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QUALITY OF RAINFALL IN EWET HOUSING AKWA IBOM STATE, NIGERIA

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ABSTRACT

The rainwater harvested from Ewet Housing Estate in AkwaIbom State, Nigeria was investigated. The essence was to determine the quality of rain water consumed by the people within three locations in Ewet housing area of AkwaIbom State. Because of increase anthropogenic and other human related activities there is accumulation of the greenhouse gases in the atmosphere. Such accumulation hindered the quality of the rainfall water in view of the adsorption and accumulation of the particulate matter enriched with trace metal. Such trace metals are easily transported from the air to the rain water. The accumulation of such contaminants directly and indirectly influenced the quality of rain water harvested thereby exposing people to severe health risk. In view of the associated risk the study was undertaken between March 2017 and March -2018 by collected rainwater samples from different locations in Ewet housing estate, AkwaIbom State, Nigeria. The results obtained were evaluated by comparing the concentration of trace metals and other physical properties obtained with permissible limits as recommended by WHO. Multivariate statistical analysis was used to ascertain the source of pollutants in the rainwater samples. The results showed that the anthropogenic activities and other human related activities directly and indirectly influenced the physicochemical properties of the rain water samples consumed within specific locations in Ewet housing Estate, Nigeria. The results showed that the trace metal concentration Fe (2.10mg/l), Pb(0.49mg/l) and Cr (0.23mg/l) in the rainwater sample harvested from Ewet housing estate were above WHO permissible threshold limits. The studied also revealed that the sulphate and potassium of 341±47.57 and 48.1±8.31 mg/l respectively were higher than WHO permissible limits. Though the level of contaminants Fe,Cr and Pb recorded in the rainwater sample from Ewet Housing Estate were minimal in terms of the level of concentration recorded, it is imminent that the water sample collected should be treated. This is necessary to ensure that the water is free from atmosphere pollutants, but suitable and safe for human consumption. Hence in view of the level of Chromium (Cr), Iron (Fe)and Lead (Pb) present in the rainwater studied there is that tendency of humans to be exposed to Cr, Pb and Fe toxicity over time.

INTRODUCTION

According to Salve *et al*. (2008) water is an important abiotic component of the environment. It is also vital elements to both plants and animals. It is widely distributed and needed globally for domestic and agricultural purposes (Salve *et al*.2008). Apart from the surface and underground water sources, rainwater is also commonly used in developing and developed society's base on the water need of the area. It is alternative to the public water supply which is now scarce and rarely available in view of the cost incurred by the appropriate agency in providing such services. In most urban and rural areas rainwater is the only source of water supply. The over dependence of the people on rainwater supply may be attributed to the poor quality of water obtained from the surface and underground water qualities in given geographical area (Hart and White,2006).

Hart and White (2006) also stated that before the industrial revolution, rainwater was regarded as the purest source of water supply, in view it source and origin as the natural source of water free of pollutants. However, recently the impact of climate change perpetuated by industrial revolution and other associated anthropogenic activities in the urban and rural areas has worsened the quality of the water obtain from the rain (Hart and White,2006). Studies has shown that rain water quality in the rural and urban contained contaminants generated from the anthropogenic activities and distributed over the atmosphere which get trap during the rainfall. This view was opined by Omele (2011) who also revealed that many of the contaminants such as trace metal present in rain water were higher than the permissible exposure limits. Omele(2011) also attributed such increase in the trace metal load in the rain water to effect of the anthropogenic and other related human activities in the study locations. Ogazerelem*et al.* (2015) investigated the rainfall quality in the sub-urban and urban areas of Imo state, Nigeria and confirmed that the rainwater sample contained trace metal Fe,Pb,Cu at concentration higher than the permissible limits.

Ogazirelem*et al*. (2015) also reported that contamination of harvested rainwater by various pollutants available in the air has been on increase in developing and developed areas. Ogazerelem*et al*.(2015) in their study mentioned that atmospheric deposition of contaminants occurs when the contaminants in the atmosphere are transferred from air into the rainfall in form of particulate matters, trace metals and as aerosol. The use of fossil fuels also influenced the level of trace metal in the atmosphere (Omele,2011). The tendency of such metals to be washed off from air into the water droplets during the rainfall is very imminent (Omele,2011). When such occur, there is that tendency for the level of trace metal load to increase in the soil as well as plants in view of the effect of the run-off on the soil (Ubuoh,2011). The transportation of trace metal between soil and plants occur due to the mobilization of such metals in rain water between soil and plants (Ubuoh,2011). Such mobilization process leads to increase in trace metal load in surface and underground water quality widely used within the affected area (Cupido*et al*.2012). Cupido*et al*.

