Global Scientific JOURNALS

GSJ: Volume 12, Issue 8, August 2024, Online: ISSN 2320-9186

www.globalscientificjournal.com

Effect of Sludge on the Biota, Sediment of Upstream Bonny River, Rivers State

[1]Wonodi, O.E., [1]Gobo. A.E., [1]Ngah, S.A., [2]Ebere, N.

[1]Institute of Geosciences and Environmental Management, Rivers State University Nkporlu-Oroworukwo Port Harcourt, Rivers State, Nigeria.

[2]Department of Maritime Science, Faculty of Science, Rivers State University Nkporlu-Oroworukwo Port Harcourt, Rivers State, Nigeria

Corresponding Author: owene.wonodi@yahoo.com

Abstract
The study evaluated the effect the dumping of sludge on concentrations of heavy metals in gills, liver and muscle of Sarotherodon melanotheron in Woji Creek, Rivers State, Niger Delta. Four sampling stations were established and were accurately located by global positioning system. Fish samples were obtained with the help of a professional fisherman using gill nets of 1-3cm diameter at each station based on availability._Samples were collected in triplicates from each station. The collected fish were taken to the laboratory and preserved in the freezer prior to processing and analysis. Descriptive and inferential statistics were used for the data analysis. The inferential statistics used was analysis of variance to investigate the significant difference among the locations. Findings showed that the concentration of heavy metals analysed in the gills, liver and muscle were not significantly varied. In Fimie Creek, Abuloma Creek and Furoamakiri (Control), Chromium was higher than permissible in the gills and muscle. Copper (Cu) concentration was above permissible limit in all station and organs except the gills and muscle in Fimie Creek. Ni, Ar, Hg, and Pb in the gills, livers, and muscle were below the permissible limit. Bioaccumulation potentials of >1 was found in Cu in Liver from Fleet offshore Jetty and in the gills, liver and muscle in Furamakiri (Control). The study concluded that the consumption of Sarotherodon melanotheron in Fleet Offshore Jetty (S1) and Fimie Creek (S3) is not encouraging as the biosorption of heavy metals especially chromium and copper into the gills, liver and muscle of the fish was high. It is recommended that the consumption of Sarotherodon melanotheron in Fleet Offshore Jetty (S1) and Fimie Creek (S3) should be discouraged. Discharging of sludge and other anthropogenic activities in these areas should be effectively monitored by the regulatory authorities; and creation of public awareness and sensitization of established the dangers associated with discharging of sludge and solid waste into the creek should be ensured, and implemented.

Keywords: Heavy metals, Sarotherodon melanotheron, Creek, Gills, Liver, Muscle

Introduction
Clean, safe and sufficient fresh water is vital for the survival of all living organisms and smooth functioning of ecosystems, communities and economies. Water quality refers to the basic physical, chemical and biological characteristics of water in relation to all other hydrological properties, usually in respect to its suitability for a particular purpose. Any characteristic of water

that effects its portability, the survival, reproduction, growth and production of aquaculture species, influences management decisions, causes environmental impacts or reduces product quality and safety can be considered a water quality variable (WHO, 1997).

The impacts of municipal sewage are felt at multiple levels of biological organization, from cellular, organ, and organism levels, to community and trophic levels (Porter & Janz, 2003). Materials contained in municipal waste water effluents that have a negative effect on aquatic ecosystems include: nutrients, such as nitrogen and phosphorus; pathogens, such as Cryptosporidium; and endocrine disrupting substances, such as antibiotics and hormones from birth control pills. Agricultural activities are among the most frequently cited sources for degradation and pollution of aquatic systems. Agriculture is the largest consumer of freshwater globally. More than 95% of the arable grassland has been converted to production of cereal crops and livestock using intensive agricultural practices that are environmentally damaging. The conversion of riparian areas and native grasslands to crop and pasture land can have a profound influence on stream chemistry and also affects stream discharge, temperature, channel characteristics, bed disturbance regime, and organic matter input (Osborne & Kovacic, 1993). These physical changes in turn affect stream biota through changes in species composition and degradation of habitat (Cuffney *et al*., 2000).

These negative effects seem to increase as agricultural intensity increases as well. For example, fish communities showed an almost linear decline in condition as the level of agricultural intensity increased in multiple rivers in the United States (Cuffney *et al*., 2000). The major pollutants arising from agricultural lands are nutrients, particularly nitrogen and phosphorus; pesticides; sediment; pathogens; and endocrine disrupting substances (Chambers *et al*., 2000b).

Nutrients are chemical substances that provide nourishment and promote growth of micro-organisms and vegetation. They include nitrogen, phosphorus, carbon, hydrogen, oxygen, potassium, sulphur, magnesium and calcium (Chambers *et al*., 2001). The addition of nutrients to an aquatic or terrestrial ecosystem increases the biomass of plants and, ultimately, decreases the number of species (Carpenter *et al*., 1998). Rivers receiving moderate nutrient enrichment from sewage and agriculture have shown increases in biological productivity (Chambers *et al*., 2000b). Elevated algal levels in agriculturally impacted rivers are present worldwide.

