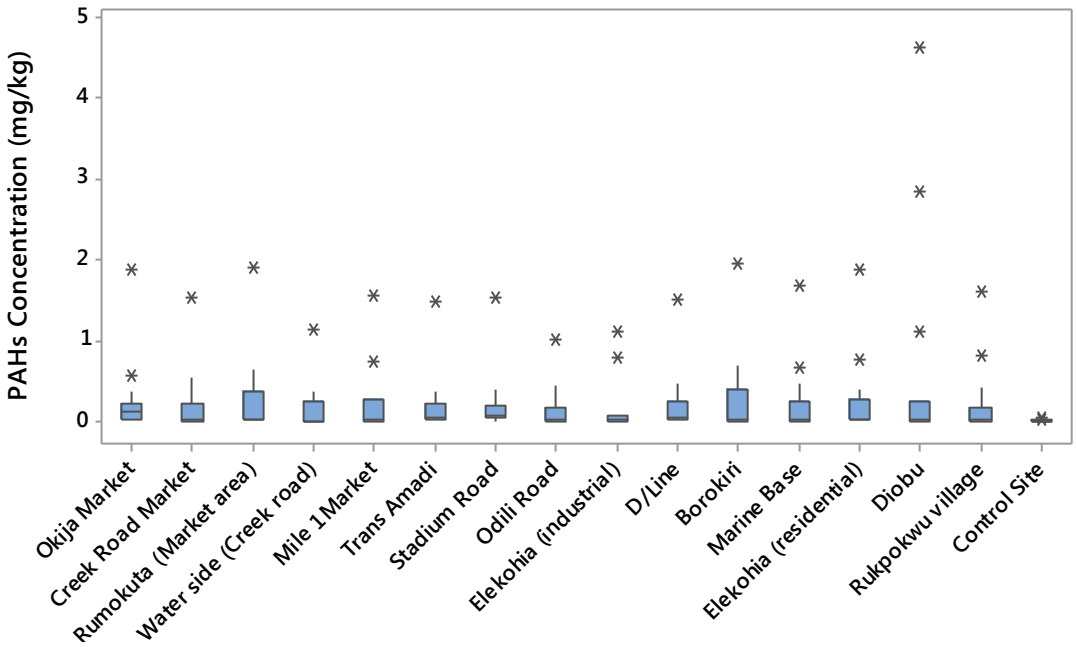

Fig 2: Showing the boxplot of the impacted dump site and the control

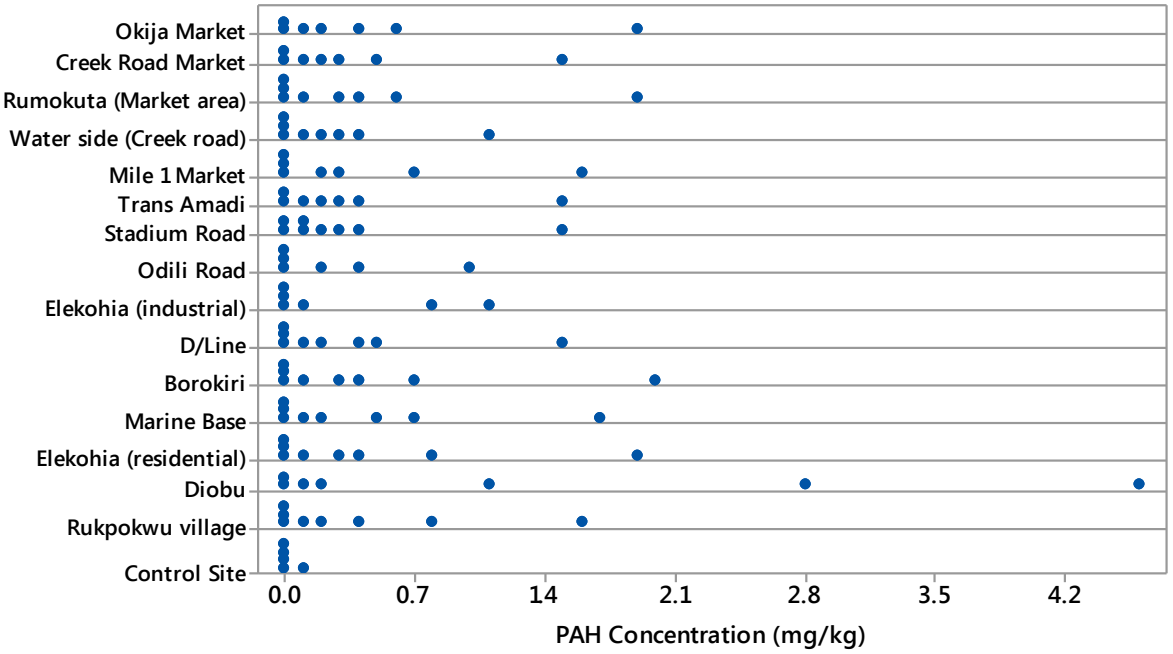

