ISSN 2229-5518

Heavy metals concentration of surface water, Sediments and some selected Fish species of Gurara reservoir, Kaduna State Nigeria.

*Auta, Y. I[1]., Ojutiku, O.R[2]., Kolo, R. J[2]., Francis, O. A[1]., Tsado, A.N[3] and Ayanwale, A.V[1].
[1] Animal Biology Department, Federal University of technology, Minna.
[2] Water resources, Aquaculture and Fisheries Technology Department, Federal University of Technology, Minna.
[3]Department of Biological Sciences, Niger State Polytechnic, Zungeru.

***Corresponding author: auta.iliya@futminna.edu.ng**

ABSTRACT

The concentrations of Iron (Fe), Copper (Cu), Zinc (Zn), Lead (Pb), Cadmium (Cd) and Chromium (Cr) in water, sediment and selected fish samples from Gurara water reservoir, Kaduna State, were assessed using Atomic Absorption Spectrophotometer (AAS 220 FS). Three samples each of selected Fish species (*T. Zillii*, *O.niloticus* and *S.Galileaus),* water and sediment from each Station were collected and analyze for heavy metals. Data obtained was subject to analysis of variance (ANOVA). The results showed higher levels of Fe (248.7±55.78mg/l)Sediment, (11.7±3.13mg/l) Fish and (20.68±17.29mg/l) surface Water. Zn (1.01±0.67mg/l) Sediments,(1.53±1.51mg/l) fish and (0.64±0.37mg/l) Water, in comparison with FAO, NIS and WHO standards,{(Fe; 0.3mg/l); (Zn:3mg/l);(Cr;0.05mg/l);(Pb;0.01);Cu;1mg/l) and(Cd;0.003mg/l)} of Drinking water quality Fe, Zn, Cr, Pb and Cu has exceeded the toxicity threshold in all the different samples. Cadmium was not detected in sediment, while it was in other samples (Water and Fish).The concentration was in trace amount below the United State Environmental Protection Agency (USEPA) allowable limits in water. Other metals were below allowable limit in water with reference to the World Health Organization's recommendation. This finding indicates that the surface water, Fish and Sediment is contaminated and not safe for aquatic life. The highest concentration detectable was in the sediment sample followed by the concentrations in the fish samples. Iron concentration detected was highest followed by Zinc, Lead, Copper, and Chromium, However, Cadmium was mostly undetectable in most samples. Strategies need to be develop to reduce the contamination and the biological effects on fish and other living organisms in the reservoir.

Key Words: Heavy metals, surface water, Sediments, selected Fish species, Gurara reservoir.

Introduction

The problem of heavy metals contamination has been on the increase globally especially in developing countries. Bagdatlioglu, *et al*.(2010). An aspect to consider in food quality assurance is contamination of food items by heavy metals due to their effects on human health Ogunkunle, *et al*, (2014). In general, various heavy metals are not degraded by living systems; they however have long biological half-lives and the potential to accumulate in different body organs resulting to unnecessary harmful effects, Rahimzadeh and Rastegar, (2017). The type of activities prevalent in any given environment determines the type of contamination in that area. Soil in a particular area may have been sinks for many hazardous wastes, organic wastes sewage and several other waste types generated from different human activities. In most cases, large ponds and heaps of wastes are left in the trail of excavations for minerals, rains wash the waste heaps into the surrounding water bodies, and farmlands, the ponds overflow their banks resulting in pollution even outside the area of production. A typical example is in Lead (Pb) or Zinc (Zn) mining fields of Ishiagu, Ebonyi State in Nigeria. lead (Pb) Poisoning is due to the interaction of the metal with biological electron-donor groups, specifically the sulf-hydryl groups that affect so many enzymatic processes. Clinical indications of Lead(Pb) toxicity consist of symptoms related to the central nervous system, the peripheral nervous system, the hematopoietic system, the renal system, the gastrointestinal systems and the reproductive system, Abdel and Abdellseid, (2013).

Iron (Fe) is a constituent of hemoglobin, *myoglobin*, some enzymes and approximately 30% of Fe in the body is present in storage forms such as *ferritin and hemosiderin* in the spleen, liver, bone marrow and a trivial amount is associated with the blood transport protein *transferring*, Kayika, *et al,* (2017). While excess of iron (Fe) has been reported to cause colorectal cancer, its deficiency causes anemia with one third of the world being affected Hassan, *et al*, (2014). Copper is one of the vital elements necessary for important biochemical functions and the maintenance of well-being, Hassan, *et al,* (2014). An adult body weight has around 1.5 - 2.0 ppm of copper (Cu) that is an important component of a number of metal enzymes necessary for hemoglobin synthesis and in the catalysis of metabolic oxidation. Copper (Cu) is also necessary for the maintenance of a healthy nervous system, body pigmentation in addition to iron and is interrelated with the function of zinc(Zn) and iron(Fe) in the body, Duran, *et al*,(2007). Cu deficiency may give rise to gastrointestinal disturbances, bone demineralization and depressed growth, whereas, excess may cause dermatitis, liver cirrhosis, neurological disorders Hassan,*et al,* (2014); iron(Fe) deficiency, lipid peroxidation and destruction of membranes Ogunkunle, *et al,* (2014); kidney damage and even death, Kayika, *et al,* (2017). Manganese (Mn) is a vital trace element, which performs important biochemical functions and is important for the maintenance of health throughout life. It is required for the development of connective tissues and bone, growth, carbohydrate and lipid metabolism, embryonic development of the inner ear and reproductive function, Tiimub, and Dzifa (2013). In recent times, Mn has been identified as a mineral that plays important role in the genes and progression of several diseases related in certain manner to oxidative stress Hossieni, (2011). Manganese deficiency resulting from poor diet, alcoholism and mal-absorption causes dwarfism, hypogonadism and dermatitis. Its presence in environment and consequent up take by humans causes pulmonary manifestation, fever, chills and gastroenteritis, Hossieni, (2011). it is necessary to analyze these food items to ensure the levels of these contaminants meet the agreed international requirements, Sajib, (2014).

