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HUMAN ACTIVITIES AND HEAVY METAL CONCENTRATIONS IN ABA RIVER, ABIA STATE, NIGERIA

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ABSTRACT: *Water samples were collected from seven different locations along the Aba River close to various human, industrial, commercial and domestic activities. The heavy metals were analyzed using the Atomic Absorption Spectrometer (AAS). The result revealed that the concentration of some heavy metals like Iron, Copper, Manganese and Chromium are above the WHO and FMEnv Standard limits for surface water. These high values could be attributed to indiscriminate disposal of wastes into the river. The various parameters of the water samples from the control site (Okpu-Umuobu) were significantly different from those of locations close to the major industrial/commercial activities. This confirms the impact of human activities on the quality of the Aba River. The impacts of dredging and sand mining in and along the river bank were obvious. These activities have an adverse effect on the environment and ecology, speeding up flow and potentially increasing the risk of flooding downstream. This also has the potential to damage ecology by directly affecting its physical habitat, disrupting riverine processes and reduced connectivity with the floodplain. It is therefore recommended that effluent treatment plants be installed to treat waste generated before they are discharged into the stream as well as regular monitoring of the River should be encouraged by the regulatory bodies.*

KEYWORDS: Anthropogenic Activities, Heavy Metals, Dredging, Pollution, Effluents, Aba River

INTRODUCTION

The Aba River is a tributary of Imo River and it is the major river that passes through Aba town. Fig.1 is a map showing the various towns through which the river passes and the seven sampling points along the river course. The coordinate of the study area lies within latitudes $5^0$2'30''N to $5^0$10'00" of the equator and Longitude $7^0$20'0'' to $7^0$25'0''E of the Greenwich Meridian. The study area is characterized by relatively low elevation and near flat and low-lying topography (Uma, 1989) which enhances its runoff. The low-lying plain is the inland extension of the Coastal Plain from the Bight of Benin (Amadi & Nwankwoala, 2013). Aba River is a tributary of Imo River that passes through Aba Town (Fig.2). The River flows in the North-South direction towards the Atlantic Ocean.

The area is endowed with natural springs and streams including Imo River on the western flank which flow in a southerly direction and empty into the Atlantic Ocean. The study covers all parts of the Local Government Area where World Bank Housing Estate, Industrial/ Technology Village, Cattle market, Electricity Sub- station and River Basin Development Area are planned / situated. The resulting increase in population will greatly stress the groundwater resources and consequently requires special management and protection.

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The term heavy metal refers to metallic chemical elements that have relatively high density, toxic or poisonous at low concentration values. They are natural components of the Earth's crust that cannot be degraded or destroyed, which would mainly include the transition metals, some metalloids, lanthanides and actinides. Examples include copper, zinc, selenium, iron, lead, mercury, cadmium and silver etc. heavy metals are also classified based on density, atomic weight, chemical toxicity in relation to living organisms. Heavy metals can cause serious health effect with different symptoms depending on the nature and quality of the metal ingested (Njiiar *et al*., 2012).

The enrichment of heavy metals in Aba River has been reported by Ezeronye and Ubalua, (2004). Process water from the cosmetic, detergents and textile industries located near the river contains large amounts of heavy metals, which when in super abundance may cause disruption to the ecological balance of the river (Pickering, 1980). However, the rush by African countries to industrialize has resulted in discharge of partially treated or raw wastes into the surrounding bodies of water since the development of treatment facilities cannot keep pace with the rate at which the wastes are generated by the industries (Nwachukwu, *et al.*, 1989).

Industrial effluents have potentials to contaminate the water bodies into which they are discharged. Several industries and commercial activities located along or close to the Aba River discharge their effluents into the river which is a source of water supply for various human activities. This has serious human health implications and it is therefore important to ascertain the various ways in which human activities have impacted on the water quality of the Aba River.

Aba River is of economic importance in Abia-State, Nigeria. The industrial effluents resulting from the area have potentials to contaminate the water bodies into which they are discharged. Several industries and commercial activities located along or close to the Aba River discharge their effluents into the River which is a source of water supply for various human activities. This has serious human health implications.