Fig 3. A dot plot showing variation of the constituents

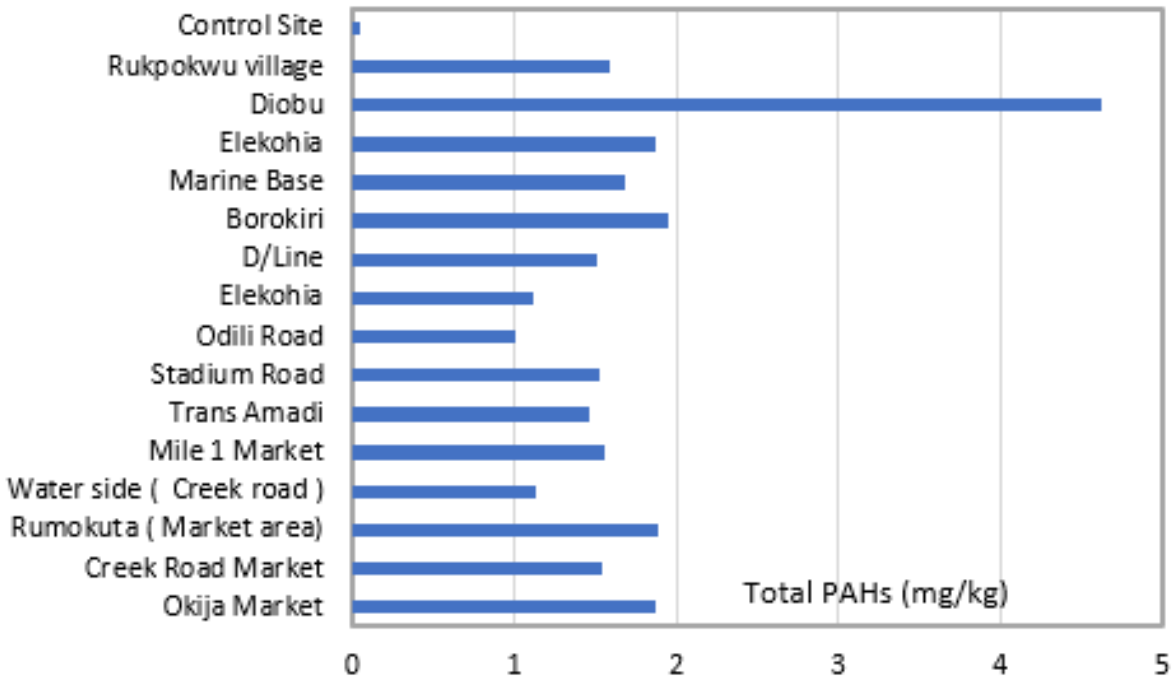

Fig 4: Comparison of the total PAHs between impacted and control site at various locations