MATERIALS AND METHODS

Description of Study Area

The study area covers the upper Gurara Dam area in Kaduna State, Nigeria, falling along Latitudes $9^{0}13'$N and $9^{0}39'$E and Longitudes $7^{0}2'$N and $7^{0}42'$E, an area approximately 150 km^2. It also encloses the pipeline route, a corridor 60m wide and 75km in length, with a pipeline for conveyance of water from upper Gurara Reservoir in Kaduna State to the existing Lower Usuma Lake in the Federal Capital Territory. The study area comprise parts of the Akwana West and East reserves and some scattered settlements such as Atara, Angwan Kagarko, Akwana. It is a rugged terrain with light to heavy bush and farms. The pipeline runs through Giwa Forest reserve, the vast rugged terrain of Chinka, Douphe, Gami in Kagako Local Government Area (LGA.) and Bwari settlement area to Usuman Forest Reserve around Ushafa in the Federal Capital Territory (FCT) with Jere occupying about 4016 km^2 of the area. Jere is where the Federal Ministry of Agriculture and Water Resources (FMA&WR) constructed a dam for the purpose of inter basin water transfer to supplement the lower Usman dam and Shiroro reservoirs for municipal water supply and hydroelectric power generation, respectively. The basin is oriented NE-SW with its headwaters originating from the west of Jos, Plateau State. The basin lies in the intermediate zone between the semi-arid north and the sub humid climate in the south. Its climate is characterised by dry Northern-winters and wet Northern summers. The vegetation type is savannah (Southern guinea savannah zone) grassland interspersed with

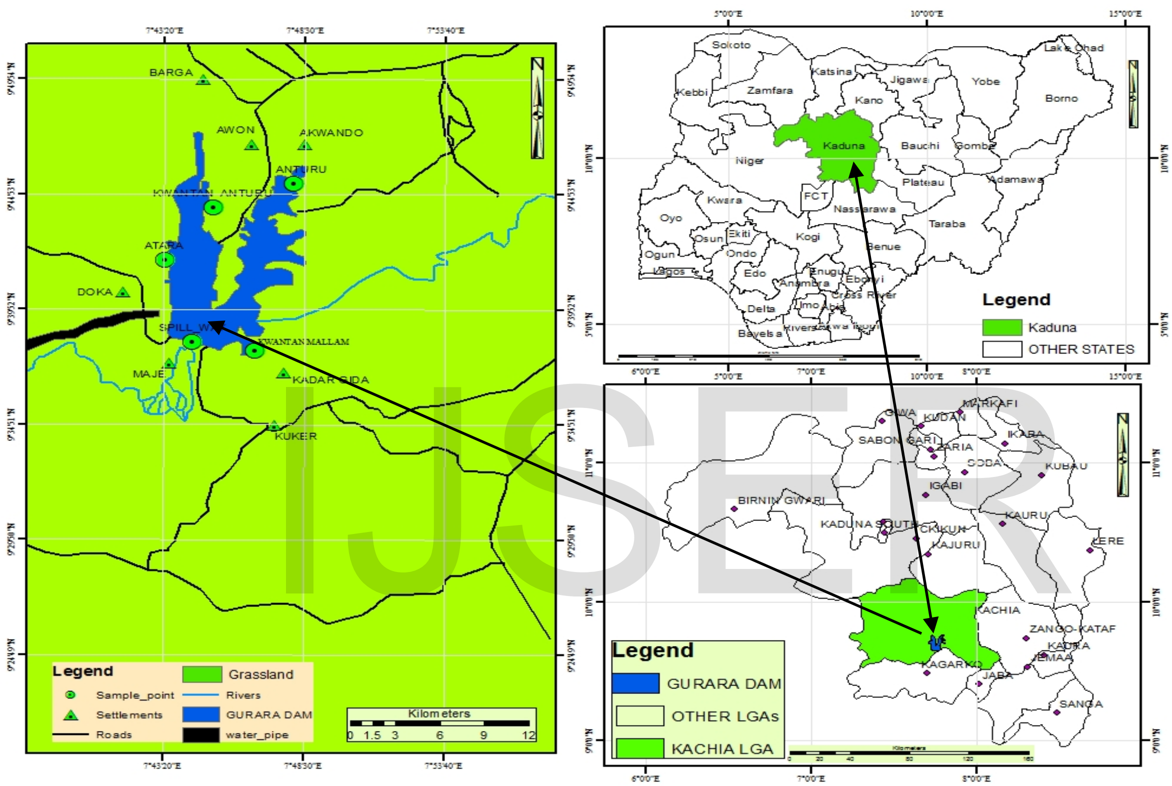
ISSN 2229-5518
tropical forest remnants. The watercourse is forested with large trees. The terrain is undulating conforming to the dominant structure of the underlying rocks-undifferentiated basement complex. The soil type is generally gravely red literate and in the river valleys, it is alluvial. The mean annual rainfall at the location is 1400 mm, while the mean monthly maximum and minimum temperatures in the catchment are 37.3°C and 19.7°C, respectively (Jimoh and Ayodeji, 2003). The study area has six tributaries namely River Iku, River Gurara, River Layi, River Rudu, River Kwohu, River Tapa and many streams, which are also tributaries of the Gurara River that flows North-South dropping gently from the Kukku hill ranges.