Sources of nitrogen in aquatic systems include precipitation, nitrogen fixation both in the water and in the sediments, and inputs from surface runoff and groundwater. The amount of nitrogen added to surface waters from precipitation can be significant to the nitrogen cycle and for productivity (Wetzel, 2001). Inputs of nitrogen from groundwater can also be large, particularly in regions rich in limestone. Surface runoff, especially in agricultural areas, is most likely the dominant input of N to aquatic systems (Wetzel, 2001).

Strong relationships between nitrogen concentrations in aquatic systems and agricultural land use have been shown in many studies (Tong & Chen, 2002). Cooke and Prepas (1998) also showed that agricultural watersheds exported up to 50 times more nitrogen than forested watersheds. They also showed that agricultural practices also influenced the fractionation of nitrogen in runoff. Nitrate was the predominant form of N in runoff draining cropland, whereas ammonia was the dominant form of N in mixed agricultural watershed. Since ammonia is the preferred form of nitrogen for the algal community, this could have a significant effect on the aquatic environment. The dominant form of N in municipal waste water is also ammonia (Chambers *et al*., 2001). Nitrate causes methaemoglobinaemia, also known as “Blue Baby Syndrome”, in young animals and human infants. This condition decreases the ability of the blood to carry oxygen (Chambers *et al*., 2001). Prolonged exposure to excessive nitrate concentrations has also contributed to the decline in amphibians in southern Ontario. Tadpoles exposed to nitrate have shown reduced feeding activity and weight loss, and decreased survivorship. Ammonia is toxic to fish and other aquatic organisms, even in very low concentrations. When levels reach 0.06 mg/L, fish can suffer gill damage while at concentrations of 0.2 mg/L, sensitive fish like trout and salmon begin to die (Chambers *et al*., 2001). Ammonia levels greater than approximately 0.1 mg/L usually indicate polluted waters (Chambers *et al*., 2001). Phosphate is also an important component of a number of low molecular weight enzymes and vitamins essential to metabolism. Compounds containing P influence nearly all phases of cellular metabolism and are particularly important in the energy transformation of phosphorylation reactions during photosynthesis in plants (Wetzel, 2001). Studies also showed that P has a primary role in promoting algal growth in a series of whole lake enrichment studies in the Experimental Lakes Area of Ontario (Schindler, 1974, 1975). Studies such as these firmly established P as the central focus of biogeochemical and ecological studies in freshwater. This early work even prompted detergent companies to remove phosphorus from their products to reduce eutrophication problems (Wetzel, 2001). Studies have shown that the effects may occur at extremely low concentrations and be expressed in the following generations well after the original environmental exposure. These subtle effects may be extremely difficult to detect, even though they may have significant impacts on populations and ecosystems. Intensive agriculture and municipal waste water effluent are two major sources of EDS in the environment.

Studies have demonstrated a clear link between concentration of sewage effluent and the percentage of hermaphroditic fish caught below sewage treatment plants (McMaster, 2001). Studies have also linked exposure to sewage treatment effluent with alterations in sex steroid hormone levels (Porter & Janz, 2003). Porter and Janz (2003) determined that it is the presence of estrogens and estrogen-mimicking compounds in sewage that are causing adverse effects in fish. Studies have also demonstrated a clear link between animal wastes and other agricultural runoff and endocrine disruption in fish. Heavy metals and polycyclic aromatic hydrocarbons may enter the sediment and aquatic environments via industrial waste disposal, refuse, sewage, application of fertilizers and pesticides, atmospheric deposition (Amadi, 2010). Heavy metal concentrations analysis of water, sediment and fishes is also employed to ascertain the mobility of the heavy metals, and the bioaccumulation and bio-magnification of these heavy metals in the tissues of fishes and the adverse health risk these metals may pose on communities that use water these rivers. Having observed the previous studies, it is largely observed that few studies have evaluated the level of biosorption of heavy metals in surface water by aquatic organisms especially in the tropics whereby Woji Creek is located. The present study investigated the concentrations of heavy metals in gills, liver and muscle of *Sarotherodon melanotheron* in Woji Creek, Rivers State, Niger Delta, Nigeria.

Materials and Methods

The study was carried out in Woji Creek, Port Harcourt, Rivers State, Nigeria. The study area lies within the latitude between 4° 45’ 0’’N and 4° 49’ 0’’N and longitudes between 7° 1’ 0’’E and 7° 4’ 0’’E (Figure 1). This study adopted pure experimental research design which measures the degree of interaction between variables of interest and establishes and determine the cause-and-effect relationship among variable in this study. Four (4) main sample collection stations were selected about 500m apart in the study area as shown in Fig 3.1 and described in Table 3. 1. These included Fleet Offshore Jetty as Station 1, Abuloma Creek River as Station 2, Fimie Creek as Station 3, and Furamakiri (Kalio-Ama) as Station 4. Fish samples (*Sarotherodon melanotheron*) were obtained with the help of a professional fisherman using gill nets of 1-3cm diameter at each station based on availability._Samples were collected in triplicates from each station. The collected fish were taken to the laboratory and preserved in the freezer prior to processing and analysis. Descriptive and inferential statistics were used for the data analysis. The inferential statistics used was analysis of variance to investigate the significant difference among the locations.