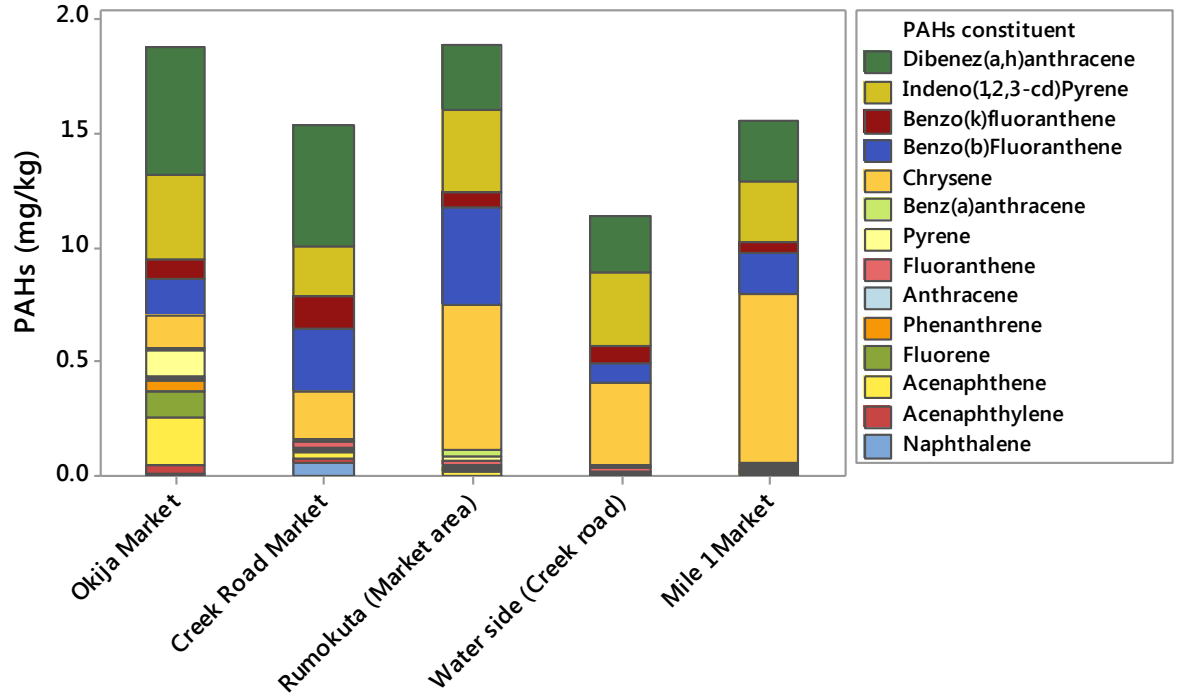

Fig 5a: Variation in concentration (mg/kg) of PAHs constituents for impacted dump site at market area

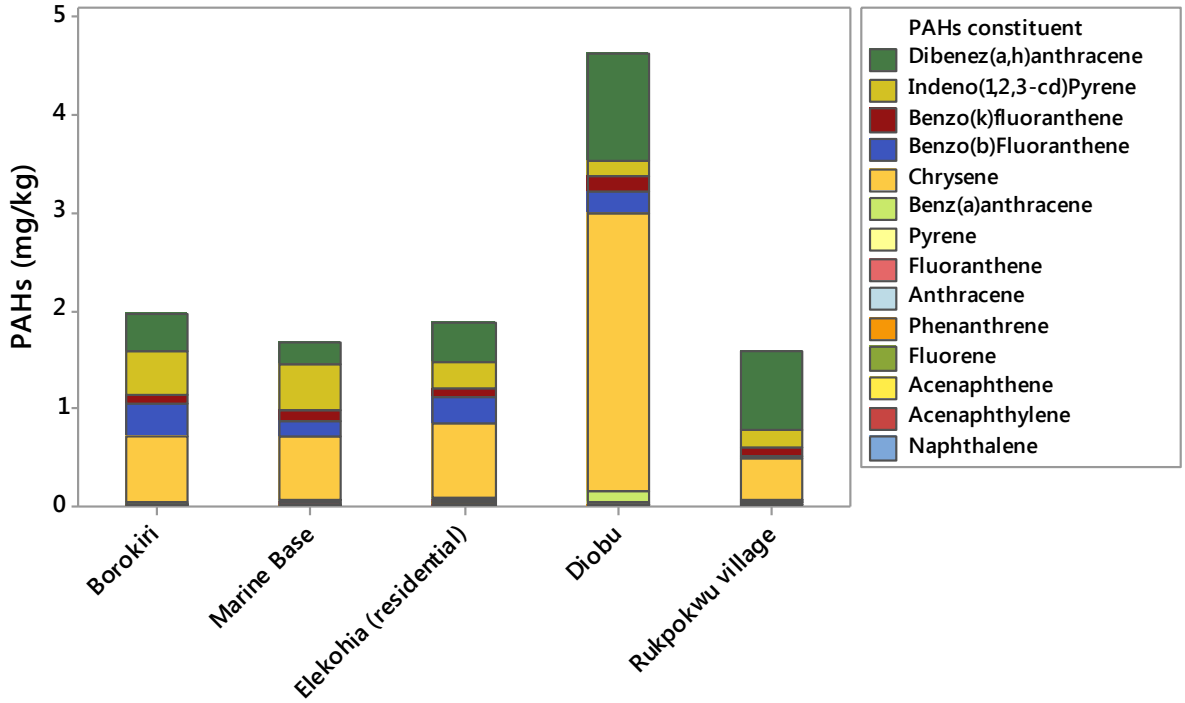

Fig 5b: Variation in concentration (mg/kg) of PAHs constituents for impacted dump site at residential area

