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IMPACT OF SURFACE RUN-OFF ON IKPA RIVER IN AKWA IBOM STATE

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ABSTRACT

Impact of surface run-off on Ikpa River has been studied. The surface run-off contains toxic chemicals, heavy metals and suspended solids. Water samples were collected from four discharged points in the month of July – the peak of rainy season and November for the dry season. The samples were subjected to physiochemical and microbial analysis at Akwa Ibom State Water Company Limited. The result of the analysis of the samples show the concentration level of iron, selenium, chromium, cadmium, cyanide, lead and barium as (0.7mg/l; 0.22mg/l, 0.117mg/l, 0.16mg/l, 0.04mg/l; 24.7mg/l respectively in the mid-stream (MS) and 0.68mg/l, 0.22mg/l, 0.10mg/l, 0.015mg/l, 0.05mg/l, 0.042mg/l, 23.4mg/l respectively in the down-stream (DS). The concentration levels exceeded PFPA/WHO and NSDWQ permissible level for drinking water. In addition, the water quality of the up-stream (US) location of the river shows lower level of the concentration of the heavy metals probably due to lesser product of human activities. The presence of this pollution in water is hazardous to health. Ballasted flocculation technology and baffling mechanism techniques can be used to further reduce the concentration level of these pollutants.

Keywords: Ikpa River, surface run-off, down stream concentration, mid and up-stream, ballasted flocculation technology.

1 INTRODUCTION

Before the advent of science and technology, our environment, particularly water environment was wholesome. Occupational and recreational activities which included fishing, boating etc, took place in some Nigerian rivers and streams. In the domestic, manufacturing and agricultural sectors, water is the most essential import. Occupationally, river water could help to fashion out a finishing career for people with a view of generating revenue to improve their economic wellbeing.

But with the development of science and technology, various types of wastes are generated in the solid, liquid and gaseous phases. Most of the wastes, especially the solid ones, are carried to our rivers and streams through surface run-off which contributed a major pollution, comprising 90% of heavy metals (Pb, Fe, Cd, CN, Cr), in River Galveston in USA (Nwagozie and Ogele, 1996). It has been observed that heavy metals in wastewaters are extremely toxic to biological degradation of wastes (Enyioma, 1989). At high temperature and low pH, heavy metals can cause stunted growth and death of most marine organisms. Human beings can also be affected by drinking water polluted by heavy metals and eating marine organisms bio-accumulated with heavy metals. The amount of heavy metal beyond a required limit in human system could lead to cancer, nervous disorders, lack of bladder control etc (Harmmer and Harmmer Jr., 1996).

The objectives of studying the impact of surface run-off on Ikpa River are stated as follows:

1. To identify the heavy metals present in the river.
2. To assess the extent to which the river is polluted by the heavy metals.
3. To determine the effect of the heavy metals on the human health and on the life of aquatic organisms.
4. To determine the degree of pollution the river by the discharges from slaughter house at Iba Oku.

In Nigeria, motor mechanic work metal finishing workshops, dye centers, car wash centers, etc. contribute to high grease loading, fibrous materials, inorganic salt, organic chemicals and heavy metallic loading of surface run-offs (Enyioma, 1989). Poor quality of water may affect both soil and crops and this can lead to a decrease

in crop yields and possible health hazards to consumers of the produce (Oyedode, 1999). Chapman and Hall (1992) also observed that the health risk is greatest when polluted water sprays directly onto crops rather than flooding around the base of the plants. Most river banks are used for irrigation farming as the case with Ikpa River. The all seasoned vegetable garden at its bank gets its source of water supply from the polluted river water especially during the dry season. The water is usually spread directly on the vegetables with spraying cans and powered hose.

Suspended sediments constitute the largest mass of pollutant loadings to surface waters. Sediments cause an increase in turbidity and decrease in light penetration and resultant impairment of photosynthesis of aquatic plants. It can smother benthic life; impair the respiration of fish and aquatic invertebrates. Sediments can carry significant quantities of nutrients and can significantly decrease recreational values.

Ballasted flocculation technology is a more recent technology applied in the water treatment industry. It requires the use of micro-sand and polymer together in order to increase the weight of the flocs and the rate at which they settle. The use of ballasted flocculation technology ensures 90% phosphorus and heavy metal removal (Dianous and Dernaucourt, 1985).

