Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.8, 2014

Assessment of Water Quality and Heavy Metal levels of Fish Species in Oguta Lake, Imo State Nigeria.

UMUNNAKWE JOHNBOSCO EMEKA[1]*, AHARANWA BIBIAN C[2]

1. Department of Environmental Technology, Federal University of Technology Owerri, Imo State Nigeria
2. Department of Polymer and Textile Technology, Federal University of Technology Owerri, Imo State Nigeria

E-mail of Corresponding Author. jnboscokwe@yahoo.com

ABSTRACT

The level of accumulation of some heavy metals: Iron, Copper, Lead, Nickel, Mercury, Chromium, Cadmium and Arsenic in the full body of some local fishes (Mud fish, Tilapia fish, Cat fish and Ifuru fish) and impact of some physicochemical variables on the water quality of Oguta Lake was investigated. The study was carried out in the month of June, 2013 and water sampling carried out in June and September, 2013; and standard methods adopted for their analysis. The accumulation of analysed metals was specie related as their mean concentrations were higher in mud fish and tilapia fish and lowest in cat fish. Lead, mercury, arsenic were not detected in all fishes, while chromium was absent in the studied species except in mud fish. The levels of Turbidity, Nitrate, Total Coliform, Iron, Cadmium and Nickel exceeded the maximum permissible limit of Nigerian Industrial Standard and as such the raw water cannot be used in this form for domestic purposes without treatment. However, the level of nitrate-nitrogen detected shows that the water is safe as nitrification has occurred and pollution could not have been recent. The water body will sustain aquatic life taking cognizance of the values of DO and BOD which was within permissible limits. Safe disposals of domestic sewage and industrial effluents as well as enforcement of laws enacted to protect our environment are therefore recommended.

KEY WORDS: Oguta lake, Heavy Metals, Physico chemical, Fish

INTRODUCTION

Oguta Lake is the largest natural lake in Imo State of Nigeria. It is located within the equatorial rainforest region with coordinates 5’ 42’24”N 6” 47’33”E.It is of enormous importance to the local population(the people of Oguta, Orsu Obodo, Nkwesi and Awo Omama) as a source of water, fish, tourism, marine transport and also as an outlet for sewerage(Oguta lake,2008).The primary inflows are Utu, Obana and Njaba rivers and its maximum depth is 8m(Oguta lake,2013) with Nigeria as the only basin country. Water quality refers to the chemical, physical and biological characteristics of water (Diersing, 2009). It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose (Johnson et al., 1997). Another general perception of water quality is that of a simple property that tells whether water is polluted or not. In fact, water quality is a complex subject, in part because water is a complex medium intrinsically tied to the ecology of the Earth. Industrial and commercial activities (e.g. manufacturing, mining, construction, transport) are a major cause of water pollution as are runoff from agricultural areas, urban runoff and discharge of treated and untreated sewage. The parameters for water quality are determined by the intended use. Work in the area of water quality tends to be focused on water that is treated for human consumption, industrial use, or in the environment. Environmental water quality, also called ambient water quality**,** relates to water bodies such as lakes, rivers, and oceans. Water quality standards for surface waters vary significantly due to different environmental conditions, ecosystems, and intended human uses. Toxic substances and high populations of certain microorganisms can present a health hazard for non-drinking purposes such as irrigation, swimming, fishing, rafting, boating, and industrial uses. These conditions may also affect wildlife, which use the water for drinking or as a habitat. Modern water quality laws generally specify protection of fisheries and recreational use and require, as a minimum, retention of current quality standards.

Fish is a low fat, high quality protein. Fish is filled with omega-3 fatty acids and vitamins such as D and B2 (riblovin). Fish is rich in Calcium and Phosphorous and a great source of minerals, such as Iron, Zinc, Iodine, Magnesium and Potassium, Fish products have been shown to contain varying amounts of heavy metals from water pollution. Environmental pollution is a worldwide problem heavy metals belonging to the most important pollutants. Metals tend to accumulate in water and move up through the food chain; so studies to ascertain the level of heavy metals in environment and determine particularly hazardous level for human are necessary. Heavy metals are commonly found in natural waters and some are essential to living organisms, yet they may become highly toxic when present in high concentrations. Aquatic animals (including fish) bioaccumulate trace metals in considerable amounts and stay over a long period. Fishes have been recognized as good accumulators of organic and inorganic pollutants (King and Jonathan, 2003).