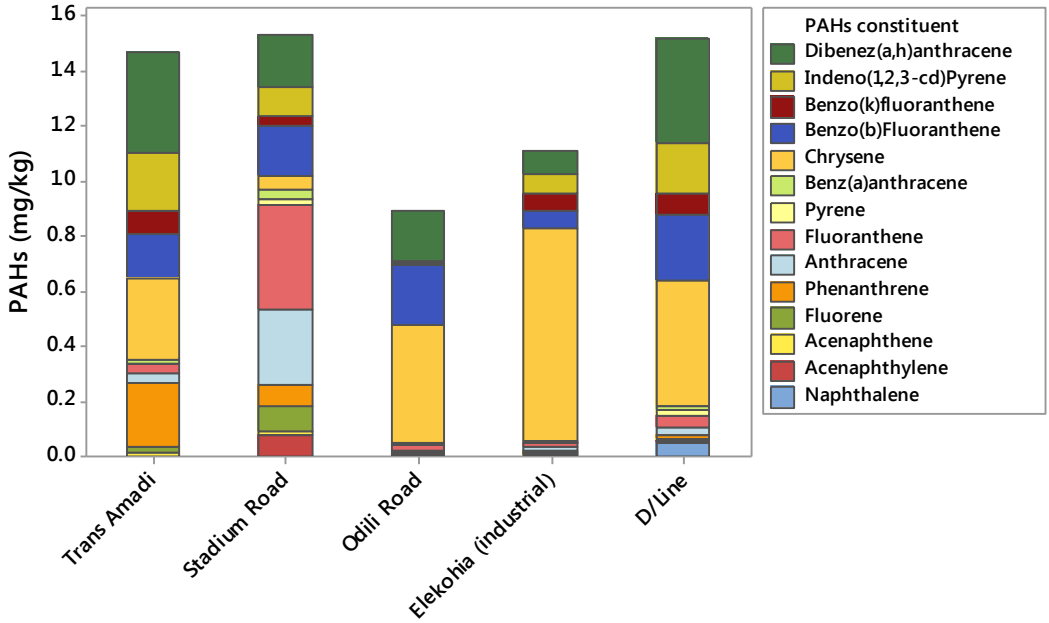

Fig 5c: Variation in concentration (mg/kg) of PAHs constituents for impacted dump site at semi- industrial area

Table 3: Summary of 2 sample t-test result with the Control sites

Comparison	T-value	p-value	Remark
Okija Market vs Control Site	3.10	0.008	Significant
Creek Road Market vs Control Site	2.59	0.022	Significant
Rumokuta Market area vs Control Site	2.38	0.033	Significant
Water side (Creek road) vs Control Site	2.24	0.043	Significant
Mile 1 Market vs Control Site	1.95	0.073	Not significant
Trans Amadivs Control Site	3.03	0.010	Significant
Stadium Road vs Control Site	3.58	0.003	Significant
Odili Road vs Control Site	1.76	0.103	Not significant
Elekohia (industrial) vs Control Site	1.40	0.186	Not significant
D/Line vs Control Site	2.63	0.021	Significant
Borokirivs Control Site	2.27	0.041	Significant
Marine Base vs Control Site	2.15	0.051	Not significant
Elekohia (residential) vs Control Site	2.20	0.047	Significant
Diobuvs Control Site	1.57	0.140	Not significant
Rukpokwu village vs Control Site	1.79	0.097	Not significant

Hierarchical Cluster Analysis (HCA)