Amadi (2012) carried a study on quality assessment of Aba River using heavy metal pollution index in which the degree of heavy metal contamination of Aba River was assessed. The metals exhibited a good linear correlation coefficient and the application of factor analysis on the data revealed three sources of pollution arising from the various human activities taking place along the river channel such as Anthropogenic activities, discharge of untreated industrial effluent and laundry waste that take place along the river course are the likely sources of the heavy metals in the river. Determination and assessment of heavy metal content in fish and shellfish in Aba River, Abia State, Nigeria was studied by Ubalua *et al*., (2007). The result of the study showed high levels of lead in Aba river fish could be traced to urban and industrial wastes, leaded-petrol and expired motor batteries commonly dumped by battery chargers around their workshops located near the river. Waste management in urban and industrial centers in Nigeria, especially around the city of Aba, has remained very unsatisfactory to-date and it can be concluded that this poses a health hazard to both aquatic life and humans alike. The pollution estimates of the Rivers Nworie, Otamiri, Imo, Aba and Mbaa were studied (Obodo, 2002).

Umunnakwe *et al*., (2013) carried out a research work on the influence of industrial and abattoir wastes on some physicochemical and bacteriological variables of Aba River, southeastern Nigeria and the study showed that the abattoir station is slightly acidic (pH = 5.9) showing organic pollution and elevated values of coliform indicate faecal contamination. Ezeronye and

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Ubalua (2005) also carried out Studies on the effect of abattoir and industrial effluents on the heavy metals and microbial quality of Aba River in Nigeria.