Several studies have reported the accumulation of heavy metals in fishes of some Nigerian Rivers (Babatunde et al,.2013,Ademoroti,1996,Jaji et al,.2007)

METHODS

Description of study area

The study area is Oguta Lake in Imo State, Nigeria (See Figures 1 and 2). The temperature is generally high with an average of 27^0c. The hottest months are February and March when the temperature rises to between 33^0C and 35^0C. The climate is tropical high forest with two distinct seasons, a dry season which lasts from October to March, and the rainy season which lasts from April to September (Nnaji, 2011). Oguta Blue Lake is the largest hydrological feature in the state. The major activities that take place here include bathing, fishing, marine transportation and sewage discharge, There is prevalence of sea albatross that eat up fish in the lake environs. There are no pipelines, crossing the area and no oil bunkering take place here.

Figure 1: Map of Nigeria showing Imo State

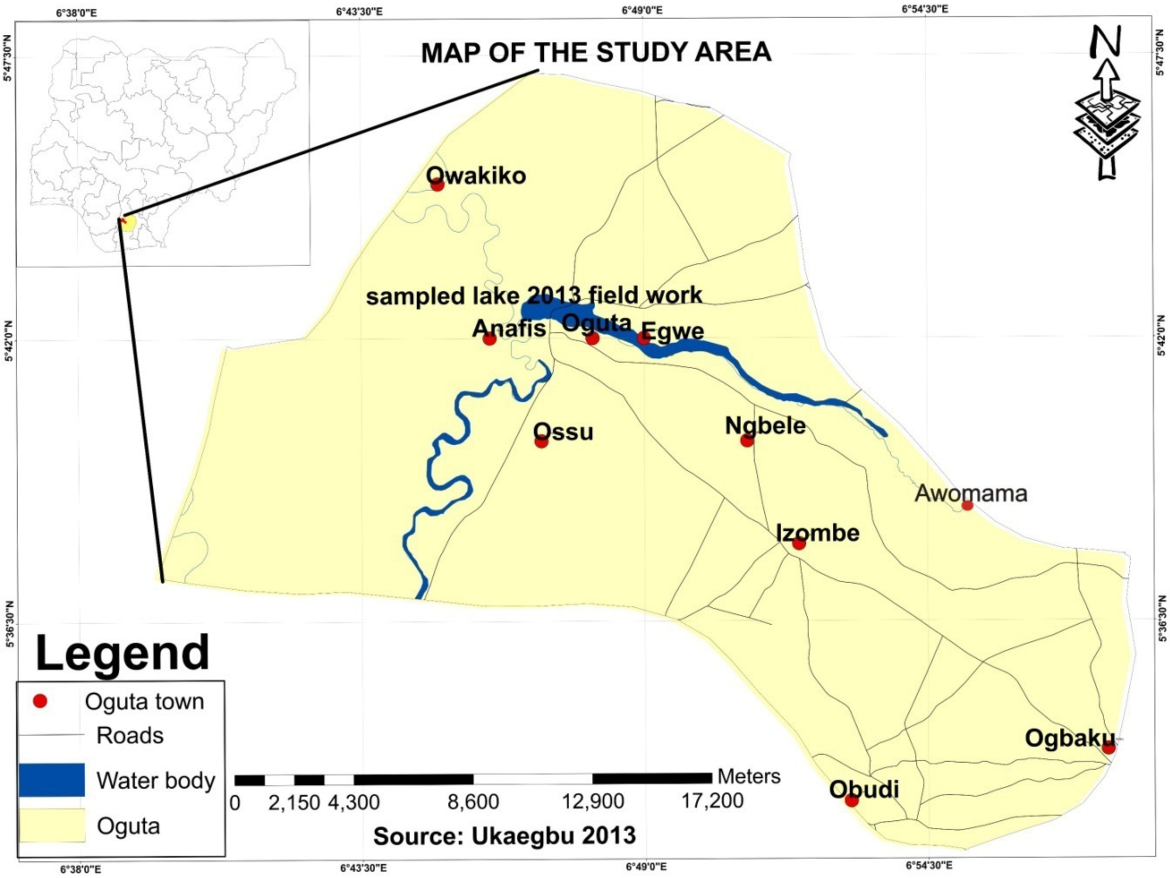

Fig. 2: Map of Oguta lake showing sampling stations

Oguta Lake is the largest natural lake in Imo State and is supposed to have originated from a natural depression. This region is located within the equatorial rain forest belt with an average annual rainfall of 3,100 mm, but most of the rain forest has been replaced by oil palm plantations especially around the lake. The lake has a high diversity of phytoplankton community. It contains as many as 258 species of phytoplankton which fall in 107 genera (Omin, 1983). Despite this diversity of phytoplankton, the estimated level of primary productivity of 160 279 mg C m^{-3} day 1 (Egi, 1983) is generally low. This may be the reason for the low level of fishery production estimated at 12.5 metric tons (Ita & Balogun, 1983). The lake is of immense value to the people of Oguta, Orsu, Nkwesi and Awo. In fact, the lake is the identity and pride of the Ogutaman. They draw their water from it. They obtain 80% of their protein from it. The common fish species are identified by their local names and include Ebi (Mud fish), Atuma (Catfish), Egu (Tilapia), Oporoma, Ifuru and Ofu It