METHODOLOGY

Field Activities and Laboratory Procedures

The water sample for Heavy Metals Analysis was collected on monthly basis for a period of twelve months (March 2017-February 2018) from five stations (kwatan Mallam, Anturu, kwatan Anturu, Atara and Spill-way) within the reservoir based on accessibility. Sample collection was in 200mls Sampling bottles properly cleansed with de-ionized water prior to usage. Sampling was conducted by careful immersion of the sample containers in the lentic water. The containers were seal with tight fitting corks after collection in order to avoid contaminants. Samples were transfer to a refrigerator (4°C) prior to analysis. Similarly, Fish species were caught with baited non-return valve barrier traps, Gill nets of 20-45 mm mesh sizes to collect fish at depths not exceeding 25 m. Also used were cast nets of 10-22 mm mesh sizes for collecting fish at depths between 0 and 5 m. These gears were set in Stations, St_1, St_2, St_3, St_4 and St_5 respectively. Baits included earthworms and liver of animals. Services of anglers operating along the river were employed for the setting gears. Fish Samples were collected from the traps and nets at intervals of 24 hours and were preserved in cool box at 4°c before transportation to the laboratory. In the laboratory, identifications of the fish species were carried out following Reed *et al.* (1967), FAO,(1999), Oguzie,(1997). Fish Base,(2006) software was use as a guide. Further descriptions of the species were carry out on season Wikipedia,(2009) The free encyclopedia. The fishing gears were identified with reference to FAO, (1999) Catalogue of Small Scale Fishing Gears in Nigeria.

Figure : 1



Source: Remote Sensing/ Geographical information system (GIS) Laboratory, Geography Department, FUTMINNA,(2017)

KEY: Figure 1

A. Map of Nigeria showing Kaduna state
B. Map of Kaduna State showing Kachia local government
C. Hydrological map of Gurara Reservoir

Sample preparation and the determination

Water samples were process according to the method prescribed by the American Public Health Association (APHA, 2014) Standard methods.

Statistical Analysis

Prior to analysing the data in the different statistics software employed in this study, the raw data were enter into Excel (Microsoft 2007 office) and copied to relevant packages.Descriptive Statistics and Analysis of variance (ANOVA) was use to calculate the mean and Standard deviation of the heavy metals in surface water, Fish and sediments collected from the Reservoir.

RESULTS.

Table 1

			Stations				F-Value				P-Value
		1	2	3	4	5	Months	Stations		Months	Stations
	Zn+	0.33±.08	.46±.15	0.53±0.22	0.64±0.29	.64±.37	13.77	1.05		1.00E-11	0.39
		(0.08-1)	(0.03-2)	(0.05-3)	(0.04-4)	(.07-5)					
	Cd+	0.09±0.08	0.16±0.15	0.24±0,23	0.32±0.31	0.39±0.38	17.86	0.98		9.02E-14	0.43
		(0-1)	(0-2)	(0-3)	(0-4)	(0-5)					
	Fe+	1.45±0.31	13.19±11.5	4.46±1.93	20.68±17.29	1.87±0.35	2.92	1.13		0.004	0.35
		(0.36-4.32)	(0.18-15.83)	0.08-24.3	(0.16-23.67)	(0.28-5)					
	Cu+	0.13±0.08	0.18±0.15	0.27±0.23	0.36±0.30	0.41±0.38	17.11	0.9		2.00E-13	0.47
		(0.01-1)	(0-2)	(0-3)	(0-4)	(0.01-5)					
	Pb+	0.11±0.07	0.18±0.15	0.26±0.23	0.34±0.31	0.41±0.34	17.6	0.99		1.17E-13	0.42
		(0-1)	(0-2)	(0-3)	(0-4)	(0-5)					
	Cr+	0.08±0.08	0.18±0.15	0.24±0.23	0.34±0.31	0.39±0.38	17.59	0.99		1.20E-13	0.42
		(0-8)	(0-2)	(0-3)	(0-4)	(0-5)					

Mean and Standard deviation, minimum and Maximum range of Heavy metals in Surface Water of Gurara Reservoir, Kaduna State, Nigeria (February, 2017-March, 2018).