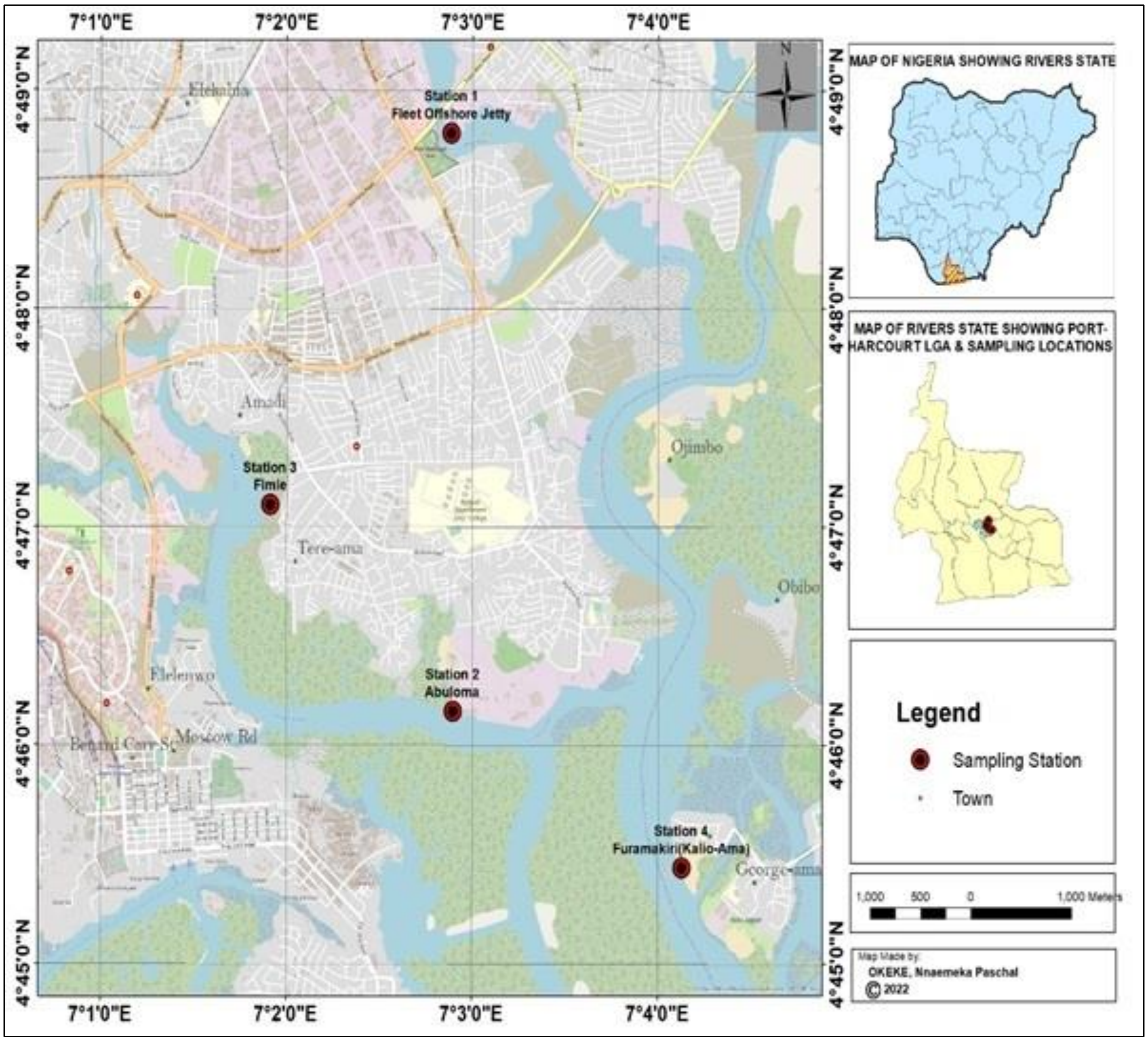

Figure 1. Study Area showing the Woji Creek

Results and Discussions

Heavy Metal Concentration in Gills, Liver and Muscles of *Sarotherodon Melanoteron*

The Zinc (Zn) concentration in gills, liver and muscles of *Sarotherodon melanotheron* is presented in Figure 2. Zn concentration ranges from 11.05 mg/kg to 32.52 mg/kg. In the gills of *Sarotherodon melanotheron*, Fimie Creek (S3) recorded the highest concentration of zinc (25.29