(2012) further opined that other physical properties such as total dissolved solids (TDS), turbidity of the surface water may also be affected.

Therefore, in view of the sequential transfer of the trace metal and other atmospheric pollutants into the plants, there is that tendency of the metal to enter the food chain (Ezeilo and Dune,2012). When such occurs, there is that tendency of the metal toxicity to manifest in humans. According to Ezeilo and Dune (2012) metal toxicity causes severe and irreversible public health problems in both humans and animals within the affected area. Presently, in AkwaIbom State, Nigeria provision of public water to various areas in the state is not sustainable due to high cost of transportation and distribution cost incurred by government agency. Hence some homes in the rural and urban areas solely depend on rainwater and underground water supplies for domestic and human consumption. Therefore, harvesting of rain in rural and urban areas cannot be completely eradicated in view of the scarcity of water supply in both rural and urban areas. Hence, there is need to assess the quality of rain water harvested in the study areas. As this will be very useful in determining the quality of rain water harvested in the study area to prevent potential contamination.

Keywords: DR3900-Direct reading Spectrophotometer model3900, Ewet Housing, Trace Metal, Principal Component Analysis (PCA). Cluster Analysis, Contaminants. COD -chemical oxygen demand, Tur-Turbidity,Col-Colour and Cal-Calcium

MATERIALS AND METHODS

STUDY AREA

AkwaIbom State, Nigeria was created out from Cross River State, Nigeria in 1988.Over the creation of the state most private, state and federal agencies and other parastatals and institutions started establishing their office and business in Uyo, the State capital. In view of the geographical location of the State, coupled with the increase in Economic growth and development there is increase in population in area such as Ewet housing estate in the State.

The study site Uyo Local Government Area also shares the west boundary with Rivers and Abia state (Figure1). Uyo lies between latitudes and Longitudes 5 ^{0}10'N and 8^{0}3'E in the North and East respectively. In terms of occupation, majority of people within the study location are public servant. Some engage in private business such as buying and selling within the designated locations in the Uyo, the State capital. Rainfall in the study area is all year round, more severe in June and September. Majority of people within the study area depends on underground and rain water for human and domestic consumption. The total and complete decay of public water supply over the years had contributed to over dependence of people on surface and rain water sources for human consumption.

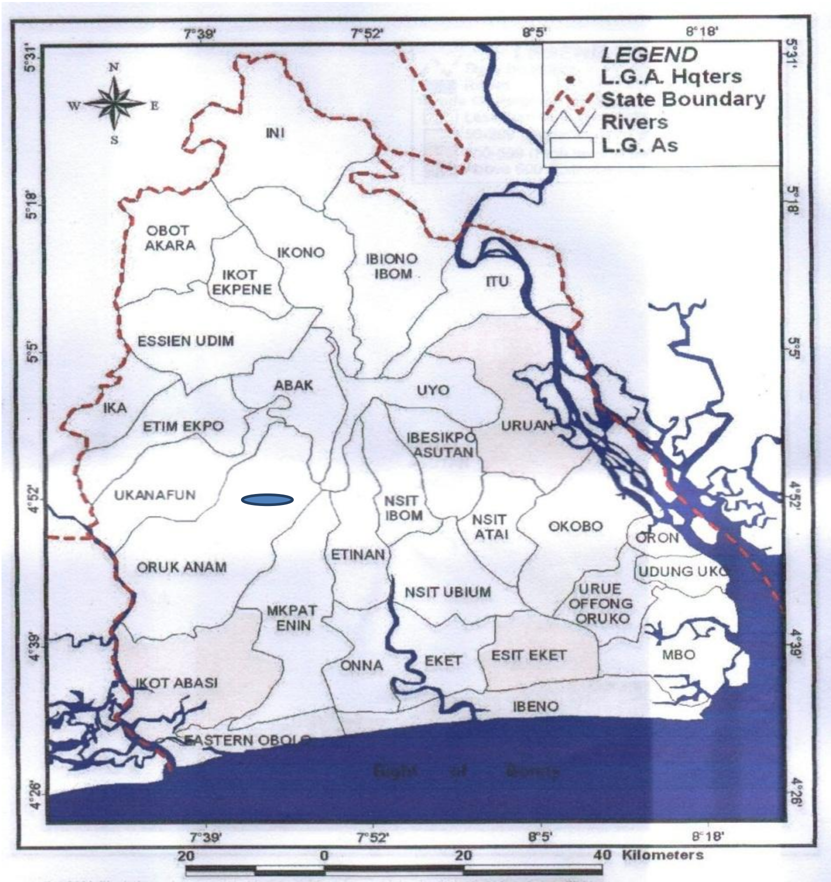
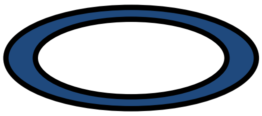