Table 2

			(March,2017-Feb-2018)			
	Lead	Copper	Iron	Zinc	cadmium	Chromium
Mar,2017	0.73±0.07	ND	6.60±1.44	0.16±0.01	0.21±0.12	0.12±0.07
	(0.09-1.39)	ND	(1.67-20.24)	(0.02-0.21)	(0.05-1.86)	(0-1.03)
April, 2017	1.32±0.23	ND	11.7±3.13	0.09±0.03	0.09±0.02	0.67±0.35
	(0.61-3.06)	ND	(2.13-44.3)	(0.02-0.39)	(0.02-0.24)	(0-4.92)
May,2017	1.05±0.29	ND	7.43±1.42	0.09±0.03	0.08±0.02	0.42±0.18
	(0.22-3.45)	(0-0.02)	(2.43-21.3)	(0.02-0.33)	(0.02-0.32)	(0-2.14)
June,2017	0.98±0.25	0.01±0.01	8.19±2.67	0.09±0.03	0.09±0.02	0.34±0.24
	(0.19-3.01)	(0-0.1)	(1.37-33.2)	(0.02-0.29)	(0.02-0.23)	(0-3.13)
July,2017	1.05±0.29	ND	7.43±1.42	0.09±0.02	0.08±0.02	0.42±0.18
	(0.22-3.45)	ND	(2.43-21.3)	(0.02-0.33)	(0.02-0.32)	(0-2.14)
Aug,2017	0.41±0.04	0.02±0.00	7.95±3.25	0.03±0.00	0.02±0.00	0.03±0.00
	(0.14-0.54)	(0.01-0.03)	(0.98-48.2)	(0.02-0.05)	(0-0.04)	(0-0.11)
Sept,2017	0.38±0.05	ND	6.68±3.78	1.53±1.51	0.01±0.00	0.02±0.01
	(0.06-0.71)	ND	(0.08-57.1)	(0-22.7)	(0-0.05)	(0-022)
Oct,2017	0.42±0.02	0.01±0.00	4.84±1.66	0.08±0.03	ND	0.01±0.00
	(0.28-0.59)	(0.01-0.02)	(0.34-25.3)	(0.01-0.46)	ND	(0-0.03)
Nov,2017	0.37±0.03	ND	4.92±1.94	0.06±0.02	ND	0.01±0.00
	(0.2-0.64)	ND	(0.21-22.8)	(0-0.27)	ND	(0-0.03)
Dec.2017	0.48±0.00	0.03±0.00	11.6±44.1	0.25±0.08	0.06±0.01	0.16±0.06
	(0.1-1.2)	(0.01-0.04)	(0.13-50.3)	(0.01-1.07)	(0-0.16)	(0-0.78)
Jan,2018	0.45±0.01	0.03±0.00	4.88±0.98	0.06±0.02	0.04±0.00	0.02±0.00
	(0.33-0.54)	(0.02-0.04)	(0.89-12.5)	(0.02-0.26)	(0-0.12)	(0-0.03)
Feb,2018	0.46±0.02	0.03±0.00	3.81±0.81	0.03±0.00	0.02±0.00	0.01±0.01
	(0.34-0.54)	(0.01-0.04)	(0.95-10.3)	(0.02-0.06)	(0-0.05)	(0-0.1)

Mean and Standard Deviation, Minimum and Maximum range of Heavy Metals in Fish Species of Gurara Reservoir in Kaduna State, Nigeria.

Table 3

	1	2	3	4	5
Zn+	1.01±0.67	0.45±0.09	0.43±0.15	0.51±0.16	0.49±0.12
	(0.06-8.35)	(0.03-1.37)	(0.03-1.96)	(0.04-2.08)	(0.06-1.72)
Cd+	ND	ND	ND	ND	ND
Fe+	196.24±47.49	226.7±6425	188.6±50.31	248.7±55.78	205.23±47.04
	(0.15-362.89)	(1.04-709.47)	(0.81-463.8)	(11.99-502)	(3.56-434.65)
Cu+	0.67±0.59	0.14±0.05	0.19±0.12	0.21±0.09	0.19-±0.09
	(0-7.24)	(0.02-0.65)	(0.01-1.5)	(0.02-1.25)	(0.01-1.18)
Pb+	0.44±0.38	0.12±0.05	0.07±0.02	0.06±0.02	0.07±0.02
	(0-4.6)	(0-0.69)	(0-0.17)	0-0.17	(0-0.19)
Cr+	0.86±0.63	0.63±0.31	0.74±0.47	1.08±0.65	0.64±0.39
	(0-7.78)	(0.03-3.93)	(0-5.83)	(0.02-8.19)	(0.01-4.98)

Mean and Standard Deviation, Minimum and Maximum range of Heavy Metals in Sediments of Gurara Reservoir in Kaduna State, Nigeria.