Baffling Mechanisms Rivers are the mechanisms that can be used for restoring rivers and streams that have already been polluted. It involve some restoration techniques that can be applied in order to control the pollution and improve the water quality and provide an environment conducive for habitation of fishes and other aquatic organisms. Examples of baffling mechanisms are cross-vane and other related structures, and engineered log jams. Other things that cause the pollution in the river are bacteria, pesticides, hydrocarbons and vehicle by-products.

2 THE STUDY AREA

Ikpa River flows across three Local Government Area – Itu, Uyo and Uruan Local Government areas in Akwa Ibom State, starting from Nung Udoe Itak in the East, through Uyo to Use Offot in the West before joining the lower Cross River beyond Nwaniba. It is located on latitude 07°48^{1}30”N and longitude 06°12^{1}25”E. The greater part of the river basin falls under Uyo Capital Development Authority. Poorly disposed wastes from these sources are conveyed by surface run-off to the river through a network of urban drains, thereby giving rise to the pollution of the river.

3 MATERIALS AND METHODS

3.1 Sample Frame of the Study

From the study area, samples were collected from storm drains at Itam Junction/Ikot Ekpene Road, Abak Road/Aka Road, Oron Road/Nwaniba Road for the month of July, a period of pronounced rainfall. Samples of waste water were also collected from the slaughter house at Iba Oku discharge points.

In addition, samples from the river were collected from Nung Udoe Itak, Ntak Inyang, along Itam-Itu-Calabar highway and Nwaniba River at Idu, Uruan Local Government Area at a depth of about 1.5m.

3.2 The Research Design

The study is investigated, fact finding and experimental.

3.3 Sample Size and Sampling Procedure

The water samples were subjected to physicochemical and microbial analysis at Akwa Ibom State Water Company Limited using the following methods:

i. Atomic Absorption Spectrophotometer (AAS) for Pb, Cd, Cn and Cr.
ii. DO meter for BOD determination
iii. Portable Hach DR-HL/4 laboratory kit for TDS, pH and conductivity.

3.4 Method of Sample Collection

The samples were collected in three different locations in clean polythene bottles which included:

a. The up-stream (US) representing samples collected from the river at Nung Udoe Itak.
b. Mid-stream (MS) which represents samples collected from the river at Ntak Inyang.
c. The down stream (DS) represents samples from the river at Idu Uruan Local Government Area in the rainy season (July) and another to be taken in dry season in November. All the samples were taken to the laboratory within 24 hours of collection for safe storage and analysis.

4 RESULTS AND DISCUSSIONS

The results of the heavy metals obtained from the storm drain samples collected along Ikot Ekpene Road/Itam Junction, Abak Road/Aka Road, Oron Road/Nwaniba Road in the month of July (rainy season) are shown in Fig 1 while the ones obtained at the same position in the month of November, (dry season) are shown in Fig 2.

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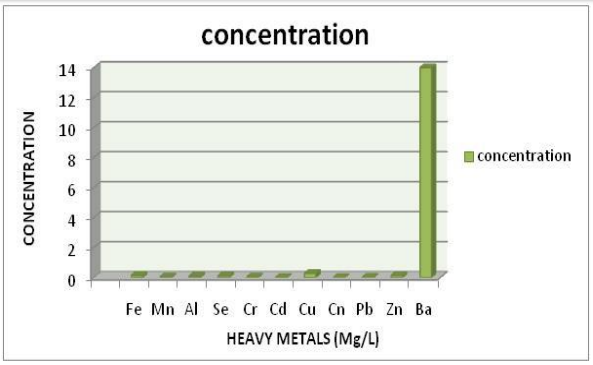
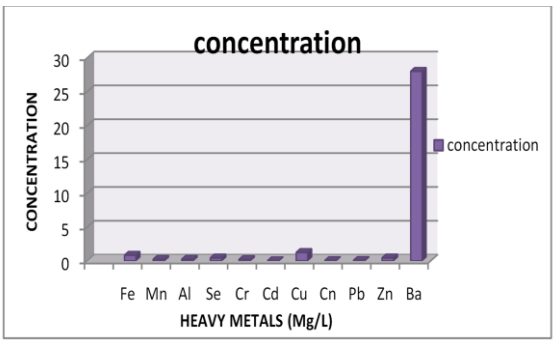
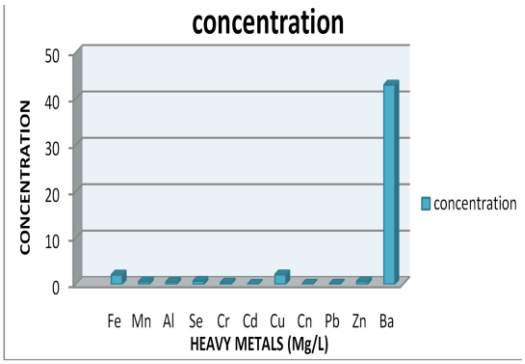


