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ASSESSMENT OF TRACE METAL CONCENTRATION INNATURAL SURFACE WATER CONSUMED IN UYO VILLAGE ROAD AKWA IBOM STATE. NIGERIA

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ABSTRACT

The study of the trace metals effect in the Surface water was undertaken in Uyo village road in Akwa Ibom State, Nigeria. This was done in order to ascertain the effect of trace metals concentration on surface water quality. The study was undertaken between January 2019 and May-2019. The study employed standard approved HACH as well as AOAC (Association of Applied Chemist) to determine the concentration of trace metals in the surface water samples in Uyo Village road, Akwa Ibom State, Nigeria. The findings revealed that indiscriminate disposal of the refuse at the dumpsite as well as other aerial factors had contributed significantly to trace metals load in the Uyo Village road surface water samples. The result also showed that the pollution load of Iron and copper and Manganese was higher than other metals tested within the study location. Cd, Cr, Hg as well as Pb had a lower concentration in the studied surface water samples. Also, the results of the principal component analysis revealed that the loading variances of trace metals such as cadmium, copper, Lead, and iron as well as zinc in the studied surface water were relatively higher. These trace metals therefore, are regarded as contaminants associated with mixed anthropogenic and lithogenic activities within the study surface water samples. As contaminants, these metals may accumulate in the surface water leading to trace metals toxicity in the humans that depends on such water sample for personal and domestic purposes. Therefore, in view of the results obtained coupled with the negative effect associated with trace metals load it is important that refuse handling and management should be given utmost attention in Uyo municipality so as to reduce the pollution load recorded on the surface water within the study area. Also, it is pertinent that waste recycling plant should be used instead of direct dumping experienced within the study locations so as to prevent the effect of trace metal contamination on the natural surface water within the area.

KEYWORDS: *Pollution, Recycling, Contaminants*

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INTRODUCTION

According to Abidemi(2013) water is an important and essential component of life. All living things depend on water for growth and development. The integrity of the water source depends on the source and the type of water. Water act as a buffer to most of the pollutants generated and disposed indiscriminately into the environment (Achike*et al*.2010). The contamination of water bodies due to pollutants released into the water source to a greater extent affected the quality of such water. Polluted water sources according to (Adedobu *et al*. (2013)harbor pollutants such as trace metals and other micro-organisms which hindered the use of such water sample for domestic activities.

Adegoke *et al*. (2009) mentioned that the pollution of surface and underground water sources often occurs when such contaminants present in the water sources exceeded the permissible exposure limit. The effect associated with such contaminants depends on the concentration of such pollutants in the water bodyAdekoya *et al*. (1995). Depending on the nature and sources of such contaminates some may be soluble in the water bodies, while some may remain as the insoluble substance in view of its physical and chemical composition. Contaminated water sources as reported by Adelana *et al*.(2011) is not suitable for domestic and agricultural purposes.

Adelekan and Agegunde (2011) stated that the application of contaminated water sources over the years has to lead to the accumulation of inorganic and organic pollutants in the surface of the soil. Plant and animals in most cases are also equally affected. The tendency also exists of such pollutants to be carried away to other areas due to soil erosion as well as by winds. Accordingly depending on the translocation and bioaccumulation index of plants existed and cultivated around the affected area some of the organic and inorganic contaminants could be bioaccumulated and translocated to edible and non-edible parts of the plant species(Chinenyeze and Ekene,2005). Adetoro *et al*. (2015) indicated that such contaminant may affect plant growth and development since the plant depends on water for growth. Accordingly, such contaminant could enter the food chain leading therefore to severe health consequence in humans and other animals since these organisms depend on the plant for food as the primary producers (Hong *et al*. 2014).

Therefore, in view of the effect of contaminants as a source of pollution of water bodies, this study was undertaken so as to determine the quality of village road surface water quality consumed by the inhabitants of the area. A multivariate statistical approach was also applied in order to determine the sources of pollution. The application of the multivariate statistical approach is very critical in the determination of the sources of environmental pollution (Akpan,2005).

Study Area

The study was conducted at three selected surface-water in Uyo village roadin Akwa Ibom State Nigeria. Uyo is the capital of Akwa Ibom State, Nigeria. The state was created out from Cross River State, Nigeria in 1992. Akwa Ibom State has thirty-one local Government Areas. The state shared a boundary with Cross State in the South and Rivers and Abia State in the East. Akwa Ibom State has abundance natural resources such as Crude oil mostly found in the coastal communities of the State. Apart from crude oil other natural resources found in Akwa Ibom State include solid minerals such as Copper, Iron Oreas well as tin and bauxite. Forest reserve found in the coastal areas of the state is also rich in abundance forest resources with unique biodiversity inIbeno, Esit -Eket,Itu and Uruan Local Government Areas. Rainfall is all year round. figure 2 and 3 below show the specific study locations in which the study was undertaken in Akwa Ibom State, Nigeria.