has been observed that a total of 2,403 full-time fishermen and 154 part-time fishermen operate in the lake. The lake serves as a septic pool for domestic urban sewage. The local people also dredge the lake for sand which is used for the construction industry. The Oguta Lake Motel with a tourist resort is a 3-star hotel aimed at attracting tourists to Oguta. In the colonial era, the Oguta Lake was a port for the evacuation of palm products. The relics of the jetties used by the United African Company (U. A. C.) still exist today. During the Nigerian civil war, the Oguta Lake was a marine base for the Biafran Navy.

A view on the lake looking a ferryboat and a fisherman's canoe

Source: Anene, A. (1983)

A research conducted by Anene (1983) shows the following features of the lake:

Physical Dimensions

Surface area [km2]	1.8*1
	2.5*2
Maximum depth [m]	8.0
Mean depth [m]	5.5
Water level	Unregulated
Normal range of annual water level fluctuation [m]	9.3 7.0
Length of shoreline [km]	10

* 1 Dry season. * 2 Wet season

Biological Features

Flora

- Emerged macrophytes: Crinum natans, Vossia cuspidata, Ipomoea bartata.
- Floating macrophytes: Pistia stratiotes, Nymphaea lotus.
- Submerged macrophytes Ceratophyllum sp., Utricularia inflexa, U. sp.
- Phytoplankton
  Cyanophyceae (Microcystis densa, Merismopedia elegans); Chlorophyceae (Chlorella sp., Closterium sp., Cosmarium, Cladophora, Pandorina, Scenedesmus spp.); Bacillariophyceae (Melosira, Cyclotella, Navicula, Diatoma, Asterionella, Fragilaria, Amphora spp.).

Fauna

- Zooplankton: Tropodiaptomus lateralis, Diaphanosoma excisuum .

Fish

Alestes baremoze*, A. dentex, Porcus filamentosus, Chrysichthys filamentosus*, C. nigrodigitatus, Clarotes laticeps, Xenomystus nigri, Hemisynodontis membranaceous*, Brachysynodontis batensoda*, Synodontis schall*, S. eupterus, S. ocellifer, Heterobranchus bidorsalis*, H. longifilis, Chromidotilapia guntheri*, Thysia ansorgii, Tilapia mariae*, T. zilli*, Oreochromis niloticus*, Ctenopoma kingsleyae, Polypterus senegalus, P. bichir, Polycentropsis abbreviata*, Clarias lazera, C. anguillaris, Pomadasys jubelini (* economically important).