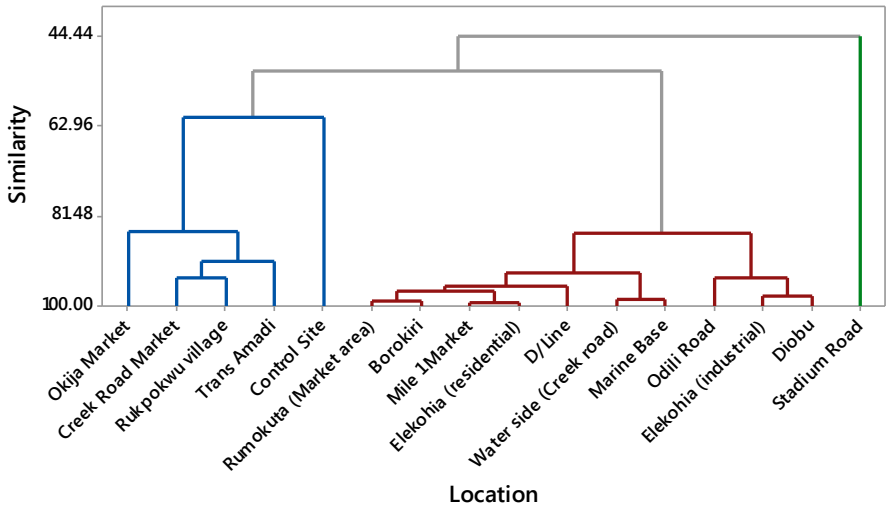

Fig 6a: Denodrogram showing the complete linkage and correlation coefficient distance of the impacted site and the control for all locations

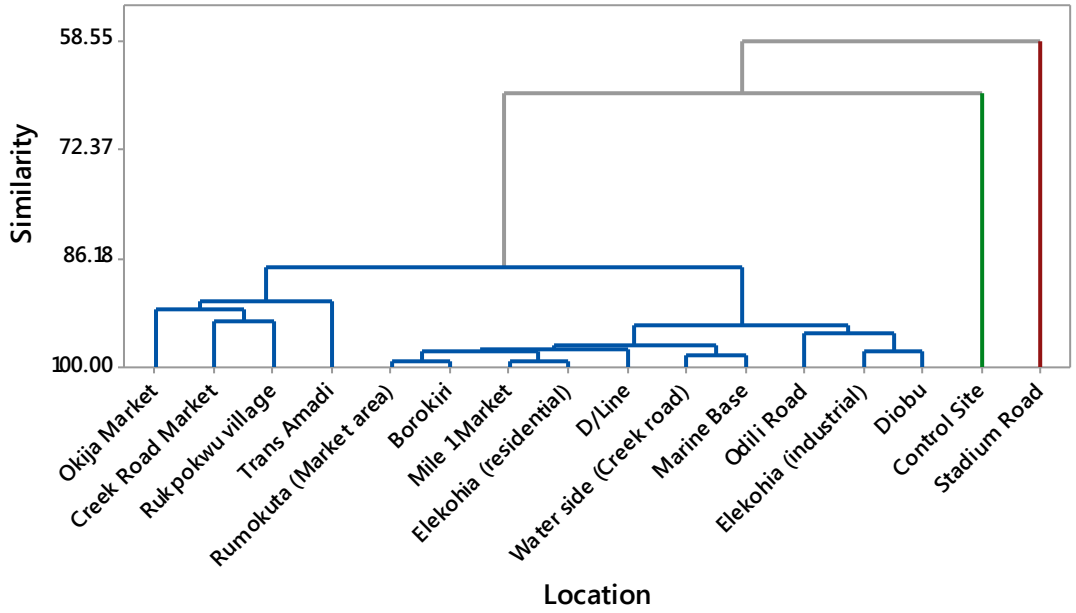

Fig 6b: Denodrogram showing the centroid linkage and correlation coefficient distance of the impacted site and the control for all locations