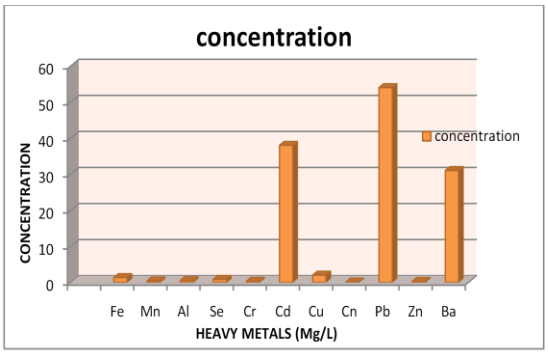
(a) Ikot Ekpene Road/Itam Junction



(b) Nwaniba Road/Oron Road

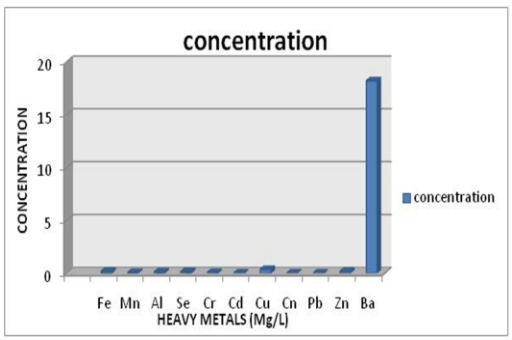


(c) Abak Road / Aka Road

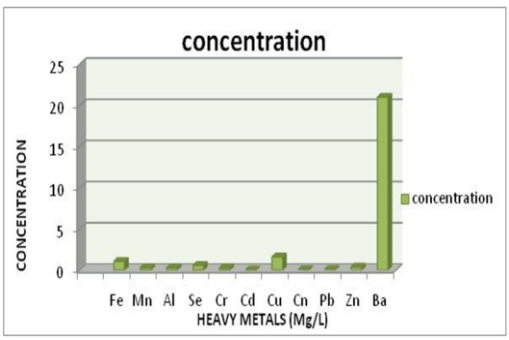


(d) Slaughter House

Fig. 1 (a,b,c,d): SHOWS THE VALUES OF THE HEAVY METALS IN IKOT EKPENE ROAD/ITAM JUNCTION, NWANIBA ROAD/ORON ROAD, ABAK ROAD/AKA ROAD DRAINS AND SLAUGHTER HOUSE IN THE MONTH OF JULY



(a) Ikot Ekpene Road / Itam Junction



(b) Nwaniba Road / Oron Road

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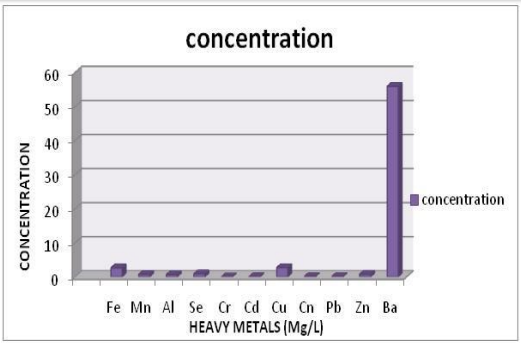
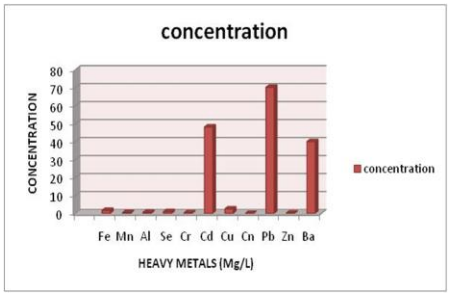


(c) Abak Road/Aka Road



(d) Slaughter House

Fig. 2 (a,b,c,d): SHOWS THE VALUES OF THE HEAVY METALS IN IKOT EKPENE ROAD/ITAM JUNCTION, NWANIBA ROAD/ORON ROAD, ABAK ROAD/AKA ROAD DRAINS AND SLAUGHTER HOUSE IN THE MONTH OF NOVEMBER

The results of sample from the slaughter house at Iba Oku discharge point is presented in Table 1, while the results from the river samples are shown in Table 2.