Land Use In The Catchment Area

- Types of important forest vegetation
  Rain forest; much of the land is now covered by palm.
- Main kinds of crops and/or cropping systems
  Oil palm, cassava and yam are the major crops produced by subsistent farmers who practice shifting cultivation.
- Levels of fertilizer application on crop fields: Light.

Trends of change in land use in recent years
The rate of deforestation is relatively high due to shift

Generation of Pollutants in the Catchment Area
Measurable Pollution with no Waste -Water Treatment.

There is an extensive build up of human settlements around the lake with little or no sewage, which results in increasing deposition of human wastes on the lake shores. These are flushed into the lake during the rainy season.

Choice of sampling stations for water samples

Three sampling stations were chosen to determine the impact of anthropogenic activities on the physicochemical variables. The upstream is called Oruru and activities that take place here include fishing and sand dredging .At the midstream a Jetty(Gogo Nwakuche) for marine navigation is located, with fishing, cassava fermentation, bathing also prevalent .The downstream receives water flow from upstream and links to Orashi river with fishing taking place at this station.

Fish sample collection

Four adult fish samples: Tilapia fish, Mud fish, Cat fish and Ifuru fish were bought from fishermen at the bank of the lake. These fish species were put in polythene bags and transported to the laboratory inside icebox. Each fish species was properly washed with distilled water to remove debris, plankton, and external adherent, and then drained under folds of filter, weighed wrapped in aluminum foil. All the fish samples were then separately stored inside deep freezer at about 10oC and were allowed to thaw; scales were removed and washed with clean running water before dissected with sterile scissors to remove unnecessary parts.

Sample Preparation

Prior to digestion, samples were dried separately in a laboratory oven at a predetermined temperature for two to three days to obtain a constant dry weight from each sample. The dried samples were each ground to powder, using ceramic mortar and pestle, and sieved with 2mm sieve.

Digestion of sample

The digestion of the sample took place according to procedure outlined in AOAC969.23.

2g of fish sample was weighed and 5ml of HNO_3 was added to the sample .The sample was digested in steam water bath or low temperature hot plate until it dissolved and evaporated to dryness. Another 2 ml HNO_3 was added and warmed without dryness. They were transferred into 50ml volumetric flask with hot water using a filter made into funnel shape. The beaker containing the sample was continuously rinsed until the hot water makes it up to 50ml.The sides of beaker was washed three times with hot water and added to the flask and diluted to volume washing the filter paper.

Test Procedures for physicochemical parameters

P^H was determined using $_P$H by first of all calibrating the equipment using P^H buffer 7 and 10.The water sample was poured into the beaker and the probe inserted into the water with switch on and reading recorded when the reading becomes stable. Conductivity/TDS was measured with conductivity meter after calibration at $25^{oc.}$The Total Suspended Solid, TSS was determined by photometric method by HACH DR/2010 spectrophotometer at a wavelength of 810nm and programme number 630.Turbidity was determined photo metrically at a wavelength of 860nm and programme number 750.Nitrate was determined by cadmium reduction method using HI83200 multiparameter bench photometer at a wavelength of 525nm.Phosphate was determined by Amino acid method using HI83200 multiparameter bench photometer at a wavelength of 525nm.Ammonia was determined using Nessler method at a wavelength of 420nm photometer reading. Calcium was determined by calmagite method using H183200 multiparameter bench photometer at a wavelength of 525nm.Magnessium was determined was determined by the EDTA calorimetric method using the H1 83200 multiparameter bench photometer at a wavelength of 525nm.Sulphate was determined by turbidimetric method using H1 83200multiparameter bench photometer at a wavelength of 466nm,while alkalinity was determined by calorimetric method at 525nm.Total Suspended Solids,TSS was determined by photometric method using HACK DR/2010 spectrophotometer at a wavelenghth of 810nm and a programme number of 630nm.Turbidity was determined by photometric method using HACK DR/2010 spectrophotometer at a wavelength of 860nm and programme number of 750nm.For heavy metals determination using bench multiparameter, Iron was determined at a wavelength of 575nm,copper at 575nm and chromium at526nm.