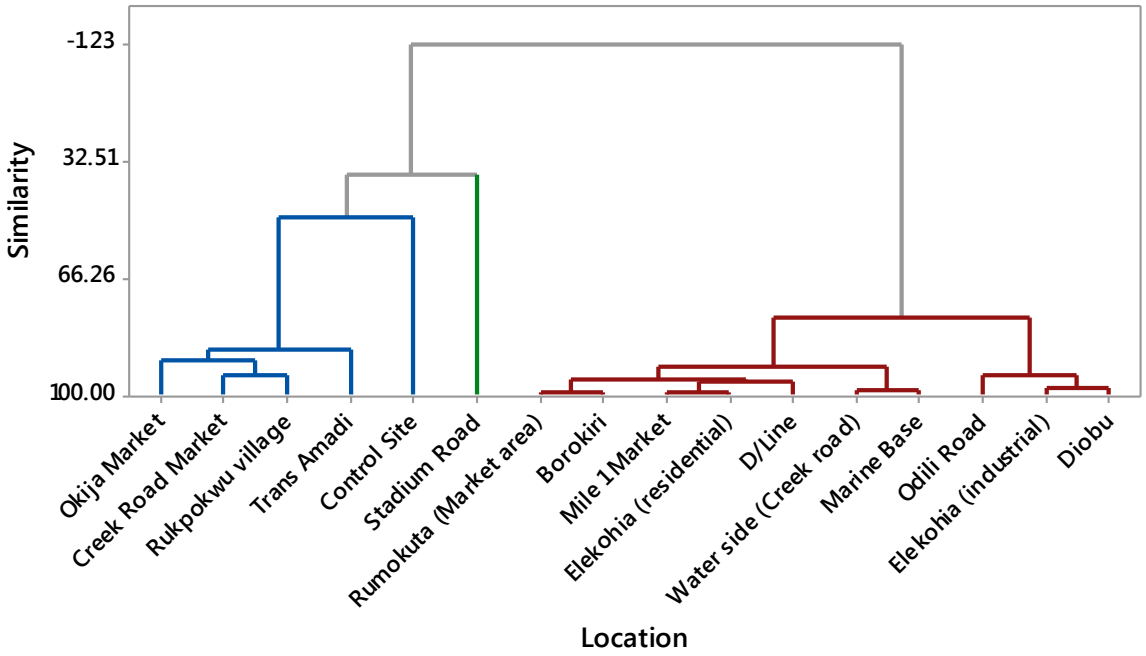

Figure 6c : Denodrogram showing the wards linkage and correlation coefficient distance of the impacted site and the control for all locations

Principal Component Analysis (PCA)

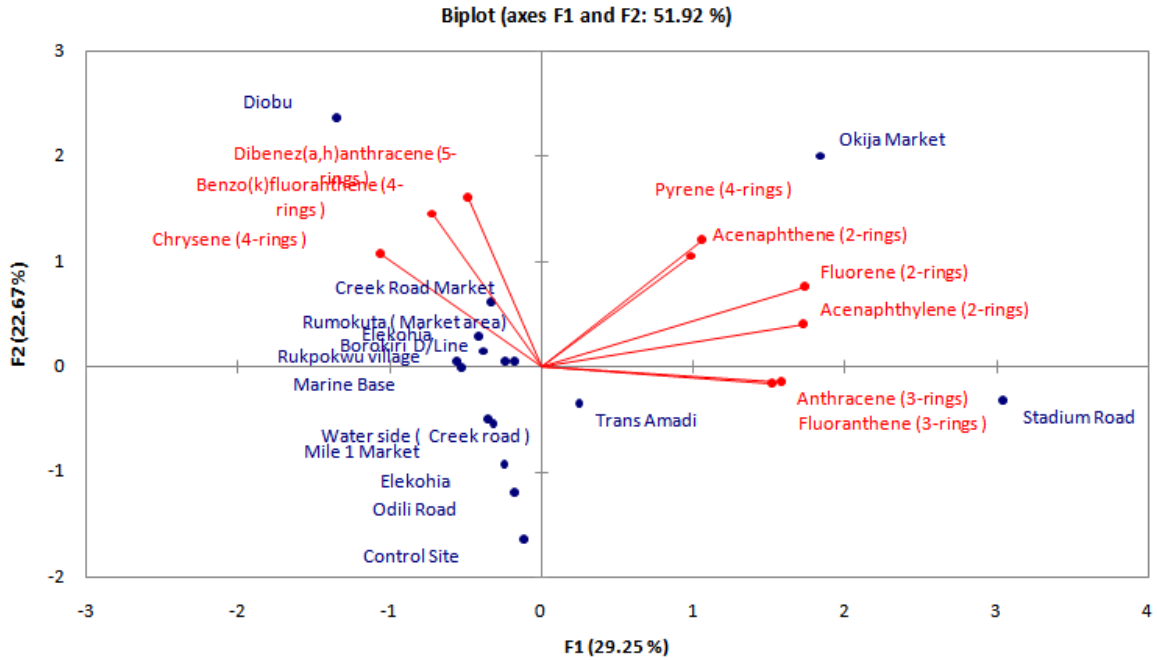

Fig 7: Showing the biplot showing the PAHs constituents (mg/kg) of the impacted dump site and the control

IV. Discussions

The laboratory results and findings of this study clearly in Table 1a, 1b for impacted uncontrolled sites shows that the sum total of all Polycyclic Aromatic Hydrocarbons (∑ PAHs) in each of the uncontrolled solid waste dumpsites is greater than 1 (>1) except the dumpsites at Odili road. However that total for the control sites in Table 2 is far less than 1 (<1). More also high molecular weight (HMWPAHs) of 4 to 6 rings arepredominantly present and of significant values higher than low molecular weight (LMWPAHs) of 2 to 3 rings at all the dumpsites. This is contrary to the findings of Edori[1]. The predominant presence of these HMWPAHs is due to the type of organic waste being dumped at these dumpsites and the longer period these waste stays at each of the dumpsites for heat reaction and combustion[2]before evacuation to the main dumpsite.