mg/kg), followed by Fleet Offshore Jetty (S1) which recorded a concentration 16.93 mg/kg, Furamakiri (control) recorded a zinc concentration of 13.9 mg/kg while the lowest concentration of zinc in the gills of *Sarotherodon melanotheron* was recorded at Abuloma Creek (S2) with a concentration of 11.05 mg/kg. In the liver of *Sarotherodon melanotheron*, Fimie Creek (S3) recorded the highest concentration of zinc (22.5 mg/kg), followed by Fleet Offshore Jetty (S1) which recorded a concentration 15.78 mg/kg, Abuloma Creek (S2) recorded a zinc concentration of 13.07 mg/kg while the lowest concentration of zinc in the liver of *Sarotherodone melanoteron* was recorded at Furamakiri (control) with a concentration of 12.69 mg/kg. In the muscles of *Sarotherodon melanotheron*, Abuloma Creek (S2) recorded the highest concentration of zinc (32.52 mg/kg), followed by Furamakiri (control) which recorded a concentration 30.48 mg/kg, Fleet Offshore Jetty (S1) recorded a zinc concentration of 30.26 mg/kg while the lowest concentration of zinc in the muscles of *Sarotherodon melanotheron* was recorded at Fimie Creek (S3) with a concentration of 27.37 mg/kg.

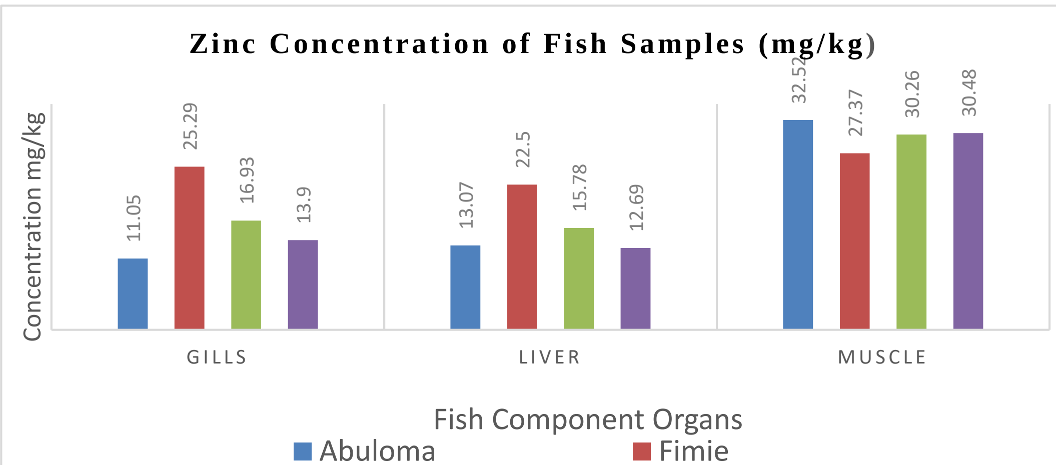

Figure 2: Zinc Concentration in Gills, Liver and Muscles of *Sarotherodon melanotheron*

The lead (Pb) Concentration in Gills, Liver and Muscles of *Sarotherodon melanotheron* is presented in Figure 3. Pb concentration ranges from 1.28 mg/kg to 32.52 mg/kg. In the gills of *Sarotherodon melanotheron*, Fleet Offshore Jetty (S1) recorded the highest concentration of lead (11.32 mg/kg), followed by Abuloma Creek (S2) which recorded a concentration 6.88 mg/kg, Furamakiri (control) recorded a lead concentration of 5.23 mg/kg while the lowest concentration of lead in the gills of *Sarotherodon melanotheron* was recorded at Fimie Creek (S3) with a concentration of 1.28 mg/kg. In the liver of *Sarotherodon melanotheron*, Abuloma Creek (S2) recorded the highest concentration of lead (9.08 mg/kg), followed by Fimie Creek (S3) which recorded a concentration 8.37 mg/kg, Furamakiri (control) recorded a lead concentration of 6.58 mg/kg while the lowest concentration of lead in the liver of *Sarotherodon melanotheron* was recorded at Fleet Offshore Jetty (S1) with a concentration of 6.02 mg/kg. In the muscles of *Sarotherodon melanotheron*, Fleet Offshore Jetty (S1) recorded the highest concentration of lead (28.89 mg/kg), followed by Fimie Creek (S3) which recorded a concentration 10.91 mg/kg, Abuloma Creek (S2) recorded a lead concentration of 5.69 mg/kg while the lowest concentration of lead in the muscles of *Sarotherodon melanotheron* was recorded at Furamakiri (control) with a concentration of 5.69 mg/kg.