Figure 1: Show Specific Study Site and Akwa Ibom State, Nigeria

Source: Ministry of Lands and Survey Akwa Ibom, Nigeria Surface Sampling Preparation and Laboratory Analysis

Surface water samples were collected randomly from three study locations selected randomly in Uyo village road. the water was collected in a cleaned labeled plastic sample container and transferred directly into the cooler and transported to the laboratory for physicochemical analysis. The surface water was however treated with 10mls dilute sulphuric acid. This was done so as to prevent interferences with other chemical substances present in the water samples. A sterile container originally washed with HCl was used for the collection of the water samples. The surface water from the three selected areas was flushed for three minutes. The sample containers then raised and the water sample collected directly into the container. The sample containers were properly labeled into the cooler and transported to the laboratory for analysis. The concentration of the metals present in each was assessed using HACH3900 model Spectrophotometer using ten 10mls of water samples with the relative powder pillows. Dilution factors applied to the results when the concentration was noticed high.

Statistical Analysis

Regression coefficient, principal component analysis, and multivariate agglomerate hierarchal cluster analysis were employed to analyze the trace metal properties of the surface water samples. The similarities between trace metals in the surface water were measured by cluster analysis. The sources of trace metals determined using the principal components analysis in the surface water tested. The level of correlation coefficient between trace metals in surface water measured at $p<0,05$, $p<0.01$ in order to determine the relationship between the trace metals in the surface water collected from the village road according to Adewiuyi and Olowu(2012).

RESULTS AND DISCUSSIONS

Table 1 below shows the descriptive statistics of the surface water sample in the study locations. The study shows that Fe had a mean value of 17.67±10.00. Indicating higher variability existed for Fe concentration in the study surface water sample of Uyo village road. The value was however higher than other trace metals tested in the surface water sample. Mn also varies between 4.67 t0 19.43 with a mean value of 8.12±1.56. Mn also shows lower variability when compared with Fe in the study location concentration in the study surface water varied between 0.08 to 0.23ppm with a mean value of 0.13±0.04. Indicating that Pb had lower variability when compared with Fe, Mn in the surface water sample. Cu concentration in the surface water sample varied between 2.33ppm to 3.46ppm with mean of 2.71±0.42. This show lower variance when compared with Fe, but higher variance when compared with Hg, Cd and Cr. Cr and Cd, however, showed lower variances with a mean standard deviation of 0.33±0.020 and.075±0.012 respectively.

Table 1: Descriptive Statistics of Village Road Surface Water Samples

	Minimum	Maximum	Mean	Std. Deviation	Variance
Fe	7.67	35.67	17.6740	10.00483	100.097
Mn	4.67	10.43	8.1220	1.56412	2.446
Pb	.08	.23	.1270	.04270	.002
Cu	2.33	3.46	2.7140	.42141	.178
Hg	.07	.12	.0910	.01729	.000
Zn	.34	.98	.6870	.23142	.054
Cr	.11	.16	.1330	.02003	.000
Cd	.06	.09	.0750	.01269	.000

Table 2 shows the t-test value and relative degree of freedom of the studied surface water sample. The t-test values of the trace metals tested were relative with varying t- value which was, however, significant at p≤0.05. Fe had t value of 5.566 with p-value≤ 0.5 indicating a positive effect of Fe in the surface water of the village road water sample. Apart-from Fe other metals Mn, Pb, Cu, Hg, Zn, Cr, Cd also exhibited various t-values as shown in Table 2 with p≤0.05. This showed a positive effect this non-essential micro-nutrient had on the water samples within the Uyo village road in Akwa Ibom State, Nigeria.