Fig.1 Map of Nigeria with an arrow showing the study area

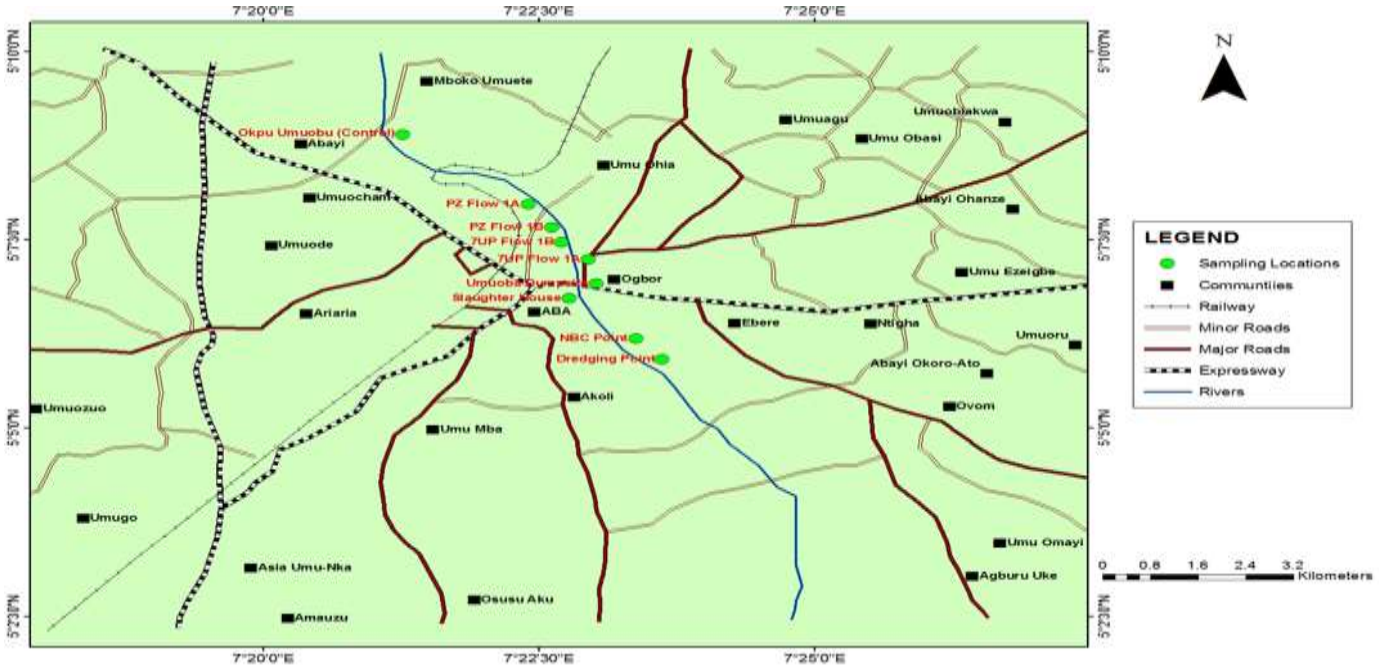

Fig. 2: Map of Aba and its environs showing the sampling points

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Methods of Study

A total of seven sampling locations were selected for the study and the areas covered under this study are: Okpu-Umuobo in Eziama community which serve as a control point, Paterson Zochonis discharge point, 7Up bottling Company discharge point, Slaughther House (Under Ogbor Hill Bridge), Dredging site at (Ovom Umuope Ehere Ogbor-Hill Aba) and a waste dump site at Omoba Junction. The sample points are shown on the location map in Fig.2**.** Samples were collected at depth 0.3m and stored in sterilized sample bottles and the containers were filled to the brim and corked immediately to avoid contact with air. Each of the sample bottles were labeled correctly in the field to regulate the temperature of these samples and were stored in a cooler containing ice. Within twenty four hours, the samples were taken to the laboratory for analysis to minimize variation of the parameters from the actual field values. A GPS was used to take the coordinates of the various sampling points and snap shots of photographs were also taken in the field.

The following heavy metals: Fe, Zn, Mn, Cr, K, Pb and Cu were analyzed using the Atomic Absorption Spectrometer (AAS) as described in APHA 3111-B and ASTM D3651. This involved direct aspiration of sample into an air/ acetylene or nitrous oxide/acetylene flame generated by a hollow cathode lamp at a specific wavelength peculiar only to metal programmed for analysis. For every metal investigation before sample were aspirated and concentrated at specific absorbance displayed on the data system monitor for printing.

RESULTS AND DISCUSSION

Table 1: Results of the heavy metal parameters in the Aba River

SAMPLE IDENTITY	GPS CORDINATES	Fe (mg/l)	Zn (Mg/L)	Mn (mg/l)	Cr (mg/l)	Pb (mg/l)	Cu (mg/l)	Mg (mg/l)	Ca (mg/l)	$P0_4$ (mg/l)
OKPU-UMU CONTROL	N04^{0}29.620' E007^{0}16.658'	0.20	0.05	0.03	0.01	<0.01	0.62	0.18	1.40	0.10
7UP FLOW	N05^0 07' 16.0" E007^0 22' 52.8"	1.01	0.07	0.50	0.38	0.02	1.41	0.03	3.00	0.20
PZ FLOW	N05^0 07' 34.6" E007^0 22' 32.8"	0.88	0.01	1.80	0.33	0.01	1.82	0.06	3.67	0.20
WASTE POINT UMUOBA	N05^0 06' 56.6" E007^0 22' 52.6"	6.86	6.58	15.08	15.08	0.15	2.76	0.43	0.12	0.00
SLAUGHTER POINT	N05^0 06' 54.8" E007^0 22' 49.0"	3.00	0.01	2.80	0.01	0.01	3.00	0.04	5.60	12.90
NBC	N05^0 06' 00.0 E007^0 23' 20.5	2.15	0.03	0.84	0.35	0.02	2.13	0.04	7.40	0.20

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UMUOPE DREDGING SITE	N05^0 05' 57.5 E007 ^{0}23' 28.8	0.89	3.21	2.30	0.08	0.02	1.24	0.08	6.20	0.30
WHO (2008) STANDARD		0.30	5.00	0.05	0.25	0.05	1.00	30	70.00	5.00
FMEnv STANDARD		1.00	1.00	NL	0.05	0.5	1.50	100	100	3.00

Table 2: Descriptive statistics for the analytical results of water samples

PARAMETERS	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	WHO (2008)	FMenv
Fe (mg/l)	0.200	6.858	2.141	2.111	0.300	1.000
Zn (Mg/L)	0.010	6.580	1.423	2.373	0.500	1.000
Mn (mg/l)	0.030	15.080	3.336	6.175	0.050	NL
Cr (mg/l)	0.010	15.080	2.226	5.249	0.250	0.050
Pb (mg/l)	<0.010	0.150	0.034	0.048	0.050	0.500
Cu (mg/l)	0.620	3.000	1.854	0.785	1.000	1.500
Mg (mg/l)	0.030	0.430	0.123	0.178	3.000	-
Ca (mg/l)	0.120	6.200	3.913	2.444	70.000	NL
$P0_4$ (mg/l)	0.100	12.900	1.986	4.456	0.050	3.000

The water samples analyzed from the seven locations contain chromium in the range of 0.01 to 15.08 mg/l. The values obtained are relatively higher than the WHO and FMEnv limits except at the control point 0.01, 7Up flow point 0.02 and the Slaughter point 0.01 mg/l (Table 1). The graphical distribution of chromium in Fig. 3 displayed waste point location as having the highest spike value of 15.08 mg/l. This value could be attributed to inadequate disposal of wastes. Chromium is used for plating, dyes, leather and pigments. Other sources of chromium entering the environment are air, water erosion of rocks, power plants or liquid fuels, brown and hard coal, industrial and municipal waste Fatoki *et al*., (2002).