RESULTS AND DISCUSSION

The results of the analysis of the levels of heavy metals in sampled fish species and surface water samples at Oguta lake are presented in tables 1,2 and 3.The concentration of Iron ranged between 1.387ppm (Catfish) and 34.198ppm (Ifuru). Copper ranged between 0.011ppm (Ifuru) and 0.071ppm (Tilapia); while Lead was not detected in all the fish samples (0.00). Nickel ranged between 0.129ppm (Catfish) and 0.225ppm (Tilapia); while Mercury and Arsenic were not present in the fish samples and recorded 0.00 concentration. Chromium value was 0.568ppm in Mudfish while other fish species recorded 0.00. Cadmium ranged between 0.178ppm (Ifuru) and 2.842ppm (Mud fish)

The water sampled in June 2013, showed that pH ranged between 6.5 and 7.4, while Temperature ranged between 28^oc and 29.6^oc.Conductivity ranged between 13µS/cm and 35µS/cm; while TDS ranged between 8.45mg/l and 22.75mg/l.TSS ranged between 3mg/l and 6mg/l, and also Turbidity valued between 6.36mg/l and 12.28mg/l; while Colour ranged between 4pcu and 54pcu. Alkalinity was highest at midstream (60mg/l) and lowest at downstream (25mg/l).The Nitrate and Nitrate-Nitrogen ranged as follows 65.1mg/l and 79.4 mg/l;14.7mg/l and 17.70mg/l respectively. The Phosphate, Phosphorus and Phosphate (P_2O_5) values ranged as follows; 0.1mg/l and 0.9mg/l, 0.00 and 0.3mg/l and 0.1mg/l and 0.6mg/l. Sulphate was not present in any of the stations. DO varied between 6.5mg/l and 9,0mg/l. Ammonia ranged between 0.15mg/l and 0.27mg/l, while Ammonium Nitrogen varied between 0.09mg/l and 0.23mg/l.BOD concentrations varied between 2.4mg/l and 3.6mg/l, while COD ranged between 3,8mg/l and 5.8mg/l. For the heavy metals, Cadmium ranged between 0.210ppm and o.359ppm; Lead ranged between 0.004ppm and 0.031ppm; Iron ranged between 3.258ppm and 4.751. Chromium varied between 0.030ppm and 0.873ppm; Nickel ranged between 0.084ppm and 0.259ppm; Copper varied between 0.262ppm and 1.801ppm.Mercury and Arsenic had zero concentrations.

Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.8, 2014

TABLE 1: RESULT OF MEAN CONCENTRATION(PPM) OF HEAVY METALS IN THE TISSUES OF THE FISH SPECIES IN OGUTA LAKE, JUNE, 2013..

PARAMETERS	MUD FISH FULL	TILAPIA FISH FULL	CAT FISH BODY	IFURU FISH FULL
IRON (ppm)	3.385	21.174	1.387	34.198
COPPER (ppm)	0.059	0.071	0.034	0.011
LEAD (ppm)	0.00	0.00	0.00	0.00
NICKEL (ppm)	0.155	0.225	0.129	0.158
MERCURY (ppm)	0.00	0.00	0.00	0.00
CHROMIUM (ppm)	0.568	0.00	0.00	0.00
CADMIUM (ppm)	2.842	0.650	0.317	0.178