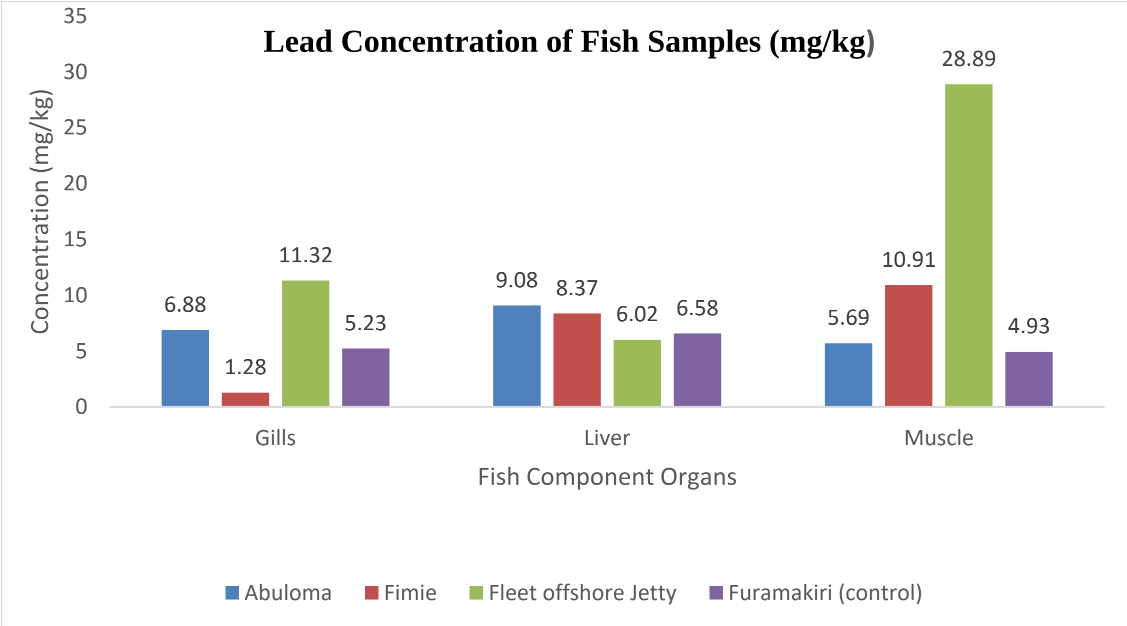

Figure 3: Lead Concentration in Gills, Liver and Muscles of *Sarotherodon Melanotheron*

The cadmium concentration in gills, liver and muscles of *Sarotherodon Melanotheron* is presented in Figure 4. Cadmium concentration ranges from 0.19 mg/kg to 1.55 mg/kg. In the gills of *Sarotherodon Melanotheron*, Fimie Creek (S3) recorded the highest concentration of cadmium (1.55 mg/kg), followed by Fleet Offshore Jetty (S1) which recorded a concentration of 1.28 mg/kg. Abuloma Creek (S2) recorded a concentration of 0.85 mg/kg while Furamakiri (control) recorded the lowest cadmium concentration of 0.19 mg/kg. In the liver of *Sarotherodon Melanotheron*, Fimie Creek (S3) recorded the highest concentration of cadmium (1.21 mg/kg), followed by Fleet Offshore Jetty (S1) which recorded a concentration of 0.49 mg/kg, Furamakiri (control) recorded a concentration of 0.48 mg/kg while Abuloma Creek (S2) recorded the lowest cadmium concentration of 0.23 mg/kg. In the muscles of *Sarotherodon Melanotheron*, Furamakiri (control) recorded the highest concentration of cadmium (0.95 mg/kg), followed by Abuloma Creek (S2) which recorded a concentration of 0.70 mg/kg. Fleet Offshore Jetty (S1) recorded a cadmium concentration of 0.39 mg/kg while the lowest concentration of cadmium in the muscles of *Sarotherodon melanotheron* was recorded at Fimie Creek (S3) with a concentration of 0.36 mg/kg.

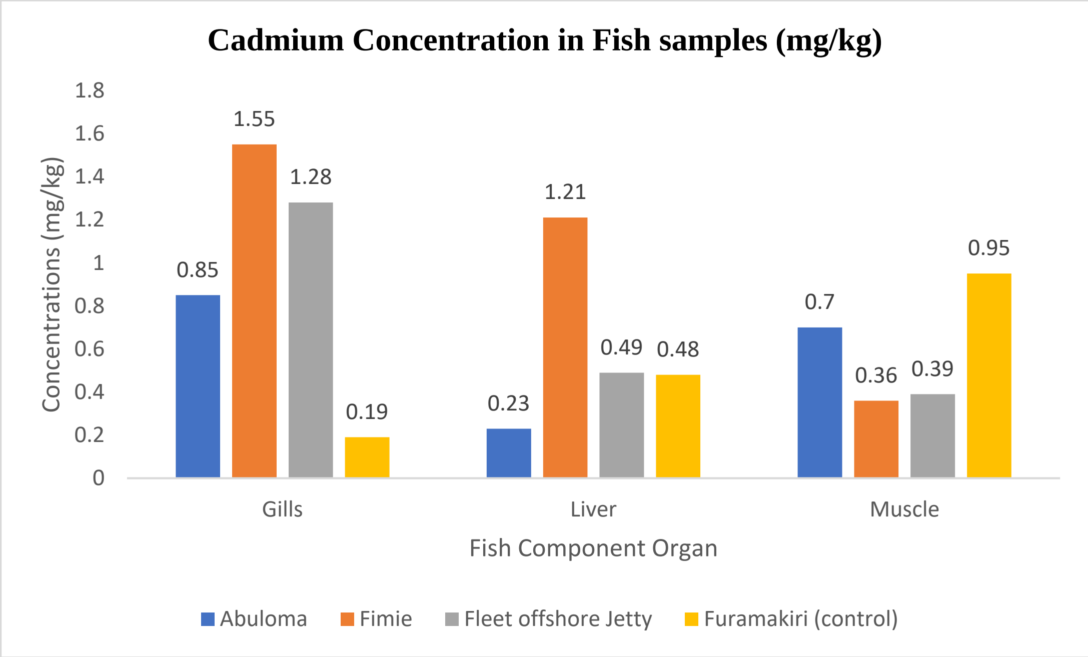

Figure 4: Cadmium Concentration in Gills, Liver and Muscles of *Sarotherodon melanotheron*

In the gills of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of nickel (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg. In the liver of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of nickel (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg. In the muscles of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of nickel (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg (Table 1 and Table 2).