Iron and Copper concentrations in the samples analyzed are relatively higher than the limits set by WHO and FMEnv except at the control site (Okpulu-Umuobu). Figure 4 shows a graphical distribution of Iron with the waste point having a sharp rise at the value of 6.58 mg/l. this could be attributed to the dumping of iron scraps. Copper also recorded the highest value 2.36 mg/l at the waste location. This probably could be due to the dumping of electronic gadgets at the location. Copper are also found in pipes which serve as channels through which the waste product from industries are discharged into the river.

The concentrations and distributions of Zinc and Manganese in all the samples analyzed are shown in Table 1. The values of Zinc are within the permissible limit of 5 mg/l (WHO) and 1.0 mg/l (FMEnv) except at the waste point in which the value, 6.58 mg/l exceeded the acceptable

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limits. Manganese exceeded its limit set by WHO 0.05 mg/l except at the control site 0.03 mg/l. The concentrations of Manganese are enhanced by industrial waste disposal, leaching of manganese from dry cell batteries at dump sites. Concentration of Manganese when in excess of 0.2 mg/l makes water distasteful to drinking with no specific toxic effect (Nwachukwu *et al.*, 1989). Lead is present in all the locations in a small proportion ranging from <0.01 to 0.15 mg/l that is within the WHO and FMEnv limits except at the waste point. This is clearly shown in Table 1 and Fig 7. Table 2 shows the descriptive statistics for heavy metal analysis of water samples in the study area. Figures 3 – 10 shows the graphical representations of all the heavy metals while Fig.11 shows the distribution of the Mean and Standard Deviation of heavy metals in the water samples in the area.