Table 1: HEAVY METALS PRESENT IN SLAUGHTER HOUSE DISCHARGED SAMPLES

Heavy metals	**November**	**July**
Units	**mg/l**	**mg/l**
Iron (Fe)	1.71	1.32
Manganese (Mn)	0.487	0.375
Magnesium (Mg)	166.4	128.0
Aluminum (Al)	0.61	0.47
Selenium (Se)	1.04	0.80
Chromium (Cr)	0.36	0.28
Cadmium (Cd)	48.1	37
Copper (Cu)	2.58	1.99
Cyanide (CN)	0.083	0.064
Lead (Pb)	70.2	54
Zinc (Zn)	0.29	0.23
Barium (Ba)	40.3	31

Table 2: CONCENTRATION OF HEAVY METALS IN THE RIVER

Heavy Metals	**November**			**July**		
	(US) mg/l	(MS) mg/l	(DS) mg/l	(US) mg/l	(MS) mg/l	(DS) mg/l
Iron (Fe)	0.19	0.7	0.68	0.15	0.54	0.53
Manganese (Mn)	0.037	0.172	0.171	0.029	0.133	0.132
Magnesium (Mg)	132.6	325	291.2	102	250	224
Aluminum (Al)	0.00	0.22	0.19	0.00	0.17	0.15
Selenium (Se)	0.013	0.22	0.27	0.01	0.17	0.21
Chromium (Cr)	0.13	0.117	0.10	0.01	0.09	0.08
Cadmium (Cd)	0.001	0.016	0.015	0.001	0.018	0.012
Copper (Cu)	BD	0.741	1.130	BD	0.57	0.87
Cyanide (CN)	0.005	0.040	0.05	0.004	0.031	0.04
Lead (Pb)	0.005	0.049	0.042	0.004	0.038	0.033
Zinc (Zn)	0.05	0.23	0.32	0.04	0.18	0.25
Barium (Ba)	3.9	247	23.4	3	19	18

US = Up stream of sampling point
MS = Mid stream of sampling point
DS = Down stream of sampling point

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BD = Below Detection

The results show that the values of the heavy metals, Fe, Mn, Alg, Al, Se, Cr, Cd, Cu, CN, Pb, Zn, Ba present in the slaughter house discharge sample in the month of November were Fe (1.71mg/l), Mn (0.487mg/l), Mg (166.4mg/l), Al (0.61mg/l), Se (1.04mg/l), Cr (0.36mg/l), Cd (48.1mg/l), Cu (2.58mg/l), CN (0.083mg/l), Pb (70.20mg/l), Zn (0.29mg/l), Ba (40.3mg/l) while the values obtained in July were Fe (1.32mg/l), Mn (0.375mg/l), Mg (128mg/l), Al (0.47mg/l), Se (0.80mg/l), Cr (0.29mg/l), Cd (37mg/l), Cu (1.99mg/l), CN (0.064mg/l), Pb (54mg/l), Zn (0.23mg/l), Ba (31mg/l), Offiong and Edet (1988)

The results from the storm drain samples show appreciable values of the heavy metals along Ikot Ekpene Road/Itam junction in the month of November as Fe (0.18mg/l), Mn (0.54mg/l), Mg (109.2mg/l), Al (0.11mg/l), Se (0.14mg/l), Cr (0.05mg/l), Ca (0.06mg/l), Cu (0.36mg/l), CN (0.007mg/l), Pb (0.018mg/l), Zn (0.16mg/l), Ba (18.2mg/l) while the values obtained in July were Fe (0.14mg/l), Mn (0.042mg/l), Mg (84mg/l), Al (0.09mg/l), Se (0.11mg/l), Cr (0.04mg/l), Cd (0.005mg/l), Cu (0.28mg/l), CN (0.006mg/l), Pb (0.014mg/l), Zn (0.13mg/l) Ba (14mg/l).