Discussion and Conclusion

The concentrations of heavy metals determined in the samples are presented in Tables 1-3. Zinc (Zn), Cadmium (cd), Iron (Fe), Lead(Pb), copper(Cu) and Chromium(Cr) were detected in the surface water, Fish and sediments. However, Cadmium was not detected in the sediments in some stations, while copper was not detected in the Fish species collected in some months (see Tables 1-3). The fish species collected were *T.zillii, O.Nilotucus and S.Galileous* and were collected based on their distribution and abundance in all the stations.

The concentration of Iron is highest in the sediment, Fish and surface water in decreasing order (Sediments>Fish>Surface water). The high content of Iron in the sediment may be due to clayey materials that may form the Riverbed. It may also be due to human activities such as the discharge of untreated sewage that contain Iron as well as the ability of the sediment to act as Sink, Kakulu and Osibanjo, (1998). Adeniyi and Yusuf, (2007) reported high concentration of Iron in sediment. In this research, the concentration of Iron has a mean lowest value of 188.6±50.31mg/l and a highest mean value of 248.7±55.78mg/l in the sediment, while surface water has a lowest mean value of 1.45±0.31mg/l and highest meant value of 20.68±17.29 (mg/l). Fish had a lowest mean value of 3.81±0.8mg/l and a highest mean value of 11.7±3.13 (mg/l) these values are above the recommended standards,(NIS, 2015;WHO,2011). Similarly, heavy metals concentration was higher in fish than in water of Gurara reservoir. This may be due to the ability of fish to bio accumulate much of these metals into their body tissue from the aquatic environment. The bioaccumulation of metals by fish has been reported by many researchers including Oguzie and Izevbigie (2009) and Murugan et al, (2008). Metals including Cr, Cu, Zn, Cd, Fe, and Pb were bio accumulated to varying levels. This is because fish like other aquatic organisms have the ability to concentrate heavy metals in their tissues to concentration level which comprised of several orders of magnitude higher than those in water, Oguzie (2003). Many species of fish especially the benthos have been found to bio accumulate most of these metals in their tissues. Asuquo and Bassey,(1999) reported that the intake of these toxins in the tissue of organisms may create health hazard to humans as its major predator and other fishes that prey on them. Several studies have indicated that metal accumulation in fish depends on numerous factors such as food habit of the fish, Tuzen (2003), tropic status, sources of a particular metal, distance of the fish from the contamination source and the presence of the other ions in the environment, Deb and Fukushima,(1999). Also Kalay and Canil (2000) reported that metal accumulation in the tissues of fish varied according to the rate of uptake, storage and elimination. The high level of Iron (Fe) and Zinc in this research could be attribute to their high demand as essential element in blood haemoglobin and as a dietary essential trace metals, Kambole, (2002).

Zinc as an essential trace metal becomes toxic when in the nutritional supply its becomes excessive, Olojo et al,(2005). The concentration of zinc in the surface water, fish and sediment analyzed are, water 0.3±0.08mg/l (low), 0.64±0.64mg/l (high), Fish 0.03±0.00mg/l (low), 1.53±1.5mg/l (high) and sediment 0.43±0.15mg/l (low), 1.01±0.67mg/l (high).National and international Standard organizations (NIS) and WHO acceptable limit is (3mg/l) for drinking water. These values are below the standard limits as such are safe for consumption by humans and other aquatic organisms. Zinc is release into the environment by natural processes, but most comes from human activities like mining, steel production, coal burning and burning of waste. Moderately increased zinc concentrations in water stem from the release of zinc from drainage pipes due to corrosion, it accumulates in fish and other organisms. Joshi,(1990). Cadmium is toxic to humans when the daily uptake is 250-300 micrograms; its effect on human health includes skeletal deformities and kidney damage Brandl, (2005). In this studies the concentration of cadmium in the surface water, fish and sediment are 0.09±0.08mg/l

ISSN 2229-5518
(low), 0.39±0.38mg/l (high),0.01±0.00mg/l (low), 0.21±0.12mg/l (high) respectively, but not detected in bottom sediment. The acceptable limit set by Nigerian industrial standard for drinking water NIS, (2015) and World health organization WHO (2011) and drinking water is 0.003 (mg/l). Cadmium is naturally present in water at small quantities. They are released from car exhaust into the environment and they found their way into water. Once in the air, it spread with the wind and settles into the ground or surface water as dust, Nzubechukwu et al, (2015). Although no health benefits to humans, it could be toxic above its set limit Wiltman, (2002), Duruibe *et al*, (2007).

The effect on aquatic organisms can be directly or indirectly lethal and can impact population and ecosystems as well as individuals. Skeletal deformities in fish can result in impaired ability to find food and to avoid predators, Laudis and Yu,(2003). This result indicates that Fishes and water in Gurara reservoir is gradually becoming unsafe for consumption if the Cadmium concentration is not properly managed.