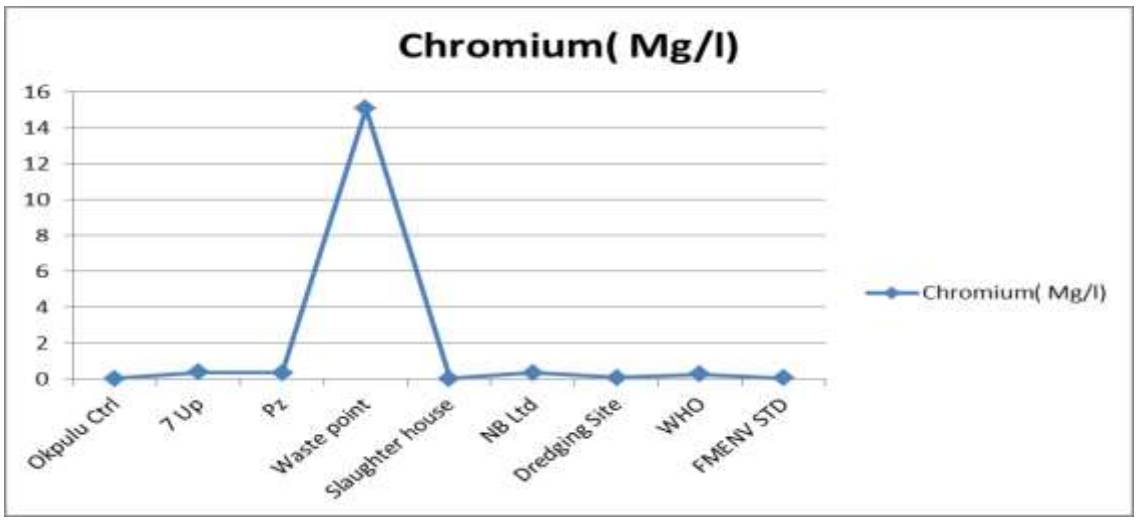

Fig. 3: Distribution of Cr in the water samples

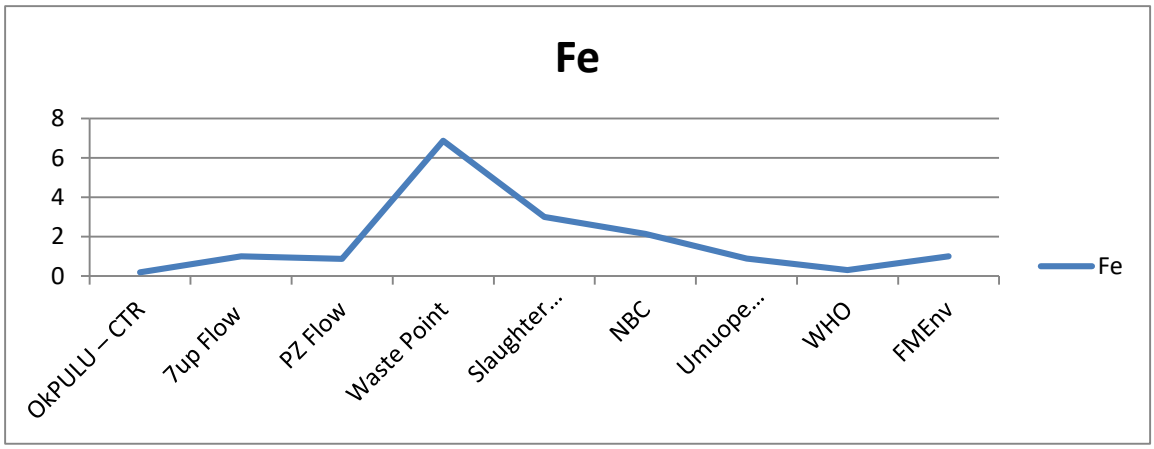

Fig. 4: Distribution of Fe in the water samples

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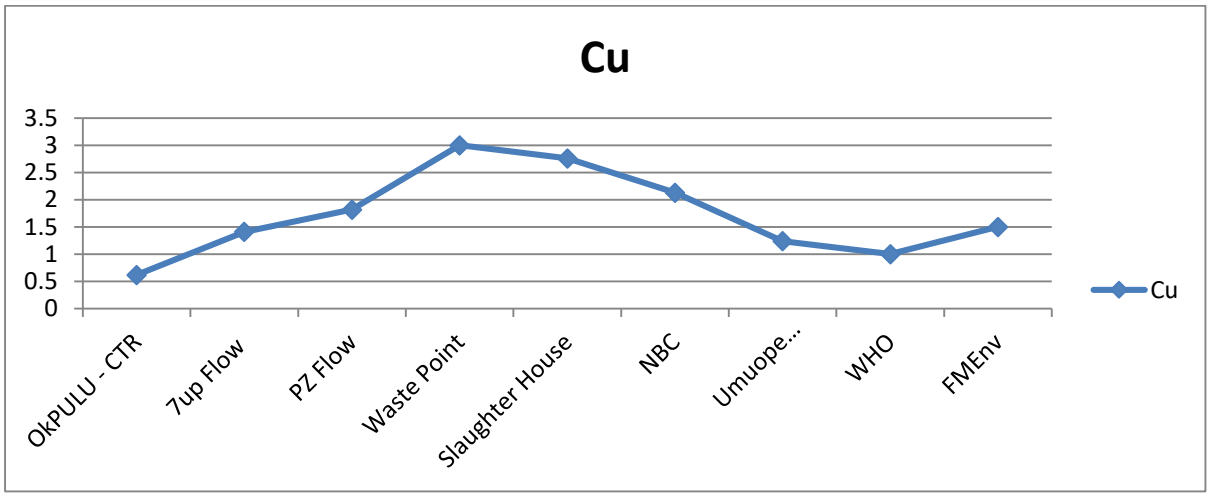