Test of the Surface Water Sample and Relative Significance Value

Table 2: Statistically Significant at P< 0.05

	T	DF	P-Value	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Fe	5.586	9	.0001”	17.67400	10.5170	24.8310
Mn	16.421	9	.0001”	8.12200	7.0031	9.2409
Pb	9.405	9	.0001”	.12700	.0965	.1575
Cu	20.366	9	.0001”	2.71400	2.4125	3.0155
Hg	16.645	9	.0001”	.09100	.0786	.1034
Zn	9.388	9	.0001”	.68700	.5214	.8526
Cr	21.000	9	.0001”	.13300	.1187	.1473
Cd	18.685	9	.0001”	.07500	.0659	.0841

Multivariate Analysis and Correlation Analysis

Correlation matrix in table4 shows that most of the trace metals correlated with one another either positively or negatively, but also insignificant at P< 0.05 as indicated by their r values in table4. However strong positive correlation existed between Fe and Zn at P<0.05 with r-value of 0.761.Consequently, the present of Iron (Fe) may have lead to the increase concentration of Zinc (Zn) in the surface water samples also correlated weakly and negatively with other trace metals Mn, Cu, Cr, Cd in the surface water studied. Mn, however, showed a negative correlation with Cu and Zn.Hg also correlated strongly with Cd at p±0.01 with r-value 0.785. Consequently the present of Hg in the surface water may have lead to an increase in the concentration of cadmium in the surface water. Nevertheless, the availability of other trace metals in the studied surface water may have influenced the availability of others negativelybut insignificantly and therefore their concentration may be affected by variable factors Adewiuyi and Olowu(2013).

Table 3: Correlation Coefficient of Surface Water Sample

Correlations								
	Fe	**Mn**	**Pb**	**Cu**	**Hg**	**Zn**	**Cr**	**Cd**
Fe	1							
Mn	-.158	1						
Cu	-.141	-.354	-.378	1				
Zn	.761*	-.407	-.189	.163	1			
Cr	-.371	.128	.207	-.115	.007	1		
Cd	-.069	-.543	.400	.303	.785**	-.191	-.372	1
*. Correlation is significant at the 0.05 level (2-tailed).								
**. Correlation is significant at the 0.01 level (2-tailed).								

Principal Component Analysis

The results of the principal component analysis of trace metals in the water of Uyo village road surface water are shown on table5. Results obtained indicated three main components with Eigen value greater than one and significant total variance of79.35%. Factor one contributed total variance of 34.43% with strong positive loading for Copper, Mercury, and Cadmium but with negative loading for Manganese (table 6). This actually represented the impact of the trace metal in the surface water was influenced by the leachate and effluent produced at the transported through surface erosion to the surface water within the study locations. Factor two as shown in Table 5, contributed total variance of26.65% with strong positive loading on Zinc and Iron this represented the impact of the leachate and other associated waste in the surface water consumed by the people within the study location. Table 5 showed that Factor three accounted for a total variance of 18.27 % and defined strong loading for lead and Copper. This represented the effect of aerial and human activities experienced in the study area.

Table 4: Total Variance Explained

Total Variance Explained									
Component	**Initial Eigen Values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.755	34.433	34.433	2.755	34.433	34.433	2.707	33.843	33.843
2	2.132	26.645	61.077	2.132	26.645	61.077	2.114	26.425	60.268
3	1.462	18.274	79.352	1.462	18.274	79.352	1.527	19.084	79.352
4	.985	12.315	91.666						
5	.442	5.530	97.196						
6	.141	1.767	98.963						
7	.061	.757	99.721						
8	.022	.279	100.000						
Extraction Method: Principal Component Analysis.									

Table 5: Rotated Component Extracted

Rotated Component Matrix[a]			
	Component		
	1	**2**	**3**
Fe	-.071	.929	.164
Mn	-.708	-.353	.046
Pb	.138	-.082	.924

Table 5: Contd.,			
Cu	.579	-.040	-.664
Hg	.911	-.305	-.216
Zn	-.032	.917	-.204
Cr	-.415	-.422	.102
Cd	.918	-.080	.325
Extraction Method: Principal Component Analysis.			

Cluster Analysis

The association among the trace metals at the surface water sample from the village road is as illustrated in figure 2. Figure 2 shows two main clusters. Clusters showed were based on Wards method of extraction. Cluster 1 showed linkage between Hg, Cd, Pb, Cr, Zn, Cu.While cluster two shows the linkage between Fe with Cr, Zn, Cu and Mn. Cluster 1 can be sub-divided into Cr, Zn, Cu and Mn. The linkages and interactions among these trace metals showedthat close similarities existed between them in the surface water sample (Aghalina and Eyinla (2009). The relationship showed that these metals are contaminants which originated from leachate produced and transported through the surface erosion into the surface water sample (Ahaneku and Sadig(2014).However, Cr, Zn, Cu and Mn are also regarded as contaminants that originated from mixed anthropogenic and lithogenic sources in view of the similarities shown by these metals with Iron. Pb in cluster 2 showed that same lithogenic relationship with Iron. This is in line with the results obtained from the principal component analysis.