The mean values of copper in Gurara reservoir surface water, Fish and sediment indicates that water is 0.13±0.08mg/l (lowest) and 0.41±0.38mg/l (highest), Fish recorded trace and in some stations not detected, sediment, 0.14±0.05mg/l (low) and 0.64±0.59mg/l (high). Significantly($p<0.05$) high presence of copper in the water and sediment might be due to erosion and leaching from natural deposits among other factors, Smith and Hashemi, (2003). Sediment content the highest concentration of copper compared with water and fish. This is because the drainage water transport considerable amount of allochthonous sediment into the reservoir, which are distributed by current and water movement throughout the surface water. These sediments are deposited on the bottom and constitute with autochthonous deposits the total sediment of the reservoir. Nguyena *et al*, (2005). However, the mean concentration value was lower than Nigerian industrial standard (NIS) and the World Health Organization (WHO) recommended standard (1.0mg/l) for portable drinking water quality.

Lead toxicity has become very important due to its great concern for human health, Healey, (2009). In this research, lead mean value in surface water, fish and sediment are as shown in table 1-3. Water has a lowest value of 0.11±0.07mg/l and its highest mean value of 0.41±0.34 mg/l. Fish has lowest concentration of 0.37±0.03 mg/l and its highest value of 0.06±0.02mg/l and its highest value at 1.32±0.23 mg/l while sediment has it lowest mean value of 0.06±0.02 mg/l and highest mean value of 0.44±0.38 mg/l in the order of fish> sediment>water in decreasing order. These values when compared with the Nigerian industrial standard for drinking water quality and the world health organization (WHO), 0.01 -10 mg/l) are above the acceptable limit. Bio-magnification of a pollutant may lead to toxic levels in species high up in the trophic food chain and in fresh water systems. People and fish are mainly exposed to lead by breathing and ingesting if in food, soil or dust Elder and Collins, (1999). Lead enters water system through run-off and from sewage and industrial waste streams. Raising level of lead in the water can cause generative damage in some aquatic life and cause blood and nervous changes in fish and other animals that live in water, Kalay *et al*, (1999). The above result indicate that the fish species collected accumulate lead in their organs more then contents in water and sediments, its concentration above the recommendated level poses a danger to the aquatic organism as well as humans. In addition, since there is cumulative effect of these heavy metals, their concentration may rise to a level which will become toxic both to aquatic organisms and man with unabated generation and disposal of heavy metals containing waste into the reservoir. The continue consumption of these species of fishes could result in outbreak of diseases associated with lead poisoning such as cancer, liver, brain and nervous disorders, FAO, (1999). Chromium (vi) compounds are toxins and known human carcinogens where as chromium (iii) is an essential nutrient. The concentration of chromium(Cr) in this work shows that the lowest concentration in water is 0.08±0.08 mg/l, while the highest mean value is 0.39±0.3mg/l. Fish mean lowest concentration is 0.01±0.00mg/l, while the highest is 0.67±0.35mg/l and sediment has 0.63±0.31mg/l as the lowest mean value with 1.08±0.65 mg/l as the highest mean concentration. The concentration of chromium was lower in the fish samples when compared to the value reported for Ovia River (0.09 mg/l) by Abolagba *et al*, (2005). The mean concentration value (1.08±0.65 mg/l) in sediment, (0.03± 0.03mg/l) in water and 0.67±0.35mg/l in fish are above the recommended standard limit (0.05mg/l) for drinking water quality by (NIS, 2015, FAO, 1999 and WHO, 2011). Chromium is found in rocks, animals, plants and soils and can be a liquid, solid or gas. its compounds bind in soil and are likely to migrate to ground water, but they are very persistent in sediment in lakes and reservoir, Sabine and Wendi, (2009). In these studies, chromium was at the toxic threshold in the fish, water and sediment in line with WHO standards in food. This may be attributed to the abundance of these metal in the ecosystem and fishes Species. USEPA,(2010). A remarkable relationship between heavy metals concentrations in water and fish was observed by Fernanders *et al*, (2008)

Conclusion and Recommendation

This study examined the concentrations of Iron (Fe), Copper (Cu), Zinc (Zn), Lead (Pb), Cadmium (Cd) and Chromium (Cr) in the fish samples from Gurara reservoir and compared the results with the Nigerian industrial Standard (NIS,2015) and World Health Organization (WHO,2011) allowable limits in Drinking water quality. Also, the same elements were determined in water and sediment in line with Nigerian industrial Standard (NIS,2015) and USEPA, (2010). The observed differences in metal concentrations in the three species of fish examined indicated difference in metal uptake as reported by Oguzie,(2003). Metal uptake and accumulation has a direct link with the feeding habit of fish and where fish resides in water Pradeep, *et al*,(2003). The reason for higher metal uptake in Tilapia Species collected is they are pelagic. It was generally observed that Fe and Zn were more concentrated in the fish, although there was a lack of general pattern of uptake and elimination which is species dependent as reported by Tuzen,(2003). The concentration of heavy metals in water and sediments in the present study showed trace amount of heavy metals, mainly from anthropogenic input from the surrounding local Governments (Kachia and Kagarko) through which the main tributary flow into the reservoir and the nature rocks the water flow. The level of metal accumulation in fish, water and sediment in the study area has constitutes health hazards to aquatic life and man. However, it is necessary to monitor the usage of the reservoir by appropriate agencies by adhering strictly to the rules guiding its safety. Government must ensure safe disposal of agricultural, domestic sewage and industrial effluents and recycled where possible to avoid these metals and other contaminants from going into the Reservoir. It is hereby recommended that, location of automobile workshops, dumping of domestic sewage and other activities that are inimical to the safe use of the Reservoir should be discouraged, while regular assessment of the reservoir to see to its cleanness and proper maintenance should be encouraged.