Fig.5: Distribution of Cu in the water sample

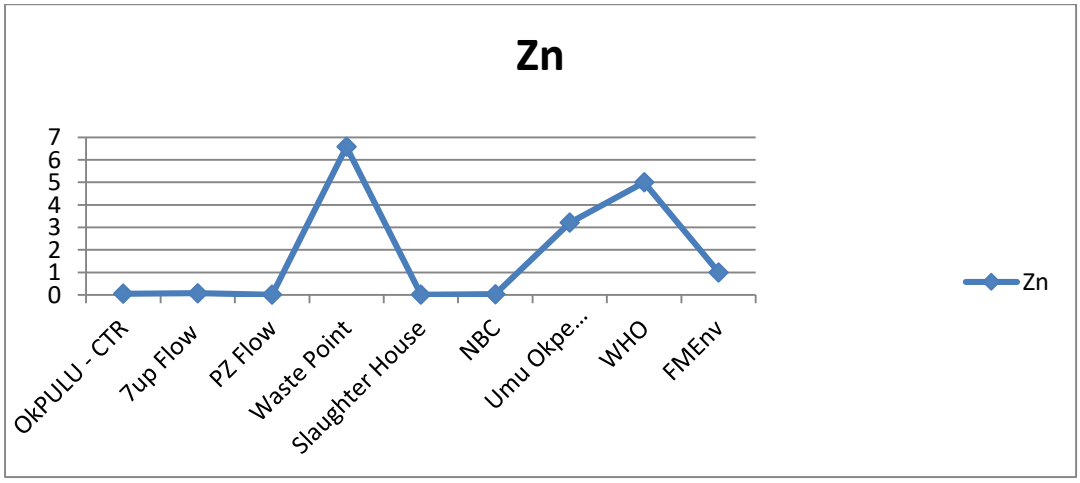

Fig. 6: Distribution of Zn in the water samples

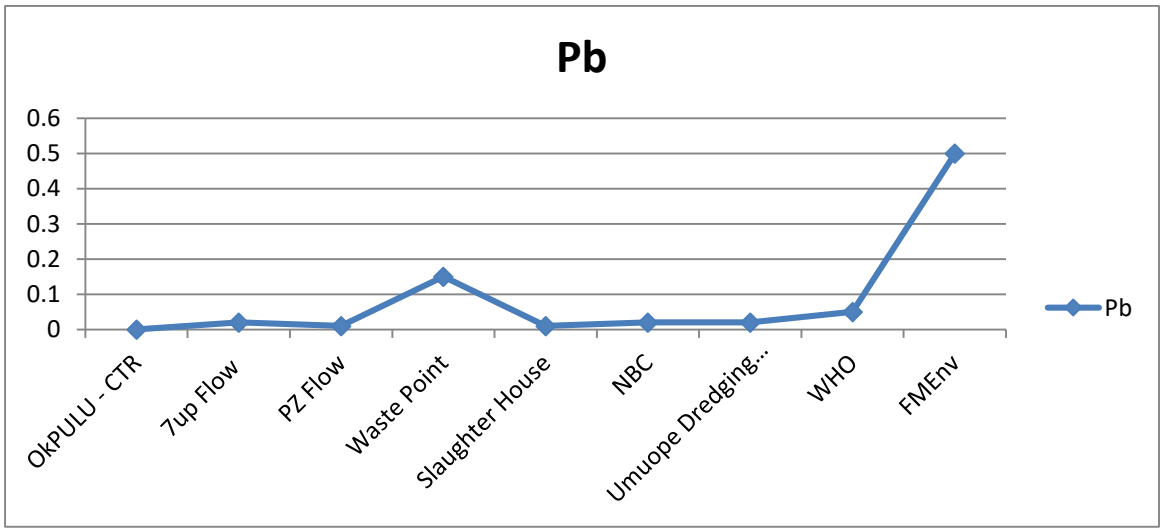

Fig. 7: Distribution of Pb in the water samples

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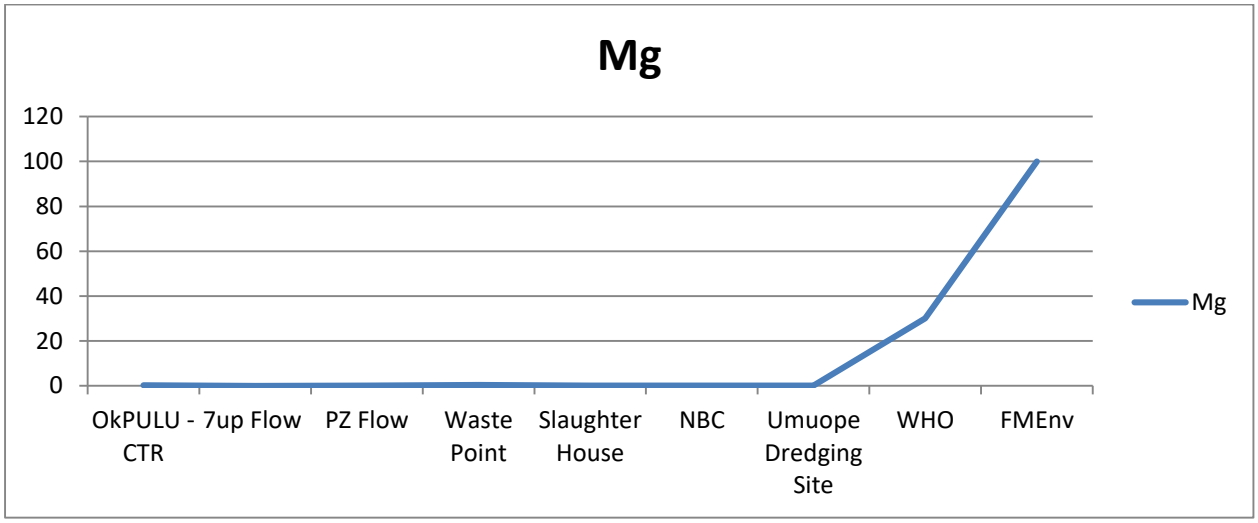