The heavy metals present in the storm drain samples obtained along Nwaniba/Oron road in the month of November were Fe (1.07mg/l), Mn (0.286mg/l), Mg (BD) Al (0.29mg/l), Se (0.57mg/l), Cr (0.26mg/l), Cd (0.029mg/l), Cu (1.61mg/l), CN (0.057mg/l), Pb (0.084mg/l), Zn (0.37mg/l), Ba (21mg/l), while in July the result were Fe (0.83mg/l), Mn (0.22mg/l), Mg (BD), Al (0.23mg/l), Se (0.44mg/l), Cr (0.20mg/l), Cd (0.023mg/l), Cu (1.24mg/l), CN (0.044mg/l), Pb (0.065mg/l) Zn (0.44mg/l), Ba (28mg/l), Udom and Others (1998).

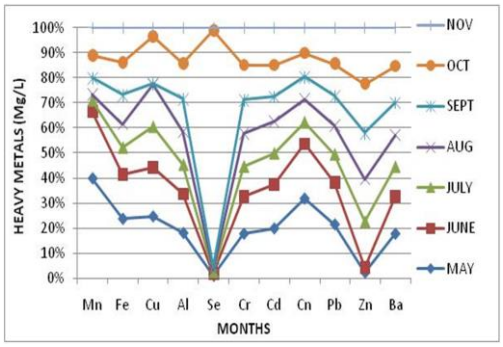
Heavy metal present in the storm drain sample obtained along Abak road/Aka road in the mouth of November were Fe (2.65mg/l), Mn (0.712mg/l), Mg (BD), Al (0.62mg/l), Se (0.89mg/l), Cr (0.04mg/l), Cd (0.05mg/l), Cu (2.71mg/l), CN (0.096mg/l), Pb (0.115mg/l), Zn (0.75mg/l), Ba (55.9mg/l). While in July the result obtained were Fe (2.04mg/l), Mn (0.548mg/l), Mg (BD), Al (0.48mg/l), Se (0.69mg/l), Cr (0.31mg/l), Cd (0.042mg/l) Cu (2.09mg/l), CN (0.074mg/l), Pb (0.089mg/l) Zn (0.58mg/l) and Ba (43mg/l).

From the estimated monthly variation of the concentration levels of these parameters, the month of May recorded the highest level of heavy metal concentration decreases as rainfall persists into the rainy season. The high level concentration in the month of May can be attributed to the fact that the appreciable amount of waste accumulated at different source locations during the dry season (November – April) was washed into the river in the first approach of the heavy rains in the month of May.

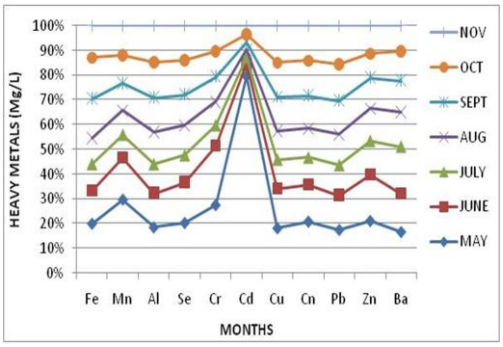
The waste loads of the subsequent run-off are low, meaning that there is a decrease in concentration of the heavy metals in the storm drains with time as displayed in Fig 3.

In the case of the receiving water body, the results of the heavy metals at the three sample points (US, MS, DS) were subjected to distance variation analysis. It is observed from Fig 4 that the values of heavy metals at the mid-stream (MS) is highest followed by down stream (DS) and lastly the up-stream (US).

An explanation to this is that all the discharge points of storm drain including slaughter house discharge point are located in the mid-stream.