FIGURE 1: Akwa Ibom State showing the 31 Local Government Area

Specific Study Site 

2.2 EXPERIMENTAL DESIGN

A single factorial experimental in randomized block design was utilized for this study. This enabled the selection of the five study sites for the study. From the five study sites randomly selected, three locations in Ewet Housing estate highly populated with increase human and vehicular activities were selected. Samples of rainwater collected in triplicate from the three locations randomly selected for this study.

2.4 SAMPLING AND LABORATORY ANALYSIS

Rainwater samples were collected into sterile polyethylene containers sterilized with HCL and Ethanol. The containers were labelled and placed into the cooler and taken to laboratory for analysis. The sample was taken from three different locations of Ewet housing Estate-Road safety road, BannetBassey Street, The Housing Estate Entrance road all in Uyo Metropolis, AkwaIbom State, Nigeria. The TDS, was measured using portable multipurpose TDS, meter. COD was determined by incubating the COD reactor with the water samples in HACH COD for period of 24hrs, Then COD measured using the DR3900 model spectrophotometer. Trace metals were determined using Atomic Absorption Spectrophotometer. Other nutrient content of the water sample Calcium, Phosphate, Sulphate were measured using 25mls of water sample with the specific powder pillows in line with DR3900 USEPA test method procedure for the analysis of fresh water samples. Colour was measured using the DR3900 model spectrophotometer.

3.0 STATISTICAL ANALYSIS

Data were descriptively analysed for mean and Standard deviation. Multivariate statistical analysis which entails the use of correlation coefficient matrix, Principal component analysis and cluster analysis were employed to evaluate the source of pollution. The level of significant between the physicochemical properties of rainwater samples harvested then measured at $P \leq 0.05$ and $P \leq 0.01$ to determine the level of significant according to Daribi *et al*. (2016).

4.0 RESULTS AND DISCUSSION

The results of the physicochemical properties of the rain water from Ewet housing study area AkwaIbom State, Nigeria is as indicated on Table1. The mean value of 6.78±0.46 for color was however higher than 5.0 recommended by WHO (2011). Indicating that the suspended particles in the air which then transported to the rainfall may have impacted on the color of the rainwater sample tested. The turbidity of the harvested rainwater from Ewet housing AkwaIbom State showed 2.45±0.61NTU turbidity. Indicated that the turbidity value was lower than that 5.0 NTU recommended by WHO (2011). The value was also lower than 4.15NTU obtained by Eruola*et a*l. (2010) in their study on the quality of harvested rainwater in Abeokuta. Ogun State, Nigeria. The total dissolve solid of the studied rainwater sample was also, lower than the permissible limits 0f 250mg/l as recommended by WHO (2011). The value of 12.12 ±0.17mg/l total dissolve solid obtained was also lower than 24.49 mg/l value obtained by Ogazerelem*et a*l. (2015) in their study on the rainwater sample harvested in Owerri metropolis. The result showed that the rainwater collected in Ewet housing area of AkwaIbom State, Nigeria contained little dissolve solid materials.