Fig. 8: Distribution of Mg in the water samples

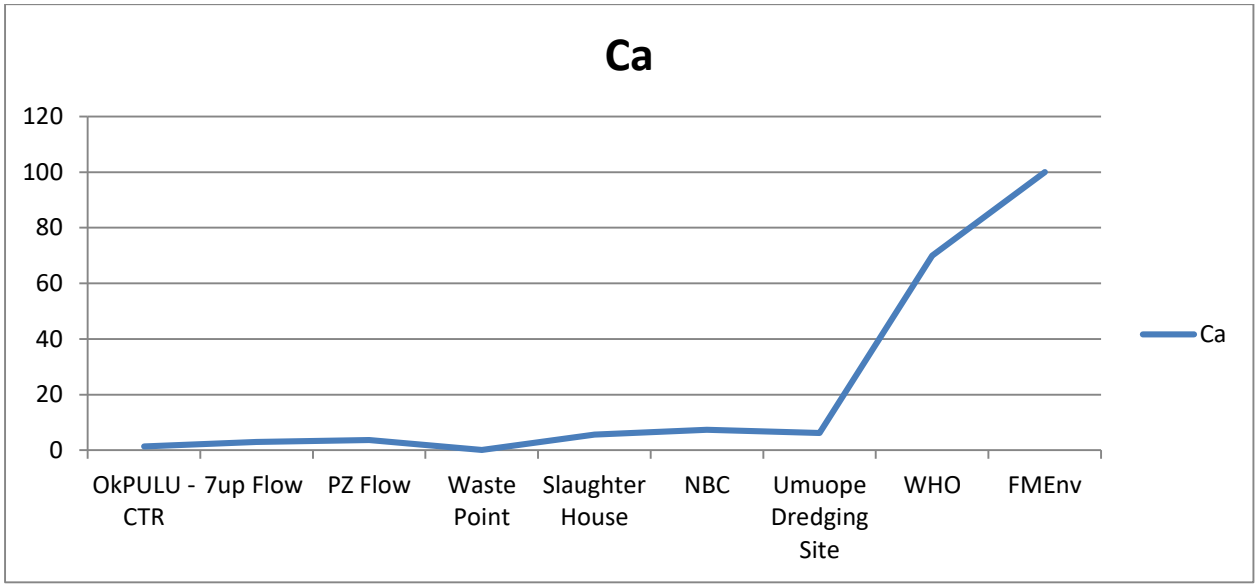

Fig.9: Distribution of Ca in the water samples

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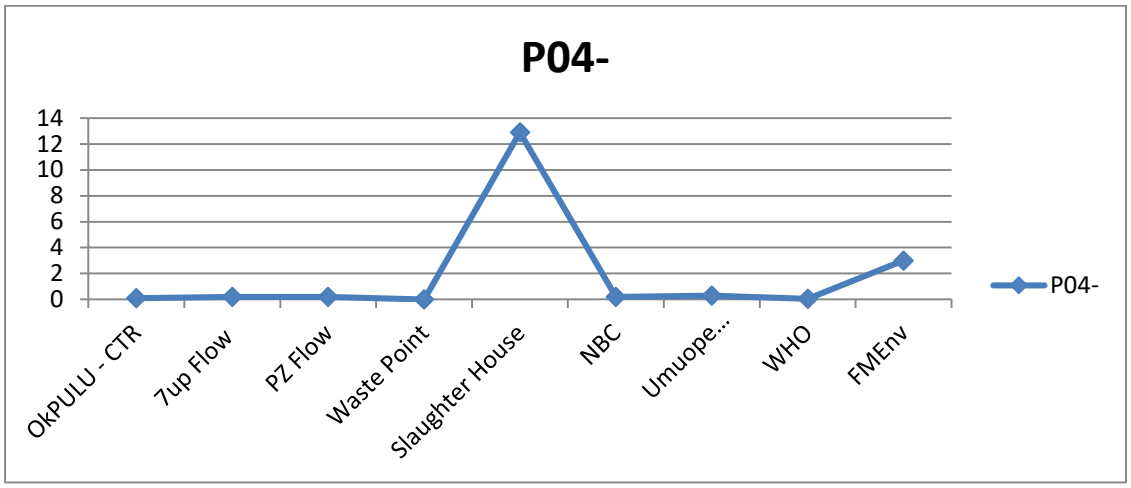