(a) Ikot Ekpene Road / Itam Junction



(b) Nwaniba Road / Oron Road

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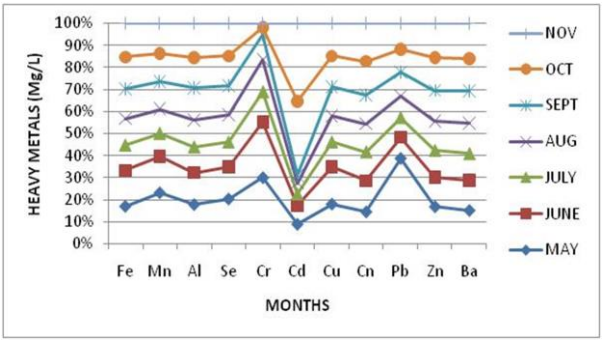
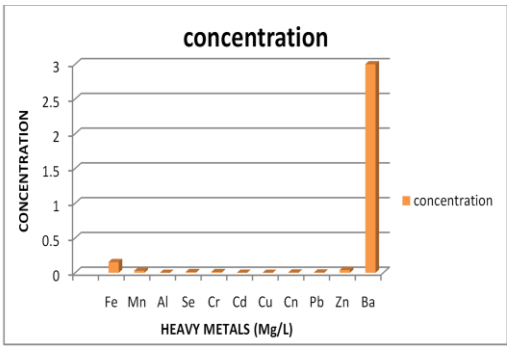
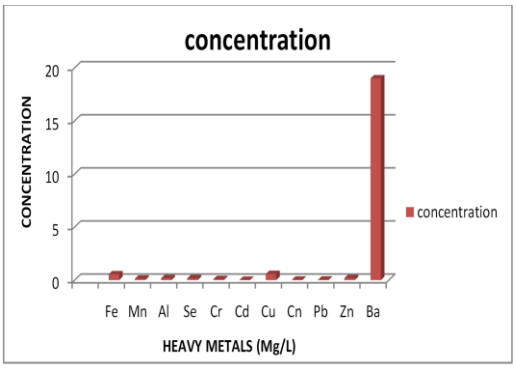


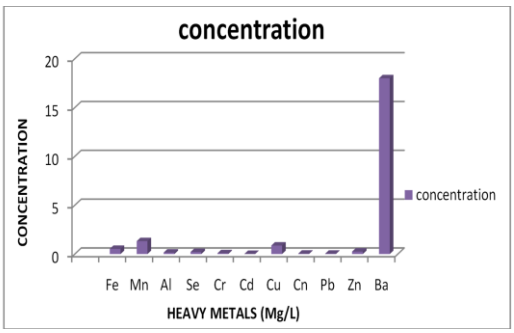
(c) Abak Road / Aka Road

Fig. 3 (a,b,c): SHOWS THE MONTHLY VARIATION OF HEAVY METALS IN DRAINS ALONG IKOT EKPENE ROAD/ITAM JUNCTION, NWANIBA ROAD/ORON ROAD, ABAK ROAD/AKA ROAD

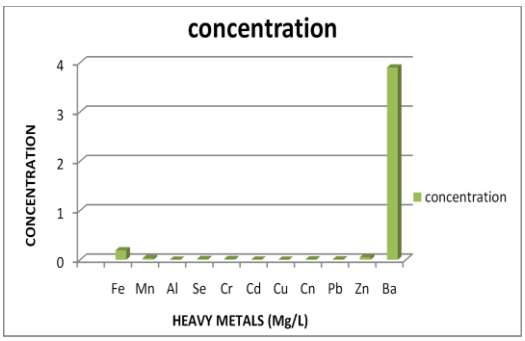




(b) Mid- Stream (Ms)



(c) Down - Stream (Ds)
For the month of July



(d) Up- Stream (Us)
For the month of November

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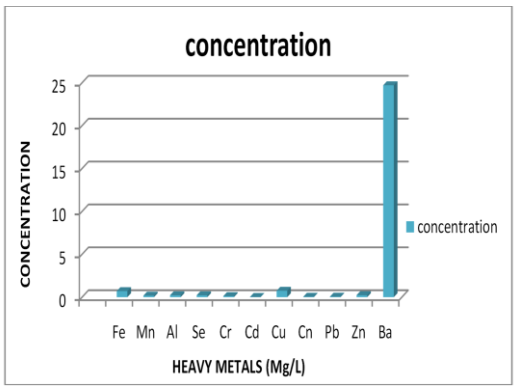
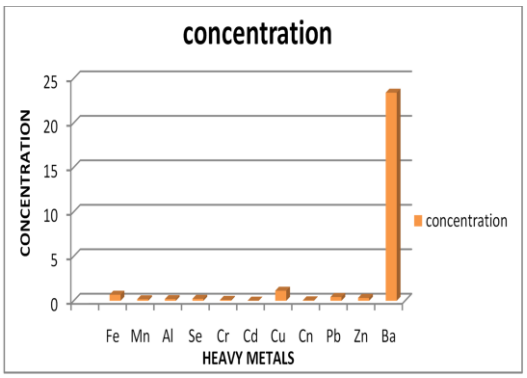


(e) Mid- Stream (Ms)



(f) Down-Stream (Ds)

Fig. 4 (a, b, c, d, e and f): SHOWS THE PICTORIAL REPRESENTATION OF HEAVY METALS ANALYSIS OF IKPA RIVER IN THE MONTH OF JULY AND NOVEMBER

The dilution effect of the river due to mixing explains the decrease in values of the heavy metals at the down stream (DS), Dianous and Demaucourt (1985).