TABLE 2: RESULT OF OGUTA LAKE SURFACE WATER ANALYSIS,JUNE 2013

S/N	PARAMETERS	WHO STD	OGUTA UPSTREAM	OGUTA MIDSTREAM	OGUTA DOWNSTREAM
1	pH	6.5- 8.5	7.4	6.8	6.5
2	TEMPERATURE (^{O}C)	20 – 30	28.0	29.3	29.6
3	CONDUCTIVITY (us/cm)	100	17	35	13
4	TDS (mg/l)	250	11.05	22.75	8.45
5	TSS (mg/l)	50	3	6	5.28
6	TURBIDITY (NTU)	5	6.36	12.28	10.55
7	COLOUR (PCU)	15	4	54	23
8	ALKALINITY (mg/l)	200	40	60	25
9	NITRATE ((mg/l)	50	65.1	79.4	78.4
10	NITRATE-NITROGEN(mg/l)	10	14.7	17.1	17.70
11	PHOSPHATE (PO_4^{3}) (mg/l)	5.0	0.1	0.9	0.5
12	PHOSPHORUS (P) (mg/l)	0.3	0.0	0.3	0.2
13	PHOSPHATE(P_2O_5) (mg/l)	-	0.1	0.6	0.4
14	SULPHATE(mg/l)	100	0	0	0
15	DO, (mg/l)	>40	9.0	8.9	6.5
16	AMMONIA (mg/l)	-	0.15	0.27	0.19
17	AMMONIA NITROGEN(mg/l)	17.0	0.09	0.23	0.12
18	AMMONIUM (mg/l)	-	0.11	0.29	0.17
19	SALINITY (%Brix)	-	0	0	0
20	BOD(mg/l)	-	3.4	3.6	2.4
21	COD(mg/l)	-	5.4	5.8	3.8
22	CADMIUM	-	0.335	0.359	0.210
23	LEAD	-	0.004	0.031	0.012
24	MECURY	-	0.00	0.00	0.00
25	IRON	-	4.220	4.751	3.258
26	CHROMIUM	-	0.030	0.873	0.357
27	NICKEL	-	0.084	0.259	0.148
28	ARSENIC	-	0.00	0.00	0.00
29	COPPER	-	0.262	1.801	1.270

TABLE 3: RESULT OF OGUTA LAKE SURFACE WATER ANALYSIS,September,2013

S/N	PARAMETERS	WHO STD	UPSTREAM	MIDSTREAM	DOWNSTREAM
1	TEMPERATURE (^{O}C)	20-30	29.3	30.9	30.7
2	pH	6.5-8.5	6.7	9.7	6.3
3	CONDUCTIVITY (us/cm)	100	8.0	22.0	10.9
4	TDS (mg/l)	250	5.2	14.3	6.5
5	DO (mg/l)	>4.0	9.4	8.2	9.2
6	TURBIDITY (NTU)	5	12.80	81	16.12
7	TSS (mg/l)	50	7	45	10
8	COLOUR (PCU)	15	22	54	56
9	PHOSPHATE (PO_4^3) (mg/l)	5.0	0.6	1.2	0.8
10	PHOSPHORUS (P) (mg/l)	0.3	0.2	0.4	0.3
11	PHOSPHATE(P_2O_5) (mg/l)	-	0.5	0.9	0.6
12	CALCIUM HARDNESS(mg/l)	150	0.78	0.85	0.82
13	MAGNESIUM HARDNESS(mg/l)	150	0.00	0.00	0.00
14	TOTAL CHLORINE(mg/l)	0.2-0.25	0.08	0.09	0.12
15	SULPHATE (mg/l)	100	0.00	0.00	0.00
16	NITRATE ((mg/l)	50	64.3	78.4	76.2
17	NITRATE-NITROGEN(mg/l)	10	14.1	16.9	16.2
18	BOD(mg/l)	-	1.2	1.3	1.7
19	COD(mg/l)	-	1.92	2.08	2.72
20	CADMIUM (ppm)	0.005	0.335	0.359	0.210
21	CHROMIUM (ppm)	0.05	0.030	0.873	0.357
22	LEAD (ppm)	0.05	0.004	0.031	0.012
23	NICKEL (ppm)	0.02	0.084	0.0259	0.148
24	ARSENIC (ppm)	0.01	0.00	0.00	0.00
25	IRON (ppm)	0.3	4.220	4.751	3.258
26	TOTAL COLIFORM COUN T (cfu/ml)	10	136	49	28