Table 2 also showed that calcium content of 0.54±0.01mg/l in the rainwater sample was within the WHO (2011) recommended permissible limits. The value obtained was also lower than 29.1mg/l obtained by Save *et al*. (2008) on their study on rainwater harvested from Nagpur area of India. Potassium content of 48.1±8,31mg/l in the harvested rainwater sample was also higher than 5.0 mg/l WHO (2011) permissible limits. The high standard deviation recorded in the potassium concentration showed remarkable variability in the potassium content of the rain water sample harvested from Ewet Housing Estate of AkwaIbom State, Nigeria. This value was also higher than 2.3mg/l obtained by Save *et al*. (2008) on their study on metal ions in rainwater sample harvested from Nagpur area of India. Table 2 also showed higher concentration of 341±47.57mg/l. sulphate which was higher than 250mg/l recommended for domestic water by WHO (2011). This value was also lower than 484.81±115 mg/l obtained by Ogazerelem et al (2015) in their study of rainwater sample collected from Owerri, Imo State, Nigeria. In terms of trace metal composition of the rainwater sample harvested in Ewet Housing, the study showed that the2.11±1.8mg/l Iron (Fe) obtained in the studied rainwater sample was higher than 0.3mg/l recommended by WHO (2011). This value was also higher than 0.85mg/l obtained by Ezielo and Dune (2012) in their study on the rainwater sample harvested in industrial zone of Amadi industrial area of Port Harcourt, River State Nigeria.

Therefore, the high content of iron (Fe) in the harvested rainwater though may not have any significant health consequences but could lead to the coloration of the roof and other domestic utensils used in collecting the rainwater. The zinc content of the studied rainwater with the main value of 0.3±0.18mg/l was lower than 3.0 and 5.0mg/l of zinc recommended by WHO (2011). Comparatively the value also obtained was also, lower than 0.81±0.91mg/l obtained by Ogazerelem*et al*. (2015) on their study on the rainwater harvested in Owerri industrial area of the State. The lower standard deviation of zinc and other trace metal assessed in the rainwater samples indicated the lower variability in trace metal in the studied rainwater sample.

Indicating that the lower the standard deviation the lower the variability. However, the studied showed that lead (Pb) content of 0.49±0.11mg/l was comparatively higher than 0.01mg/l permissible value recommended by WHO (2011). The value though was higher than WHO (2011) permissible value, but however, was lower than 0.568 mg/l value obtained by All *et al*. (2014) in their study of surface water quality sample obtained in Korang in Pakistan. The high content of lead value in the studied rainwater sample of Ewet housing estate showed that the rainwater may not be suitable for domestic and human consumption. As humans may be exposed to lead toxicity over time. Manganese content of 0.22ml/g each was relatively and comparatively lower than the WHO (2011) permissible maximum limits of 0.05 and 20.0mg/l respectively. The lower content of chromium and manganese is also in line with the value obtained by Eruola*et al*. (2010) on the rainwater sample harvested in the industrial area of Abeokuta Ogun State, Nigeria. Chromium content of 0.22mgl was higher than 0.05mg/l recommended by WHO (2011). The increased in the chromium content of the rainwater sample in the studied area may be attributed to the availability and adsorption of this trace metal in the air due to anthropogenic activities. Also, the availability of this metal in the air is attributed to the effect of climate change associated with anthropogenic activities within the Uyo urban. The 0.22mg/l chromium content obtained in the study sample was higher than 0.057mg/l obtained by Adewuyi and Olowu (2012) on their study of water sample quality obtained from Ibadan metropolis**.** The chemical oxygen demand (COD) of 14.98±0.95 was lower when compared with 150.0mg/l allowed in the domestic water sample (WHO, 2011). The decrease in the level of COD observed in the studied rainwater sample may be due to decrease in temperature and lower evaporation of rainwater sample as well as decrease in oxygen consumption for the degradation of organic matter and other chemical waste indiscriminately generated into the atmosphere. The lower COD also indicated that the rainwater was also able to bind with available oxygen in the atmosphere. Consequently, the free oxygen gets available in air and thereby leading to increase in oxygen in the studied rainwater sample (Ali *et al*.2014).

	WHO	Range	Minimum	Maximum	Mean		Std. Deviation
	Standard	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Colour	5	1.10	6.30	7.40	6.7750	.23229	.46458
Turbidity (NTu)	5	1.36	2.00	3.36	2.4825	.30850	.61700
TDS (mg/l)	250	3.91	10.46	14.37	12.1275	.85359	1.70719
Calcium(mg/l)	100-200	.03	.53	.56	.5400	.00707	.01414
Potassium (mg/l	5	18.00	36.11	54.11	48.1500	4.15540	8.31080
Sulphate (mg/l)	250	95.77	270.00	365.77	341.3450	23.78358	47.56716
Iron(mg/l)	0.30	4.00	.16	4.16	2.1050	.91161	1.82321
Cu (mg/l)	1.0	.13	.23	.36	.2675	.03092	.06185
Zn(mg/l)	3.0-5.0	.38	.04	.42	.3000	.08756	.17512
Pb (mg/l)	0.01	.24	.32	.56	.4875	.05648	.11295
Cd (mg/l)	0.03	.00	.01	.01	.0100	.00000	.00000
Cr (mg/l)	0.05	.03	.21	.24	.2250	.00645	.01291
Mn (mg/l)	20.0	.32	.04	.36	.2250	.06801	.13601
COD (mg/l)	150	2.10	14.26	16.36	14.9800	.47686	.95373