At the up-stream area, concentration levels of the heavy metals are lowest. This shows that human activity which provides the bulk of pollution at the up stream contains negligible amount of heavy metals, Chapman and Hull (1992).

The dilution effect of rainfall on the degree of contamination of Ikpa-river is glaring in the analysis carried out for the month of July (peak of rainy season) and November (beginning of dry season), Dianous and Demaucourt (1985).

In comparison, the concentration levels of the heavy metals in the month of November are a little higher than that of July as in Table 3.

Table 3: FEPA/WHO MAXIMUM PERMISSIBLE LEVELS OF SOME HEAVY METALS IN DRINKING WATER

Heavy Metals	Maximum Permissible Levels (mg/l) FEPA/WHO (1991)
Fe	1.0
Mn	0.5
Cr	0.05
Cd	0.01
Cu	0.5
Pb	0.05
Zn	5
Ni	0.02

It is also noted that with the pH values of 6.9 at up-stream (US), 7.163 at mid-stream (MS), and 7.67 at the down-stream the level of acidity is environmentally healthy for some marine organisms.

The high magnesium hardness of the water makes it unsuitable for use in domestic as well as industrial purposes. Hard water developes corrosion and encrustation in pipes. It consumes more soap and develops scales in boilers and also bad taste.

The biochemical oxygen demand (BOD_5) of the mid-stream (MS), and the down-stream are higher which signified the presence of a large amount of organic pollution at Ntak Inyang and Uruan parts of the river.

Organic pollution in water body reduces the amount of oxygen in the water thus endangering the life of fishes and other aquatic organisms.

5 CONCLUSION

The Collection and analysis of samples of surface run-off (storm drains) along Ikot Ekpene Road/Itam junction, Nwaniba/Oron Road, Abak Road/Aka road, and slaughter house discharge point, and the receiving Ikpa River at Nung Udoe Itak, Ntak Inyang and Idu Uruan have been presented.

Based on the results of their analysis, the following conclusion and recommendations can be made;

The degree of pollution from the surface runoff is high but that of the slaughter house discharge is higher due to the presence of heavy metals in appreciated quantity as shown in Table 1&2. Toxicity of the heavy metals present in Ikpa-River is traceable to surface run-off and the slaughter house discharge. The values of the heavy metals such as Fe, Se, Cr, Cd, CN, Pb, Ba at the mid-stream (MS) and the down-stream (DS) have exceeded FEPA/WHO permissible limits and Nigerian Standard for Drinking Water Quantity NSDWQ as displayed on Table 3. At the peak of water scarcity, the river is a source of drinking water. Also, the all-season vegetable gardening being practiced at the bank of the river at Ntak Inyang is sustained during the dry season by the river water and consumers of the vegetables from the vegetable gardens irrigated by Ikpa River are likely to be exposed to health hazard like cancer, B.B.S etc.

The State Environmental Protection Agency should encourage the use of ballasted flocculation technology. This facility provides a greater floc settleability, higher hydraulic loading rates of about $0.084m^3/s$ to $0.095m^3/s$, greater effluents clarity and excellent solid removal including the heavy metals and phosphorus, than that of the conventional primary clarifier. For instant, ballasted flocculation technology ensures 90% phosphorus and heavy metal removal.

6 RECOMMENDATIONS

These observations give rise to the sorry state of Ikpa River that necessitated the desire to carryout a study on the impact of the surface run-off on the river.

The State Environmental Protection Agency should encourage the use of ballasted flocculation technology (i.e. the use of micro-sand and polymer together to increase the weight of the flocs).

This facility provides a greater floc settleability, higher hydraulic loading rates of about $0.084m^3/s$ to $0.095m^3/s$, greater effluents clarity and excellent solid removal including the heavy metals and phosphorus, than that of the conventional primary clarifier.

Additionally, it is recommended that the State Water Corporation as well as the

Environment Ministry carry out periodic audit on the water sources in the state.

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