DISCUSSIONS

The distribution of analysed heavy metals in the sampled fish species was of the trend in ascending order; Copper, Nickel, Cadmium and Iron. The concentrations of the metals were higher in Mudfish and Tilapia while the lower concentrations alternated between Catfish and Ifuru. Copper levels were below the maximum permitted limit of Nigerian Industrial Standard (NIS), 1mg/L. Copper is known to be responsible for gastrointestinal disorder. Nickel exceeded the maximum permitted limited of 0.2mg/L in tilapia fish (0.225ppm). Elevated levels of Nickel have possible carcinogenic effect. The low levels of this parameter(0.24ppm-0.36ppm) has been reported by Oronsaye et al (2010) for Mormyops deliciosus and Mormyrus mactrophthalmus fish species from Ikpoba river dam. Cadmium level in all the sampled fish species exceeded the maximum permitted value of Nigerian Industrial Standard,0.003mg/l.Several studies have reported high levels of Cd in different fish samples from some Nigerian rivers. These include Odoemelam(2005) who reported 1.50ppm and 1.23ppm in Alestes nurse and Synodontis nigritis from Oguta Lake and Ishaq et al,.(2011) who reported 0.927ppm and 0.994ppm in C.gariepinus and T.zilli respectively from River Benue.Okoye,1991 reported concentration of 2ppm for cadmium and Oresaaye et al.,2010 reported cadmium of 0.79, 0.98ppm. Elevated levels of cadmium is toxic to kidney. Cases of high blood pressure or hypertension have been attributed to cadmium toxicity. Some hypertensive patients have been found having elevated amounts of cadmium in their kidneys (Ademoroti,1996). When inhaled, cadmium causes acute bronchitis and Pneumonities and inflammation in the liver. The levels of iron in all sampled fish species exceeded the maximum permitted limit of Nigerian Industrial Standard, 0.3ppm.High values of Iron have been recorded in many Niger delta environments by many research works (NEDECO,1961). Iron may cause Conjuctivities, Choroiditis, and Retinitis if it contacts and remains in the tissues. Inhalation of excessive concentration of iron oxide may enhance the risk of

Lung cancer development in workers exposed to pulmonary carcinogens.It is strongly advised not to let the chemical enter into the environment because it persists in the environment.

Turbidity, Nitrate, Nitrate-Nitrogen exceeded the standard limits of the water quality of Oguta Lake. Water containing some nitrate-nitrogen would be considered safe as nitrification had occurred and thus pollution could not have been recent (Ubong and Gobo,2001). On the other hand water containing high organic nitrogen and ammonia nitrogen shows pollution is recent and such water could be considered unsafe because of recent pollution. The water of Oguta Lake will sustain aquatic life because of the high level of dissolved oxygen and low level of BOD. Dissolved Oxygen is inversely proportional to Biochemical Oxygen Demand, BOD (McNeely et al,1979). For the heavy metals, Cadmium, Lead, and Iron exceeded the permissible limits of Nigerian Industrial Standard (NIS). Nickel was high at the upstream and low at the downstream. This can be attributed to dredging activities taking place at that station as nickel contamination is always associated with industrial activity. In small quantities nickel is essential, but when the uptake is too high, it can be a danger to human health. Nickel is released into the air by power plants and trash incinerators. It will then settle to the ground or fall down after reactions with raindrops. High nickel concentration in surface waters can diminish the growth rates of algae. Nickel is not known to accumulate in plants or animals. As a result Nickel will not biomagnify up the food chain in Oguta Lake.

Iron and Cadmium levels exceeded the maximum permissible limit of Nigerian Industrial Standards (0.3ppm, 0.003ppm) at all the sampled stations. It has been well established that excess Cadmium exposure produces adverse health effects on human beings. When inhaled, Cadmium causes acute bronchitis and pneumonities and inflammation in the liver. Cases of high blood pressure have been attributed to cadmium toxicity. Total Coliform count exceeded the permissible limit in all the sampled stations indicating feacal contamination

CONCLUSION

The results of this study showed that heavy metals were introduced into Oguta Lake through domestic and industrial waste discharge into the water body. Cadmium and iron exceeded the maximum permissible limit of NIS in the fish species and sampled stations of the water samples. However, the bioaccumulation of the heavy metals showed varying concentrations among the analysed fish species with iron and cadmium having higher values than the others.