Table 1: Descriptive Statistic of Rainwater Quality in Ewet Housing

PEARSON CORRELATION COEFFICIENT MATRIX OF STUDIED SAMPLE

The correlation coefficient between the trace metal and physical properties of the rainwater sample is as shown in Table 2. Positive and negative relationship existed between trace metals and other physical properties of studied rainwater sample. The study showed that TDS correlated positively and significantly with Turbidity, phosphate, sulphate and lead at $P \leq 0.05$ with r values 0.982, 0.685 and 0.655, 0.766 respectively. Also TDS also correlated negatively but insignificantly with Iron, Manganese and Calcium with r values-0.447, -886, -645 respectively .The positive relationship exhibited by TDS with turbidity, phosphate and sulphate therefore indicated that increase in the TDS of the rainwater sample in the studied area will lead to increase in the concentration of phosphate, sulphate and turbidity values of the rainwater in the studied area. Iron correlated negatively and significantly with the Turbidity at $P \leq 0.05$ with r value -.589 of the studied rainwater sample. Therefore, an increase in Iron will lead to increase in the turbidity of the studied rainwater sample. This finding is in line with Ogazerelem*et al*. (2015) on their studies conducted on the quality of rainwater sample harvested in Owerri, residential area of Imo State, Nigeria. Copper of the studied rainwater sample as indicated in table 2, correlated positively and significantly at P≤0.05 with Cr, COD and colour with r values 0.890,0.977 and 0.890 respectively. This indicated that an increase in the concentration of copper in the studied rainwater sample may lead to corresponding increase in the level of chromium, chemical oxygen demand as well as colour in the studied water sample. Correlation of copper between zinc was negative and insignificant at P≤0.05 with r value -0. 979.Table 2 also showed that Zinc correlated negatively and insignificantly with COD, Colour and Chromium at P≤0.05 wit r values -0.951,-0.934 and -0.737 respectively. Indicating that increase in Zinc content of the rainwater sample will cause decrease in the concentration of COD, Colour and Chromium of the studied rainwater sample.

Lead (Pb) in Table 2 correlated positively and significantly with Phosphate, Sulphate at P≤0.05 with r values 0.933 and 0.988 respectively. Also lead (Pb) in table 2 also exhibited negative and insignificant relationship with Manganese (Mn) and Cadmium (Cd) at P≤0.05 with r values -0,58 and -0.897 respectively. This finding showed that an increase in the concentration of lead in the studied rain water will lead (Pb) to corresponding decrease in the concentration of Manganese and Cadmium in the studied rainwater sample. Chromium (Cr) also exhibited positive and significant correlation with Manganese, Colour, Turbidity and Calcium and COD at P≤0.05 with r values of 0.816.0.806,0.588 , 0.548 and 0.910 respectively. Therefore, an increase in the concentration of chromium will lead to corresponding increase in the level of Manganese, colour, Turbidity, calcium and COD in the studied rainwater sample harvested in some locations in Ewet housing Estate in AkwaIbom State, Nigeria. Table 2 also showed that manganese correlated positively and significantly with calcium and turbidity at P≤0.05 with r values 0.797 and 0.901 respectively. This shows that an increase in the concentration of manganese may relatively lead to increase in calcium and turbidity in the studied rainwater sample harvested in Ewet Housing area of AkwaIbom State, Nigeria. Manganese also showed negative and insignificant correlation with phosphate at P≤0.05 with r value -0. 796.Therefore an increase in the manganese content of the rainwater may lead to decrease in phosphate content of the rainwater sample in the studied area of Ewet housing AkwaIbom State, Nigeria. COD in Table 2 correlated positively and significantly with colourwat P with r value 0. 934.Also turbidity on Table 2 correlated positively and significantly with phosphate and sulphate at P with r values 0.593 and 0.527 respectively. Calcium also correlated significantly with phosphate and sulphate at P with r values 0.996 and -0.947 respectively. Phosphate however showed positive correlation with sulphate which was significant at P with r value 0.969.

