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Variation of Metal Contaminants in Surface Water and Associated Aquatic Life in Gubi Dam, Bauchi, Nigeria

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Abstract

This paper is an assessment of variation of metal contaminants in the surface water and associated marine life in Gubi dam. Data sources include water samples collected along the long profile of the dam different points and fish sample. Water sample were collected for a period of one months during dry season and analyzed in the laboratory for metal contaminants of zinc, chromium, lead, cadmium and copper using Atomic Absorption Spectroscopy (AAS) and the outcome was compared with the standards prescribed by World Health Organization (WHO and Nigerian Standard for Drinking Water Quality (NSDWQ) so as to determine their safety levels while the fish sample parts of , liver, gill, skin and muscle tissues were removed and analyzed. A laboratory based study was adopted. Fish and water samples were collected at different locations from Gubi Dam and analyzed for lead, cadmium, chromium, zinc and copper. For fish samples, liver, gill, skin and muscle tissues were removed and analyzed. Samples were acid digested and analyzed for heavy metals using Atomic Absorption Spectrophotometer. The concentration of heavy metals in raw water at first sampling station were Zinc, 0.01mg/l, lead0.03mg/l, Chromium 0.0.2mg/l, Cadmium 0.04mg/l, copper 0.01, copper 0.01, The concentration of heavy metals in raw water at second sampling station were Zinc, 0.03mg/l, lead 0.05mg/l, Chromium 0.04mg/l, Cadmium 0.06mg/l, 0.03mg/l copper 0.03mg/l, The concentration of heavy metals in raw water in third sampling station were Zinc, 0.04mg/l, Lead 0.07mg/l, Chromium 0.0.5mg/l, Cadmium 0.07mg/l, 0.05mg/l, copper 0.05mg/l . The result for raw water revealed they are within permissible limits. The concentrations of heavy metals in the muscle tissues of catfish are; lead (5.17) mg/Kg, cadmium 0.73 mg/kg, chromium 6.24mg/kg, zinc 66.60 mg/kg, respectively. Concentration in gill tissue are lead 12.80mg/kg, cadmium 0.62mg/lkg chromium 4.88mg/lkg copper 11.30mg/kg zinc 137.03mg/kg. The result showed that heavy metal concentration in tissues are above permissible levels for WHO AND FEPA standards, World Health Organization and Nigerian Standard for Drinking Water Quality.

Keywords: Atomic Absorption, Aquatic life, Heavy metals, Spectroscopy, surface Water, Variation

Introduction

Water is a vital resource for the survival of all living things. Without water, life on planet earth would not exist (Abrashnky, 2004). Development of human societies is heavily dependent upon availability of water of suitable quality and in adequate quantities for a variety of uses ranging from domestic, commercial, industrial, etc (Sundaradive and Vigneswaran, 2004). Where water resources are insufficient for the population, people fall prey to diseases, dehydration and in extreme cases death. The earth's hydrosphere has about 1.36 billion km^3 water and 75 % of the earth's surface is covered with water containing 97 % salt and 3% fresh water. Only 1 % of the fresh water is available for human consumption (Ali *et al,* 2012). It is certain that societies have to confront, among other things, demographic transitions, geographical shift in population, technological advancement, growing globalization, degradation of the environment and emergence of water scarcity. (Shaban and Sharna, 2007). The increase in demand for water as a result of increase in population and changes in life style and economic activities has put pressure on water supply systems which is considered as leading to shortages. It is not any kind of water we need, of course, but fresh water. Sea water is of only limited use to us, and out of reach for people living deep inside continent; and drinking it is harmful. For the most part, therefore, we humans must obtain all the water we need from rivers, lakes and underground aquifers (Alia by, 1996). Of all the water in the world, 97 per cent is in the oceans, so our freshwater needs must be met from the remaining 3 per cent. It is not even that simple, however, because of all the freshwater, more than half is frozen in the polar ice caps and glaciers, and about 0.5 is so far below ground as to be beyond our reach. Atmospheric water vapour, falling rain and snow, and flowing rivers contain no more than about 0.05 percent of the planet's water (Kupchella and Hyland 1986).Start by explaining the importance of water to humanity, link this to the scarcity of fresh water resources as a result of over exploitation and pollution. Link this to the global concern of quality and safe water as a means of reducing water borne diseases. Follow this with how increasing pollution and anthropogenic activities is contributing pollutants into the water resources. Pollution generally denotes any unwanted alteration in the natural quality of any ecosystem brought around by the changes in their physical, chemical, as well as in biological factors (Subhendu, 2000).