The box plot (Fig.2) was used to graphically depict the experimental data collected from various waste dump sites and a control point. The essence of the box plot is to visualize the data points more easily. In the box plot above the lower line below the box shows the minimum value of the PAHs while the upper line above the box shows the maximum value. The length of the box shows the disparity or variance between the minimum and the maximum values. Similarly, the line that divides the box is the median value, it shows from the properties of the plot that the control site is significantly different from the other sampling locations. The asterisks show the high concentration values for each location. Diobu area has the highest concentration of PAHs. However, that of Odili Road and Elekohia industrial areas have smaller boxes which indicates that they are less polluted sited. This supports the result of the t-test carried out on the different samples, which showed the significance in variation between the control and the PAHs impacted sites. In the dot plot (Fig.3) each symbol (dot) represents four observations (constituents) in the sample data. It shows that Diobu location has four PAH constituents above 2.8 and 4.2mg/kg while other locations show variation between 0.7 to 2.8mg/kg. This is an indication that Diobu area has more PAHs in high level and it is highly polluted. In the fig 4 above, Diobu location seem to have the highest value of PAHs compared to other waste dump sites, followed by Borikiri area. However, Elekohia residential, Okija market and Rumuokuta market areas have similar values of the total amount of PAHs found in the site.

The variations in PAHs constituents for the different sites were plotted as stacked column charts in Minitab 17 (a statistical software). The fig 5a, 5b, 5c shows the level of the PAHs constituents at various locations. The graphical analysis using bar graphs shows that Chrycene and Dibenez(a,h)anthracene are in very high levels in almost all the impacted sites.

A 2-sample t-testwas carried out in Minitab 17, a statistical software to compare the level of significance between impacted dump site and the control site (non-impacted) for all locations using 95% confidence level at p = 0.05. This was computed in the software using 2 sample t-test under stat, basic statistics were different hypothesis tests methods are found. It is imperative to note that, the null hypothesis indicates no significant difference between variables while the alternate hypothesis indicates significant difference between

the test variables. Therefore, if p is smaller than the set value which is 0.05, we reject the null hypothesis. The table 3 shows the summary of the t-test results.It is observe that 9 sampling locations (impacted waste dump sites) which include Okija, Creek road, Rumuokuta, Waterside, Trans-Amadi, Stadium road, D/line, Borikiri, and Elekohia residential) are significantly different from the control site. This shows that these locations are highly impacted with PAHs. However, their level of significance varies between 0.008 to 0.047 respectively. This studyalso revealed that the paired sample t-test reveals no significant difference between the control and five impacted dump sites.

Hierarchical cluster analysis (HCA) is a combination of techniques to classify large data into clusters on the basis of similarities or dissimilarities. Thus, resulting groups are like each other but distinct from other groups. Researchers have widely applied HCA for classification and interpreting experimental data[8]. In the present study, HCA was used to group sampling points based on their similarities in dump sites and to detect links between PAHs constituents. A combination of linkage methods of complete, centroid and distance and the wards linkage methods of Euclidian and squared Euclidian were applied to all data sets. The fig. 6a, 6b and 6c shows the dendrograms for the various methods applied. The complete linkage method (Fig. 6a) was applied to perform cluster analysis in Minitab 17 software using multivariate under stat, the following results were obtained: Cluster 1 includes Okija Market, Creek Road Market, Trans Amadi, Rukpokwu village and Control Site. Cluster 2 areRumokuta (Market area), Water side (Creek road), Mile 1 Market, Odili Road, Elekohia(industrial), D/Line, Borokiri, Marine Base, Elekohia (residential) and Diobu while Cluster 3 is only Stadium Road. Applying the centroid method (Fig. 6b) for all locations both the impacted and the control site, the following results were obtained: Cluster 1 includes Okija Market, Creek Road Market, Rumokuta (Market area), Water side (Creek road), Mile 1 Market, Trans Amadi, Odili Road, Elekohia (industrial), D/Line, Borokiri, Marine Base, Elekohia (residential), Diobu, Rukpokwu village. Cluster 2 is Stadium Road and Cluster 3 is the Control Site.Applying the wards linkage method (Fig 6c) for all locations both the impacted and the control site, the following results were obtained: Cluster 1 includes Okija Market, Creek Road Market, Trans Amadi, Rukpokwu village, Control Site while Cluster 2 are Rumokuta (Market area), Water side (Creek road), Mile 1 Market, Odili Road, Elekohia (industrial), D/Line, Borokiri, Marine Base, Elekohia (residential), Diobu and Cluster 3 is Stadium Road