Physicochemical Properties	**TDS**	**Fe**	**Cu**	**Zn**	**Pb**	**Cr**	**Mn**	**Cod**	**Col**	**Tur**	**Ca**	**Po4**	**So_4**
TDS -mg/l	1.00												
Fe-mg/l	-.447	1.00											
Cu-mg/l	.055	.389	1.00										
Zn-mg/l	-.217	-.205	-.979	1.00									
Pb-mg/l	.716*	.304	.385	-.415	1.00								
Cr-mg/l	-.491	.392	.814*	-.737	-.194	1.00							
Mn-mg/l	-.886	.349	.335	-.213	-.658	.816*	1.00						
COD-mg/l	-.095	.327	.977*	-.951	.178	.910*	.503	1.00					
Colour	.086	-.030	.890*	-.934	.094	.806*	.382	.934*	1.00				
Turbidity-NTU	.982*	-.589	.100	.077	.583	.588*	.901*	.229	.003	1.00			
Ca-mg/l	-.645	-.284	.038	-.027	-.897	.548*	.797	.252	.355	-.562	1.00		
Po_4-mg/l	.685*	.272	.040	-.060	.933*	-.496	-.796*	-.176	-.269	.593*	.996*	1.00	
So_4-mg/l	.655*	.376	.285	-.294	.988*	-.270	.670*	.072	-.046	.527*	-.947*	.969*	1.00

**** Correlation is Significant at the 0.01 Level * Correlation is Significant at the 0.05 Level**

Table 2: Correlation coefficient between rainwater physicochemical properties of rainfall in Ewet Housing

PRINCIPAL COMPONENT ANALYSIS

Principal component analysis is used for the identification of factors responsible for the accumulation of trace metals in the studied rainwater sample. The results of the principal component analysis obtained is as shown in Table 3, revealed that two major factors with Eigen value more than one and total variance of 84.94 %. Factor one contributed 53.52% of the total variance with significant positive loading on Chromium (Cr), copper (Cu), Manganese (Mn) and Iron(Fe) Table 4.This represent the effect of anthropogenic and human related activities in the air and attendant effect in the rainwater in the studied area. Factor 2 contributed 31.42% of the total variance with strong negative loading on lead (Pb) Table 4, which represent impact of vehicular pollutant in the atmosphere on the rainwater sample.

CLUSTER ANALYSIS

The pair wise association among the trace metals in Ewet housing harvested rainwater sample is also shown in cluster analysis figure 3. Cluster analysis resulted in two main clusters namely:(1) Cu, Cr, Mn, Zn. Cd (11) consist of Pb and Fe. Cluster (1) however can be subdivided into Cu, Cr, Mn. Zn and CD. This showed similarities that existed between these trace metals. The results also revealed that these trace metals are contaminants which originated from anthropogenic activities within the studied rainwater sample from Ewet Housing Estate, Nigeria AkwaIbom State, Nigeria. The Lead (Pb) in cluster two showed lithogenic relationship with Fe. This revealed Lead (Pb), Iron (Fe) and Chromium (Cr) as contaminants which originated from mixed anthropogenic and lithogenic origins. These metals also showed close similarities as well as similar chemical properties indicating that the originated from the same anthropogenic origin occasioned by industrial and human and vehicular activities within the studied rainwater sample.

A plot of the major component in PCA resulted in figure 2 with two major components. Component 1 showed strong positive correlation with Cr, Cu,Fe and MN. This is consistent with factor one in PCA assessment of trace metals in rainwater harvested from Ewet Housing location AkwaIbom State, Nigeria as indicated in Table4. Factor 2 correlated positively and significantly with Mn. This is also consistent with factor two in PCA assessment of trace metals in rainwater harvested from Ewet Housing Estate locations in AkwaIbom State, Nigeria. (Table 4)

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Table 3: Extraction Method: Principal Component Analysis.