Fig.10: Distribution of $P0_4^{-2}$ in the water samples

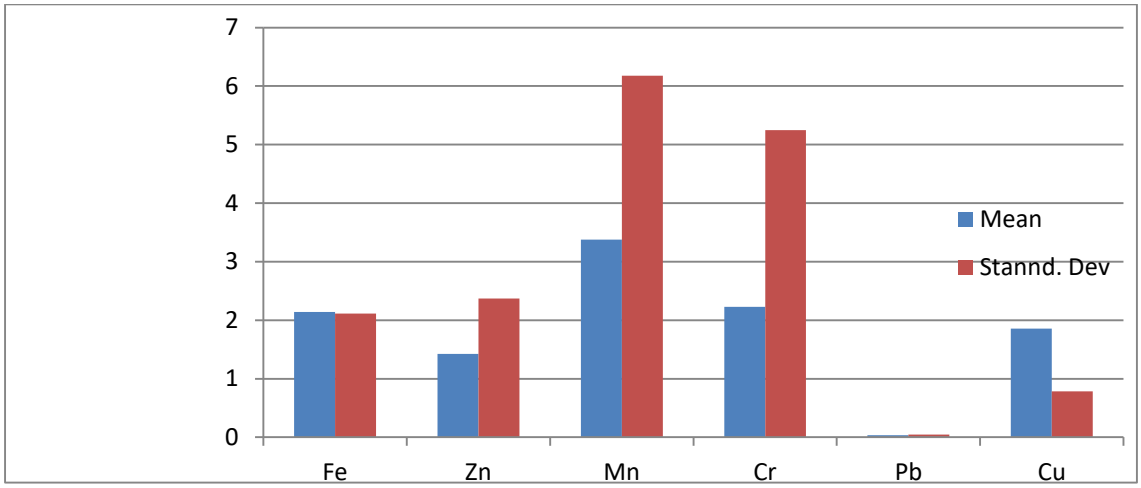

Fig. 11: Distribution of the Mean and Standard Deviation of heavy metals in the water samples

Impact of Dredging of the Aba River

Dredging activities goes on along the river especially at the Umuokpe village area. Plate 1, 2 and 3 shows the impact of dredging and sand mining in and along the river bank. These activities have an adverse effect on the environment and ecology. Dredging could in history speed up flow and potentially increase the risk of flooding downstream. It can also damage ecology by directly affecting its physical habitat, disrupting riverine processes and reduced connectivity with the floodplain. This can result in the deterioration of status. Direct removal of exposed sediments can impact on specialized species which may be protected (invertebrates of exposed riverine sediments).

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Plate 1: Dredging site

Plate 2: Dredging site

Plate 3: Sand mining site

CONCLUSION

The results of this study revealed that the concentrations of heavy metals except Zn and Pb are above the permissible limits of WHO (2008) and FMEnv for drinking water. It was observed that in some of the locations, most of the heavy metals that are within the acceptable limits may record very high values. This is quite evident at the waste point. Although the concentrations of the elements were not too high beyond the acceptable limits but, gradual accumulation of their concentrations can be dangerous to humans and fishes in the river. Total suspended solids (TSS) and Lead (Pb) are indices of the level of water pollution. The dredging activities have immensely impacted negatively on the surface water by the colour change, disruption of the ecological balance, and the vulnerability of the banks of the river to landslide (plate 2). All parameters at the control site fall within the WHO and FMEnv acceptable limits. In addition, values are generally lower were there are no activities going on.

Using the control site as a standard to ascertain the impacts of human activities along the Aba River, it is evident based on the high concentration Fe, Mn, Mn, Cr, and Cu that the Aba River is polluted due to the negative impacts of anthropogenic activities going on in the river. It is recommended that effluent treatment plants be installed to treat waste generated before they are discharged into the stream. More so, processing plants should have oil separator to remove oil from their effluents. This was evident at PZ discharge effluents which were covered with oil. Improved sanitation should also be encouraged as open dumps along the river banks must be discouraged.

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