Comparing the three methods used in the HCA it shows that the complete linkage and the ward linkage method produced similar results according to the classification into clusters. It was revealed that Okija market, Creek road market, Trans Amadi, Rukpoku village and the control site are in cluster 1. This signifies that the variation PAHs constituents in the control is similar to Okija market, Creek road market, TransAmadi and Rukpoku village. It can be deduced that these locations in cluster 1 are less polluted sites. Cluster 2 are Rumokuta (Market area), Water side (Creek road), Mile 1 Market, Odili Road, Elekohia (industrial), D/Line, Borokiri, Marine Base, Elekohia (residential), Diobu and Cluster 3 is Stadium Road. Therefore, we can classify these locations based on the level of impact as Less polluted (LP) for Cluster 1, Moderately polluted (MP) for Cluster 2 and Highly polluted (HP) for Cluster 3.

Principal Components Analysis(PCA):To identify the potential PAH sources for the three ambient environments in different seasons, principal component analysis (PCA) were employed in this study. PCA was performed on data collected from 15 sampling points (waste dump sites). PCA enables us to compare the parameter relations by the automatically produced correlation matrix and observe the relationships between the parameters. The PCA was computed in Excel STAT 2014 by using all locations and the control and repeated without the control site, the varimax rotation (Kaiser normalization) method was used to run the PCA. The type of PCA employed in this research work is the Pearson (n) and the type of biplot is the correlation biplot. Nevertheless, the Bartlett's sphericity test showed Chi-square observed value of 261.812, Chi-square critical value of 114.268 with a degree of freedom of 91. The observation axes F1 and F2 were found to be 51.92% after varimax rotation it showed 44.92% as axes D1 and D2. Since F1 and F2 > D1 and D2, the result before varimax rotation was used for the interpretation the impact of PAHs on the soil. In Fig. 7, the four quadrants of the biplot we observe that, in the first quadrant Diobu position significantly different from Creek road, Rumuokuta, Elekohia, and Rukpoku village. Only Diobu has Dibenez(a,h)anthracene and Benzo(k)fluoranthene, while at the second quadrant we have Okija market with Pyrene, Acenaphthene and Fluorene while in the third quadrant we have Trans Amadi and Stadium Road with Anthracene and Fluoranthene close to Stadium road.The biplot also shows that 5 impacted sites namely Marine Base, Waterside (creek road), Mile 1, Elekohia and Odili road are in the same quadrant with the control site where no PAH constituent was found. While Diobu is significantly in different position with Creek road, Rumuokuta, Borikiri and Rukpoku area Therefore, the use of PCA for identification of PAH sources is simply based on the similarity in the PAH profiles of source and receptors (Lee et al., 2004).This study was limited to dumpsites that has no contamination with petroleum products

V. Conclusion

This study was conducted on municipal solid waste dumpsites where only house hold solid waste are dumped. The presence of Polycyclic Aromatic Hyrocarbons shows clearly that PAHs can be generated by Pyrogenic method whenever organic waste substances are exposed to high temperatures under low oxygen or no oxygen conditions. The study conclusively show that Okija market, Creek road market, Trans Amadi and Rukpoku village are less polluted sites. Rumokuta (Market area), Water side (Creek road), Mile 1 Market, Odili Road, Elekohia (industrial), D/Line, Borokiri, Marine Base, Elekohia (residential), Moderately polluted, while Diobu area is heavily polluted with High molecular weight (HMWPAHs) of 4 to 6 rings are predominantly present and of significant values higher than low molecular weight (LMWPAHs) of 2 to 3 rings at all the dumpsites. It also further shows that that Chrycene and Dibenez(a,h)anthracene are in very high levels in almost all the impacted sites.

Acknowledgements

I wish to acknowledge the Institute of Geo – Science and Space Technology for the opportunity and encouragement for this research.

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