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.211	53.524	53.524	3.211	53.524	53.524	3.104	51.739	51.739
2	1.885	31.420	84.944	1.885	31.420	84.944	1.992	33.205	84.944
3	.903	15.056	100.000						
4	3.211E-16	5.351E-15	100.000						
5	7.424E-17	1.237E-15	100.000						
6	-1.221E-16	-2.035E-15	100.000						

Table4: Total Component Extracted

Metals	1	2
Cr	.946	.311
Cu	.941	-.294
Zn	-.865	.362
Fe	.530	-.106
Pb	.132	-.979
Mn	.619	.775

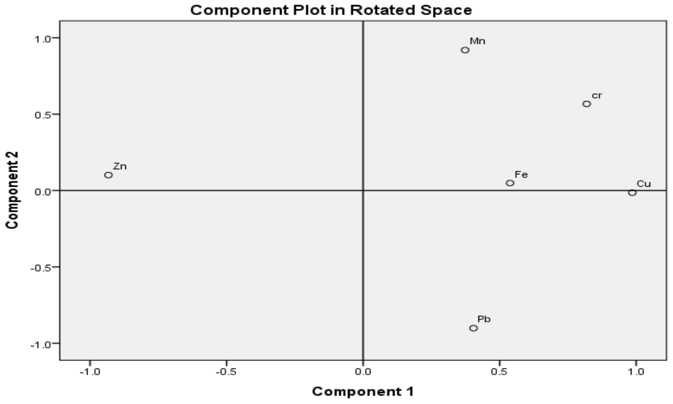

Figure 2: Rotated Metric of the Principal Component of Trace Metal in Ewet Housing Rainwater

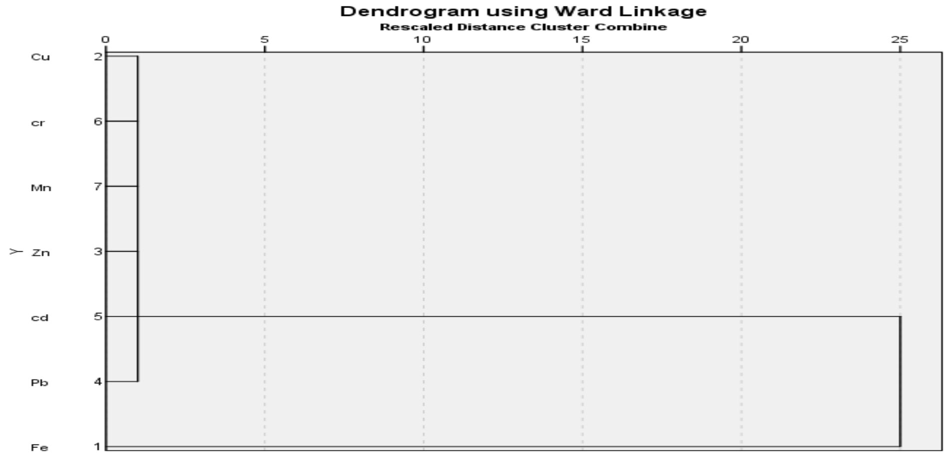

Figure 3: Hierarchical structure of Cluster analysis of Trace Metal in Ewet Housing Rainwater Samples

CONCLUSION

The study revealed that the rainwater samples from Ewet Housing area of AkwaIbom State, Nigeria is impacted with minimal concentration of trace metals largely influenced by anthropogenic activities. The study revealed that the Fe, Pb, Cr content in the water were contaminants which negatively influenced the quality of rainwater harvested from Ewet Housing area of AkwaIbom State, Nigeria. The study also indicated that the relationship and correlation of physical and chemical properties observed in rainwater samples assessed were variable within the study period. Indicating that there was positive and negative relationship between the trace metals with other physical properties tested in the rainwater samples. Therefore, since the rainwater harvested within the Ewet Housing estate of AkwaIbom state is not totally free from atmospheric contaminants.it is not actually safe for human consumption. Hence it should be properly treated to ensure that it is safe for domestic and human consumption. This is necessary to prevent trace metal toxicity in humans who depends on this source of water for consumption. Trace metal toxicity is dangerous with severe public health consequences especially when the exposure level exceeded the threshold limits. Therefore, there is need for public awareness to reduce lead Chromium and Iron toxicity in the studied environment.

However, government agency should restore public confidence in public water supply by

- Ensuring regular and sustainable supply around the housing estates within and outside Uyo metropolis.
- Repairing delipidated and obsolete water line destroyed during the road construction work in the area.
- Renovating the public water works and facilities at the designated area in Uyo metropolis to ensure timely supply on regular bases.

- Creating separate department for water supply to ensure effective management and control of public water facilities control by the state regulatory agency.
- Providing stand by generating plant to water boards at designated urban and sub-urban areas to ensure regular supply of water around the urban and rural areas.

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