A plot of the major principal components of (PCA) resulted in three different plots (figure 1 and Table 6). The plot 1 showed very strong positive loading for Copper, Mercury, and Cadmium which is actually similar to factor 1(Table 6 and figure 1). Plot two, however, showed strong positive loading for Iron and Zinc similar to factor two. Plot three of the cluster showed positive loading for Lead and Copper which is similar to factor three(Figure 1 and Table 6).

DISCUSSIONS

Trace metal pollution both at the polluted and control site is very essential in the effective management of pollutants generated and produced into the immediate environment. The results obtained showed that the trace metal generated and produced into the immediate surface water environment originated from mixed anthropogenic and lithogenic sources (Ahinor *et al*.2014). This revealed that apart from the leachate produced by the indiscriminate disposal of the waste other human activities also contributed to the trace metal pollution load experienced in the studied village road surface water sources. The study also revealed that trace metal such as lead, mercury, Cadmium present in the village water sample have no significant health benefit in the study water sample. Ahmad *et al*. (2016) reported that lead, Mercury and Cadmium present in the studied water sample can accumulate overtimes leading to the destruction of the liver, kidney in humans. Lead as reported by Aisien *et al*. (2012) when exceeded the permissible limits may also contribute to severe cardiovascular and neurological problems in humans. Cadmium a known toxicant also can accumulate in human bones leading to severe bone disorder and malfunctioning. According to Akan *et al*. (2013), Mercury just like other trace metals often leads to brain damage. Capable of also causing severe genetic disorder in human.

CONCLUSIONS

In view of the results obtained, it is seen that the surface water sample within the Uyo village road area is not suitable for human consumption in view of the level of trace metal concentration reported. The high vehicular traffic coupled with the leachate from waste indiscriminately disposed of has significantly effectedthe surface water quality within the Uyo village road. The outcome of the results also provided and in-depth opportunity for the effective management and control of the pollutants associated with contamination of the surface water in the Uyo village road surface water source.

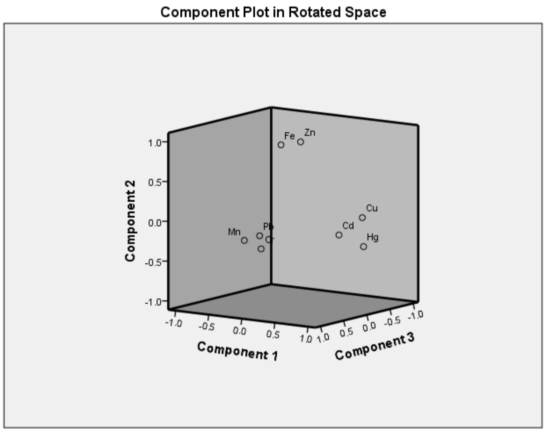

Figure 1: Plot of the Rotated Principal Components of the Trace Metal in the Village Road Surface Water Sample

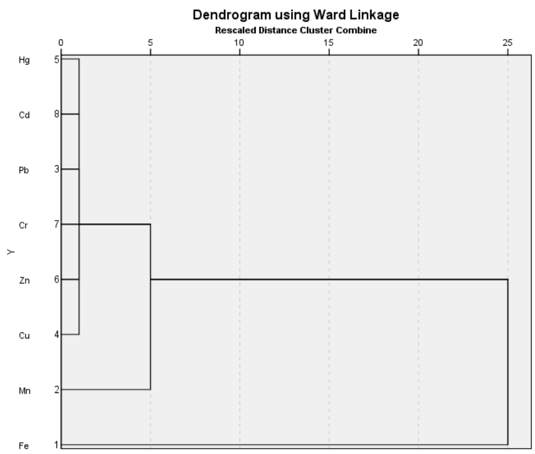

Figure 2: Hierarchical Cluster Analysis of Trace Metals in Village Road Surface Water

REFERENCES

1. *Abidemi, O. O. (2013). Accumulation and contamination of heavy metals in soil and vegetables from industrial area of Ikirun, Osun State, Nigeria Journal of Environmental Management and Applied Sciences, 1(1):234-245.*

2. *Achike, A. I., Oneja, A. O., and Adu, C. (2010). Greenhouse gas emission determinants in Nigeria. Implication for trade, climate change mitigations and adaptation: 13.*

3. *Udousoro, I., & Umoren, I. (2014). Assessment of surface and ground water quality of Uruan in Akwa Ibom State of Nigeria. Assessment, 4(6).*