In the gills of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of arsenic (0.001 mg/kg) while Fleet Offshore Jetty (S1) (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg. In the liver of *Sarotherodon melanotheron,* Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of arsenic (0.001 mg/kg) while Fleet Offshore Jetty (S1) (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg. In the muscles of *Sarotherodone melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of arsenic (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg (Table 1 and Table 2).

In the gills of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of mercury (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg. In the liver of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of mercury (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg. In the muscles of *Sarotherodon melanotheron*, Abuloma Creek (S2) and Furamakiri (control) recorded the highest concentration of mercury (0.001 mg/kg) while Fleet Offshore Jetty (S1) and Fimie Creek (S3) recorded a concentration 0.0 mg/kg (Table 1 and Table 2).

The chromium concentration in gills, liver and muscles of *Sarotherodon melanotheron* is presented in Table 1. Chromium concentration ranges from 0.0 mg/kg to 1.20 mg/kg. In the gills of *Sarotherodon melanotheron*, Fimie Creek (S3) recorded the highest concentration of chromium (1.00 mg/kg), followed by Abuloma Creek (S2) and Furamkiri (control) which recorded a concentration of 0.001 mg/kg while Fleet Offshore Jetty (S1) recorded the lowest chromium concentration of 0.0 mg/kg. In the liver of *Sarotherodon melanotheron*, Abuloma Creek (S2) recorded the highest concentration of chromium (1.20 mg/kg), followed by Furamakiri (control) which recorded a concentration of 0.94 mg/kg. Fimie Creek (S3) and Fleet Offshore Jetty (S1) recorded a concentration of 0.0 mg/kg. In the muscles of *Sarotherodon melanotheron*, Fimie Creek (S3) recorded the highest concentration of chromium (0.65 mg/kg), followed by Abuloma Creek (S2) which recorded a concentration 0.45 mg/kg, Furamakiri (control) recorded a chromium concentration of 0.001 mg/kg while the lowest concentration of chromium in the muscles of *Sarotherodon melanotheron* was recorded at Fleet Offshore Jetty (S1) with a concentration of 0.00 mg/kg.

The copper concentration in gills, liver and muscles of *Sarotherodon melanotheron* is presented in Table 1 and Table 2. Copper concentration ranges from 0.0 mg/kg to 53.24 mg/kg. In the gills of *Sarotherodon melanotheron*, Abuloma Creek (S2) recorded the highest concentration of copper (2.38 mg/kg), followed by Furamkiri (control) which recorded a concentration of 1.75 mg/kg, Fleet Offshore Jetty (S1) recorded a concentration of 1.22 mg/kg while the lowest copper concentration of 0.28 mg/kg was recorded in Fimie Creek. In the liver of *Sarotherodon melanotheron,* Fimie Creek (S3) recorded the highest concentration of copper (53.24 mg/kg), followed by Fleet Offshore Jetty (S1) which recorded a concentration of 30.90 mg/kg, Furamakiri (control) recorded a concentration of 19.16 mg/kg while Abuloma Creek (S2) recorded the lowest copper concentration of 18.23 mg/kg. In the muscles of *Sarotherodon melanotheron*, Abuloma Creek (S2) recorded the highest concentration of copper (2.52 mg/kg), followed by Fleet Offshore Jetty (S1) which recorded a concentration of 1.91 mg/kg. Furamakiri (control) recorded a copper concentration of 1.34 mg/kg while the lowest concentration of copper in the muscles of *Sarotherodon melanotheron* was recorded at Fimie Creek (S3) with a concentration of 0.00 mg/kg.

Table 1. Heavy Metal Concentration (mg/kg) in the Tissues of *Sarotherodon melanotheron*

Fish Organ			
	Gills (mg/kg)	**Liver (mg/kg)**	**Muscle (mg/kg)**
Location			
Nickel			
Fleet Offshore Jetty (S1)	-	-	-
Abuloma Creek	0.001[a]	0.001[a]	0.001[a]
Fimie Creek	-	-	-
Furamakiri (control)	0.001[a]	0.001[a]	0.001[a]
Arsenic			
Fleet Offshore Jetty (S1)	-	-	-