`

REFERENCES

Abdel. Rahman, T. & Abdellseid, A. M. (2013). Evaluation of Heavy Metals Contamination Levels in Fruit Juices Sa mples Collected from El -Beida City, Libya. *World Academy of Science, Engineering and Technology*, 77, 578 – 580

Abolagba, O.J, Igene, J.O and Oronbaye, J.A.O(2005) investigation on the fishing practice in Okemah area of Ovia northeast local Government area of Edo state , Nigeria. *J.agri.for.fis* 6(1)35-40.

Adeniyi, A.A and Yusuf, K.A (2007).Determination of Heavy metals in Fish Tissues. Environmental Monitoring assessment 37:451-458

American Public Health Association (APHA, 1998). Standard Methods for Examination of Water and Wastewater (20th edn). Washington DC: American Public Health Association, American Water Works Association and Water and Environment Federation. Available online at http:www.apha waterwaste.com. Retrieved on 24th July, 2014.

Asuquo, F.E and Bassy, F.S (1999) Bioaccumulation of heavy metals in fresh water fishes caught from cross-river system. *International Journal of Tropical Environment* 2:229-247

Bagdatlioglu, N., Nergiz, C. & Ergonul, G. P. (2010). Heavy Metal Levels in Leafy Vegetables and Some Selected Fruits. *Journal of Consumer Protection and Food Safety*, 5, 421-428.

Brandl, Heike (2005) Heavy metals in the environment: origin, interaction and remediation. *Elsevier/Academic press*, London.

Duran, A., Tuzen, M. & Soylak, M. (2007) Trace Element Levels in Some Dried Fruit Samples from Turkey. *International Journal of Food Science and Nutrition*, 59, 581-589.

Duruibe, J.O, Aguivegbu, M.O.C, and Egwurugwu, J.N (2007). Heavy metals pollution and human bio-toxic effects. *International journal of physical sciences* 2(5), 112-118.

Elder, J.F and Collins J.J.(1999) Fresh water mollusks as indicators of bioavailability and toxicity of metals in surface system. *Rev.environ.contain.toxicol.*122:37-79.

United State Environmental Protection Agency (EPA) (2010): National Guidance: Guidance for Assessing chemical contaminant data for use in fish Advisories. Volume II. Risk Assessment and fish consumption limits. 4th edn., Office of water, USA.

FAO.(1991). Catalogue of small scale fishing gear in Nigeria RAFR/014/F1/94/02. pp: 142.

Fernanders, C. , Fontainhas-fernanders , A., Cabral, D & salgado , M.A (2008). Heavy metals in water, sediment ant tissues of *liza saliens* from esmoriz-paramos lagoon, Portugal. *Environ. Monitt. Asses.* 136(1-3):267-775.

Fish Base, (2006). “Family-Search Result, Africa-Inland Waters”. In Fish base (Froese, R. and D. Pauly, ed). Available from: http: //www. Fish base. org/identification/ species. cfm? Fam code= 349 & area code =1. [Retrieved on 2007].

Food and agricultural organization (FAO 1999).Committee for inland fisheries for Africa working paper on pollution and fisheries.FAO fish, 2:105-119.

Hamed, M.A.(1998).Distribution of trace metals in the River Nile Ecosystem, Damietta branch between Mansoura city and Damietta province .*J. Egypt. Ger. soc.zoo* 27(4):399-415

Hassan, A. S. M., Abd El-Rahman, T. A & Marzouk, A. S. (2014). Estimation of some trace metals in commercial fruit juices in Egypt. *International Journal of Food Science and Nutrition Engineering* 4 (3), 66-72.

Healey, N.(2009).Lead Toxicity, vulnerable subpopulation and emergency preparedness. Rad. Prot.dosim.134:143-151

Hossieni, H. (2011). Determination of Zinc (II) Ions in Waste Water Sample by Novel Zinc Sensor Based on Newly Synthesized Schiff’s Base. *Material Science and Engineering journal,* 31, 428-433.

Joshi, H.C., (1990) Environmental coustraus in management of fisheries in open water system. Proceeding of the national seminar on management of fisheries in inland open water system of India. Barrac pore west Bengal India, 23-30.

Kakulu, S and Osibanjo, O (1998). Heavy metals in sediment and water. Nigerian Journal of chemical society,13:9-11

Kalay, M, AY, O. and Canli,M.(1999). Heavy metals in fish tissues from the northeast Mediterranean sea. *Bull. Environ. Contain. Toxicology,* 63:673-681.