4. *Adedosu, H. O., Adewuiyi, G. O. and Adie, G. U. (2013). Assessment of heavy metals in soil, leachate and underground water samples collected from the vicinity of Olugosun, landfill in Ojota, Lagos, Nigerian, Journal of Science and Technology,3(6):23-35.*
5. *Adegoke, J. A., Agbje, W. B. and Issac, O. O. (2009). Evaluation of heavy metal status of water and soil at Ikogosi warm spring, Ondo State, Nigeria, Journal of Environmental Studies and Management,2(3).:1-8.*
6. *Adekoya, J.A. (1995). Negative environmental impact of mineral Exploration in Nigeria. Impact of human activities on the West African Savanna. Proceedings of the Regional Training Workshop held at Federal University of Technology, Akure, Niferia.2(1):314.*
7. *Adelana, S. O., Adeosun, T. A., Adesina, A. O. and Ojuroye, M. O. (2011). Environmental pollution and remediation: challenges and management of oil spillage in the Nigerian coastal areas, American Journal of Scientific and Industrial Research,2(6).:346-256.*
8. *Adelekan,B.A. and Abegunde,K.D.(2011).Heavy metals contamination of soil and groundwater at automobile mechanic villages in Ibadan,Nigeria,International Journal of the Physical Sciences, 6 (5): 1045-1058.*
9. *Adetoro, V.A., Aduloju, S.C.,Udeme,E.,Dory, P.N.andAdeniyi,A.(2015).Characterization of Nigerian crude oil using ASTM D86 test method for design of mine refinery, International of Journal of Scientific Research and Engineering Studies,4(5): 1-5.*
10. *Adewiuyi, G. O. and Olowu, R. A. (2012). Assessment of oil and grease, total petroleum in surface and groundwater within the vicinity of Nigerian National Petroleum Oil Depot in Apata, Ibadan Metropolis, Nigeria, International Journal of Toxicology and Environmental Management, 4(6): 1-18*
11. *Adewuyi,A and Oluwa,T.(2013). Effect of crude oil exploration in the soil of Niger-Delta South-South region,Nigeria, Journal of Environmental Management,7(4):25-27.*
12. *Aghalina, S. O. and Eyinla, B. (2009). Oil exploration and marine pollution evidence from the Niger Delta Nigeria, Journal of Human Ecology, 28(3):177-182.*
13. *Ahaneku, I. E. and Sadiq, B. O. (2014). Assessment of heavy metals in Nigerian agricultural soils, Poland Journal of Environmental Studies,23 (4): 23-35.*
14. *Ahinnor, I. J., Ogukwe, C. E. and Nwagbo, N. C. (2014). Characteristic level of total hydrocarbon in soil and groundwater of oil impacted area in the Niger Delta region, Nigeria, Journal of Environmental and Earth Science,4(23): 1-7.*
15. *Ahmad, H., Tsafe, A.I.,Zuru.A.A.,Shehu,R,A.,Atiku,F.A.andItodo,A.U.(2016).Physico-chemical and heavy metals values of Nigerian crude oil samples, International Journal of Environmental and Apllied Sciences,6(11):10-15.*
16. *Aisien, E.T., Gbegbaje, E., and Asien, F. A. (2012). Water quality assessment of rive Ethiope in the Niger Delta coast of Nigeria, Journal of Environmental Agriculture and Food Chemistry,9(11):1-18.*

17. *Akan, J. C., Kolo, B.G., Yikala, B.S., Ogugbuaja,V.O.(2013). Determination of some heavy metals in vegetable samples from Biu Local Government Area, Borno State, North Eastern Nigeria, International Journal of Environmental Monitoring and Analysis, 1 (2): 40-46.*
18. *Akpan, I.O.(2005). Effects of sample treatment on trace metals determination of Nigerian crude oils by atomic absorption spectroscopy (Ass). technique. African Journal of Environmental Pollution and Health 4(2): 34-45.*
19. *Chinenyeze, M.A.J. and Ekene, U.R. (2015). Seismic-based environmental effects of petroleum exploration activities in parts of tropical forest areas of Nigeria, International Journal of Scientific Engineering and Research 5(7):21-23.*
20. *Hong, A.I., Laro, P.L., Selamlu, O.S. (2014). Environmental burden of heavy metal concentration levels in soil from sewage irrigation area of Geryo Catchment, Nigeria, Journal of Civil and Environmental Rsearch,6(10): 1-8*

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