Abuloma Creek	0.001[a]	0.001[a]	0.001[a]
Fimie Creek	-	-	-
Furamakiri (control)	0.001[a]	0.001[a]	0.001[a]
Mercury			
Fleet Offshore Jetty (S1)	-	-	-
Abuloma Creek	0.001[a]	0.001[a]	0.001[a]
Fimie Creek	-	-	-
Furamakiri (control)	0.001[a]	0.001[a]	0.001[a]
Chromium			
Fleet Offshore Jetty (S1) (S1)	-	-	-
Abuloma Creek	0.001[a]	1.2[a]	0.45[a]
Fimie Creek	1	-	0.65
Furamakiri (control)	0.001[a]	0.94[a]	0.001[a]
Copper			
Fleet Offshore Jetty (S1)	1.22 [a]	30.9[a]	1.91 [a]
Abuloma Creek	2.38 [a]	18.23[a]	2.52 [a]
Fimie Creek	0.28[a]	53.24[a]	-
Furamakiri (control)	1.75 [a]	19.16[a]	1.34 [a]

Table 2: Heavy metals bio-sediment accumulation factor (BSAF) in the organs (muscle, gill, liver) of *S. melanotheron* in the study area

Stations	Organs	Nickel Concentration (mg/kg)	Arsenic Concentration (mg/kg)	Mercury Concentration (mg/kg)	Chromium Concentration (mg/kg)	Copper Concentration (mg/kg)
Fleet Offshore Jetty (S1)	Gills	-	-	-	-	0.14
	Liver	-	-	-	-	3.47
	Muscle	-	-	-	-	0.21
Abuloma Creek (S2)	Gills	$3.33x10^{-03}$	-	-	$2.85x10^{-04}$	-
	Liver	$3.33x10^{-03}$	-	-	0.34	-
	Muscle	$3.33x10^{-03}$	-	-	0.13	-
Fimie Creek(3)	Gills	-	-	-	0.11	-
	Liver	-	-	-	-	-
	Muscle	-	-	-	0.07	-
Furamakiri (control)	Gills	-	-	-	$7.81x10^{-05}$	17.5
	Liver	-	-	-	0.07	191.6

	Muscle	-	-	-	$7.81x10^{-05}$	13.4

Figure 5 showed the principal component analysis of fish samples analysed during the study period. The chart presents the Eigen values and three summary plots. The Eigen value plot showed the percentage and cumulative percent accounted by each principal component; the square plot showed the scatter plot of the first two principal components; while the loading plot showed the correlations between the variables and the first two principal components. The square and loading plots showed that the first two principal components accounted for 61% (37.5% for component 1 and 23.8% for component 2) of the variation in the data. In the loading plot, Pb, Cd, Ni, V, Zn, Cr and THC were positively correlated with the first principal component accounting for the 47.3% of the factors influencing their levels of concentration in the sediment; while Pb, Cd and Ni accounted for the 22.7% of the factors influencing their levels of concentration.