Kambole, M.S (2009) Managing the water quality of the Kafue River in: Water demand Management for sustainable development. 3rd Water net werfsa symposium, Dares salaam,pp1-6

Kayika, P., Siachoono, S. M., Kalinda, C. & Kwenye J. M. (2017). An Investigation of Concentrations of Copper, Cobalt and Cadmium Minerals in Soils and Mango Fruits Growing on Konkola Copper Mine Tailings Dam in Chingola, Zambia. *Archives of Science,* 1 (1), 1–4.

Laudis, W.G andMing-Ho Yu (2003) Introduction to Environmental Toxicology: impacts of chemical upon ecological systems CRC press, Lewis publishers, Boca Raton, FL

Mugugan, S.S., Karuppaasamy, R., Padugodi,K and Rivaneswari, S (2008) Bioaccumulation pattern in zinc in freshwater fish *chanapunctatus* (Bioch) after chronic exposure Turkish Journal of Fisheries and aquatic sciences 8:55-59

Nguyena, H., Leermakers, M., Osan, J., Tfrk, S., Baeyensi, W (2005). Heavy metals in Lake Balaton. Water column suspended Matter, sediment and Biota. *Science of the Total environment*, 340:213-230

Nigeria industrial Standard for Drinking Water (2015). Standard Organization of Nigeria (SON). NIS-554-2015

Nzubechukwu, E., Udu, A.I., Okechuku, O.I., Victor, C.U, and Solomon, N.E. (2015) Evaluation of physico-chemical properties, mineral and heavy metal content of drinking water samples in two communities in south east Nigeria: A public health implication. *Journal of environmental and earth sciences*, volume 5, No 9: 2224- 3216.

Ogunkunle, A. T. J, Bello, O. S. & Ojofeitimi, O. S. (2014). Determination of Heavy Metal Contamination of Street-Vended Fruits and Vegetables in Lagos State, Nigeria. *International Food Research Journal* 21 (6): 2115-2120.

Oguzie, F.A and Izevbigie, E.F. (2007) Heavy metals concentration in the organs of the silver catfish, *chrysichthy Negrodigitatits* (Lacepede) cought upstream of the Ikpoba River reservoir in Benin city, Bioscience research communication21(1),189-197

Oguzie, F.A.(2003) Relationship between heavy metals content and body weight of selected freshwater fish species of the lower Ikpoba River in Benin city, Nigeria. *Pak. J. Sci. ind. Res*. 46(4) 246-250

Oguzie, F.A., (1999). A key to some of freshwater fishes of Nigeria (Adopted from Boulenger and Welman).Dept of Fisheries, University of Benin, Benin City. pp: 1-14.

Olojo, E. A.A., Olurin, K.B., Mbaka, G and Olumeimo, A.D (2005) Histopathology of gill and liver tissue of the African Catfish *Clarias gariepinus* exposed to lead. *African J. Biotechnology*. 40(1) 117-122

Pradeep, S., Alok, S., Abha, S (2003).Heavy metals pollution in sewage fed Lake of Blopal (M.P) India. *Lake reservoir Research Managemen*t 8(1): 1-4

Rahimzadeh, M. & Rastegar, S (2017) Heavy Metals Residue in Cultivated Mango Samples from Iran. *Journal of Food Quality and Hazards Control* 4, 29-31.

Reed, J. W.,. Burchard, A. J., Hopson, J. Jenness and Yaro,(1967). Fish and Fisheries of Northern Nigeria.1 Edition, Ministry of Agriculture press, Northern Nigeria, pp: 225.

Sabine, M and Wendy, G.(2009) Human health effect of heavy metals, center for hazardous substance research, *Environmental science and technology*, Brief for citizens, Kansas state university, 104 ward Hall, Manhattan Ks 66506.785-532-6519. WWW.engg.ksu.edu/CHSR/

Sajib, M. A. M., Hoque, M. M., Yeasmin, S. & Khatun, M. H.A. (2014). Minerals and Heavy Metals Concentration in Selected Tropical Fruits of Bangladesh. *International Food Research Journal*, 21 (5), 1731-1736.

Smith, W.F, and Hashemi, J.(2003) Foundation of material science and engineering, McGraw Hill professional, USA pg 223.

Tiimub, B. M. & Dzifa Afua, A. M. (2013). Determination of Selected Heavy Metals and Iron Concentration in Two common Fish Species in Densu River at Weija District in Grater Accra Region of Ghana. *American International Journal of Biology*, 1 (1), 45-55.

Tuzen,M(2003) Determination of heavy metals in Fish samples of the Mid dam Lake Black sea (Turkey) by graphite furnace Atomic Absorption Spectrometry. *Food Chemistry* pp:110-123

United State Environmental Protection Agency (USEPA,2010) Guidance on Evaluating Sediment Contaminant Results. division of Surface Water, Standard and Technical support section, USA.

Wikipedia, (2009) Fauna of Africa. Available from:http://en.wikipedia.org/wiki/Fauna_of_Africa.[Accessed 23 June 2009].

Witt man, R. H. (2002) Cadmium exposure and nephropathy in a 28- year old female, male worker *Environmental health prospect*.110: 1261-1269.

World Health Organization(WHO, 2011) Guidelines for drinking water Quality, fourth edition, Recommendation WHO, Geneva.