Most of the analysed physicochemical variables of the water samples were within permissible limits of the reference standard; thus the water quality will sustain the aquatic life. The levels of iron, cadmium, turbidity, nitrate, total coliform count and nickel exceeded the maximum permitted limits of the Nigerian Industrial Standard.

The consequence is that the water could not be used for domestic purposes in the raw form without further treatment.

It is recommended that safe disposal of domestic sewage and industrial effluents should be practiced by operators and relevant legislations for protection of our water bodies enforced.There is need for regular monitoring of the lake as it is designated for use as a seaport.

REFERENCES

Ademoroti, C.M.A. (1996). Environmental Chemistry and Toxicology. Ibadan: Foludex Press ltd,171-204.

Anene, A.(1983). Oguta Lake Environment Studies. Hydrobiology and Fisheries Biology Research Laboratory. Department of Zoology, University of Port Harcourt.

Babatunde, A.M.,Waidi,O.A & Adeolu,A.A.(2013).Bioaccmulation of heavy metals in fish organs in downstream Ogun coastal water, Nigeria. Department of Aquaculture and Fisheries Management, Federal University of Agriculture, Abeokuta, Nigeria.

Diersing, N.(2009).Water quality frequently asked questions. Florida Books National Marine Sanctuary. Key West, Florida.

Egi, G. N.(1983).Photosynthetic Pigments(chlorophyll) and primary production of Oguta lake. B.Sc thesis. University of Port Harcourt.

Ishaq,E.S., Rufus ,A & Annune, P.A. (2011).Bioaccumulation of heavy metals in fish organs from River Benue,Nigeria.Park.J.Anal.Environ.Chem.129(1), 25-31.

Ita,E.O.& Balogun, J.K.(1983).A feasibility report of the fisheries potentials of Oguta Lake.Kainji Lake Research Institute, New Bussa, Nigeria.

Jaji, M.O,. Bamgbose, O,. Odukoya, O.O & Arowolo, T. A. (2007).Water quality assessment of Ogun River,Nigeria. Environmental Monitoring and Assessment,133(3),473=482.

Johnson, D. L., Ambrose, S.H & Winter-Nelson A.E (1997).Meanings of environmental terms. Journal of Environmental Quality,26,581-581.

King, M.O & Jonathan G.E (2003). Aquatic environment perturbations and monitoring. African experience, USA.

McNeely,R.N., Neimanis,V.P., &Dwyer,L. (1979).Water quality sourcebook(A guide to water quality parameters).Inland Waters Directorate, Ottawa, Canada,32-70.

NEDECO, (1961). The waters of the Niger Delta. The Hague (2nd) Revised edition, p.317.

Nnaji, O. A. (2011). An assessment of developmental potential of Oguta lake as a tourism destination. Review of Tourism Research. 9(6), 266p.

Odoemelam, S. A. (2005). Journal of Chemical Society. Nigeria, 30(18).

Oguta lake. (2008). www.llec.org. retrived 06/08/2008.

Oguta lake. (2013). Wikipedia, the free encyclopedia retrived 27/07/2013.

Okoye, B. C. O., Afolabi, O. A. & Ajao, F. A. (1991). Heavy metals in the Lagos lagoon sediments. International Journal of Environmental Studies, 37. 35- 41.

Omin, V. R. (1983). The diversity and abundance of phytoplankton of Oguta lake. B.Sc Thesis, University of Port Harcourt, Nigeria.

Oronsaye, J.A., Nangboye, O. M. & Oguzie, F. A. (2010). Trace metals in some benthic fishes of the Ikpoba River dam, Benin city, Nigeria. African Journal of Biotechnology, 9(51), 8860 – 8864.

Ubong, I. & Gobo, A. (2001). Fundamentals of Environmental Chemistry and Meterology. Port Harcourt: Tom and Harry publication ltd, pp 83 – 91.