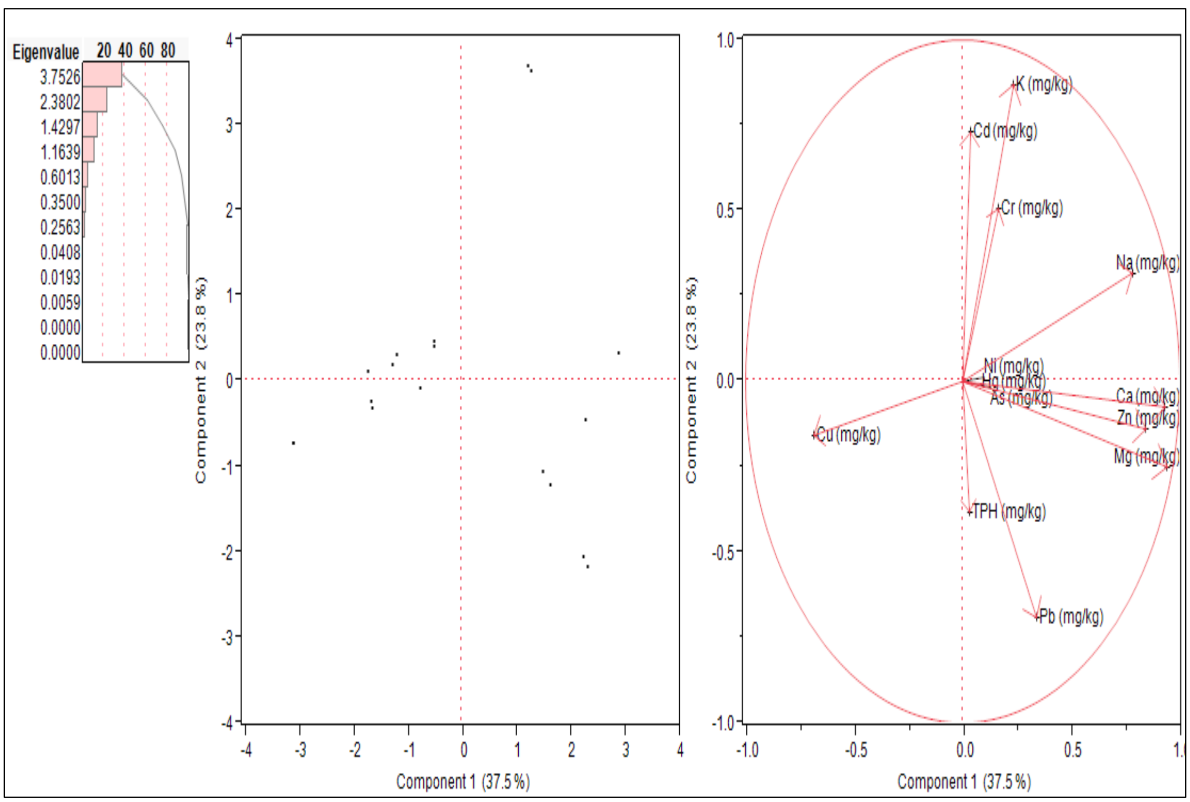

Figure 2: Principal Component Analysis (PCA) of Fish Samples

Discussions of Findings

The bioaccumulation of toxic levels of heavy metals is detrimental to organisms generally including plants and animals as they biomagnified them through the food chain as well as subsequent transfer along the trophic level to humans. Research findings revealed that heavy metals such as Zinc, Lead, Chromium, Copper and Cadmium were found gills, liver and muscles of *Sarotherodon melanotheron* ranges. Ekeanyanwu *et al.* (2010) who quantitatively analysed the presence of Pb, Ni, Cr, Mn and Cd in bottom sediment, tilapia, cat fish and water samples revealed the presence of heavy metals in the muscle and bones of the fish. It is well known that muscles are not an active site for bio-accumulation, but in polluted aquatic habitats, metal concentration in fish muscles could exceed the permissible limits for human consumption and may imply severe health threats. The studied fish accumulated metals to some extent in their gill. Gills are the main route of metal ion exchange from their surrounding media as they have very large surface area that facilitates rapid diffusion of toxic metals. Therefore it is suggested that, metals accumulated in the gills are mainly concentrated from their surrounding media and based on their feeding habits. The accumulation of metals in the liver is likely linked to its role in metabolism and the liver being the site for detoxification.

Conclusion and Recommendations

The study concluded that the consumption of Sarotherodon melanotheron in Fleet Offshore Jetty (S1) and Fimie Creek (S3) is not encouraging as the biosorption of heavy metals especially chromium and copper into the gills, liver and muscle of the fish was high. It is recommended that the consumption of *Sarotherodon melanotheron* in Fleet Offshore Jetty (S1) and Fimie Creek (S3) should be discouraged. Discharging of sludge and other anthropogenic activities in these areas should be effectively monitored by the regulatory authorities; and creation of public awareness and sensitization of the dangers associated with discharging of sludge and solid waste into the creek should be ensured, established and implemented.

References

Amadi, A.N. (2010). Effects of urbanization on ground water quality. A case study of Port-Harcourt, Southern Nigeria. *Nature and Applied Sciences Journal*, 11(2), 143-152.

Carpenter, S.R., Caracon, F., Correl, D.L., Howarth, R.W., Sharpley, A.N., & Smith, V.H. (1998). Nonpoint Pollution of surface waters with phosphorus and nitrogen, 8, 559-568.

Chambers, J.Q., Dos Santos, J. R. & Higuchi, N. (2001). Tree Damag, Allometric relationships and Above- Ground new Primary Production in central Amazon forest. *Forest Ecology and management*, 152, 73-84.

Chambers, J.Q., Higuchi, N., Schimel, J., Ferreira, L.V., & Melack, J.M. (2000b). Decomposition and carbon-cycling of dead trees in tropical forest of the central Amazon, 122, 380-388.

Cooke, E.S., & Prepas, E. (1998). Streams Phosphorus and Nitrogen export from agriculture and forested watersheds on the Borel plain, 55, 10.

Cuffney, T.F., Meador, M.R., Porter, S.D., & Gurtz, M.E., (2000). Responses of physical, chemical, and 610 biological indicators of water quality to a gradient of agricultural land use in the Yakima River Basin, 611 Washington. *Environmental Monitoring Assessment*, 64, 259-270.

Ekeanyanwu, C.R., Ogbuinyi, C.A. & Etienajirhevwe, O.F. (2010). Trace metals distribution in fish tissues, sediments and water from Okumeshi River in Delta State, Nigeria. *Ethiopia Journal of Environmental Studies and Management*, 3(3), 12 – 17.

Osborne, L.L. & Kovacic, D. (1993). Riparian vegetated buffer strips in water-quality restoration and stream management. *Journal Environmental*

Porter, C.M., & Janz, D.M. (2003). Treated municipal sewage discharge effects multiple levels on biological organization in fish. *Ecotoxicology and Environmental Safety*, 54, 109-206.

Schindler, D.W (1974). Eutrophication and recovery in experimental lakes: implications for lake management. DOI: 10.1126/science.184.4139.897

Tong-Susanna, T.Y & Chen W. (2002). Modeling the relationship between land use and surface water quality. *Journal of Environmental Management*, 377-393.

Wetzel, R.G. (2001). Limnology: Lake and River Ecosystems. Third Edition, Academic Press, San Diego, 1006 p.

World Health Organisation (1997). Guidelines for Drinking Water, Survellance and control of community supplies, 2nd Edition, 3, 445.