However, once a saturation point is reached, the body‘s mechanisms that maintain balance no longer operates. None of the metals is biodegradable, although they can change forms from solid, to liquid, to dust and gas; they never completely disappear. The ones that are toxic even in the minutest amount create instant cellular destruction in any of their forms. They all exist naturally on the earth crust and the most toxic must be mined by man before they become a threat to plant and animal life

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Heavy metals occur naturally in the ecosystem with large variations in concentration. Some of them are dangerous to health or to the environment (e.g. mercury, cadmium, lead, chromium) (Hogan, 2010), some may cause corrosion (e.g. zinc, lead), while some are harmful in other ways (e.g. arsenic, which may pollute catalysts). Some heavy metals are actually necessary for humans in minute amounts (cobalt, copper, chromium, manganese, nickel) while others are carcinogenic or toxic, affecting, among others, the central nervous system (manganese, mercury, lead, arsenic), the kidneys or liver (mercury, lead, cadmium, copper) or skin, bones, or teeth (nickel, cadmium, copper, chromium) (Zevenhoven and Kilpinen, 2001). Some metals are highly absorbable while some are difficult to absorb and that is because the body has mechanisms that prevent their over-absorption.

Pesticides used in agricultural activities are directly released into the open atmosphere by drift spray, volatilization and wind erosion of soil (Qiu et al., 2004). These pesticides present in aquatic ecosystem can affect the life cycle of aquatic organisms (Ventura et al., 2008). Several factors like increasing population, industrialization, urbanization, forest loss, lack of environmental awareness among society, lack of policy implementation, rules and regulations, effluent discharge from different industries, etc. leads to pollution in the aquatic ecosystem and ultimate loss of aquatic organisms and wellbeing humanity. The pollutants released from different types of industrial discharge and sewage not only pollute the surface water of rivers and reservoirs but also infiltrate into ground and also pollute the ground water resources. Aquatic ecosystems are exposed to pollution loads is associated with the increase in urbanization and population growth (Edokpayi and Nkwoji, 2000; Nkwoji *et al.*, 2010). These pollutants cause major threats to aquatic ecosystems, alter hydrology, physicochemical and faunal characteristics (Nkwoji *et al.*, 2010).

Water-soluble pollutants released from different industries and municipal activities, leached in soils directly and in turn, the atmosphere are quickly transported to natural water bodies. Some of the toxins decay or volatilize to form insoluble salts and the rest are precipitated and get combined into the substrate in bed surface. Fish species are the perfect model for sensing the occurrence of genotoxic toxins in aquatic ecosystems (Aich et al., 2015; Walia et al., 2015; Sharma et al., 2018) because these aquatic organisms are very sensitive to little quantity of metals within the water body, are abundant, and also live in some different habitats (Ali et al., 2008). Aquatic organisms like fish species that directly uptake these toxic substances may be followed by the metabolism of these toxic substances which results in more toxic by-products. For example, mercury can be converted into very high toxic methyl-mercury by the microbial action which in turn is taken up by fish species (Bukola *et al.*, 2015). Fish fry, larvae, yearlings and fingerlings are one of the most susceptible life stages which are harshly affected by pesticides and heavy metal pollution exposure as non-target aquatic organisms. Alterations of the vital organs i.e. gills, kidney, and liver might distress the physiology, rate of survival, osmoregulation, buoyancy, reproduction processes etc., and in turn lead to failures in stock conscription and populace changes (Khoshnood, 2017).Some aquatic animals have been identified to concentrate the toxic solutes from their habitat without any apparent harm to themselves and thus acts as pollutant amplifiers, making the toxic substances offered to predators at dangerously high levels. Some cases have been reported explaining the adverse impacts of environmental pollutants on fish's health and also to fish consumers. Due to the increased anthropogenic activities, a high load on the aquatic ecosystem determines the necessity of researches fervent to check the adverse impacts of water pollution and its probable risk for the aquatic organism and their ecosystems. Different types of lethal impacts of water pollution have been perceived in aquatic communities inhabiting the water bodies over numerous scientific researches. The decreasing fish populaces and partial loss of commercial fishing predict huge changes in the aquatic ecosystem (Hinton and Lauren, 1990). Fish communities are one of the most valued resources of high mark protein to humans. The modifications in the morphology, tissue and biochemical composition by the aquatic organism highlight the different types of stress and changes in habitat ecosystem e.g. if some fish species are exposed to chemical contaminants, acts rapidly and induces a series of modifications in different body parts and organs, mostly gills, kidneys and liver (Bukola *et al.*, 2015). Thus, a varied series of histo-cytological changes in fish species have been developed and endorsed as biomarkers for the purpose of monitoring the water pollution level.

Among environmental pollutants, heavy metals are of particular concern; due to their potential toxic effect and ability to bio-accumulate in aquatic ecosystems (Censi *et al.*, 2006) thus, the pollution of the aquatic environment with heavy metals has become a public health problem worldwide during recent years. Heavy metals that are deposited in the aquatic environment may accumulate in the food chain and cause ecological damage as well as threat to human health (Van de Broek *et al.*, 2002; Gagnaire *et al.*, 2004). Studies have shown that fish accumulate these heavy metals from the surrounding water bodies thereby leaving a health risk if taken as food (Prusty, 1994; US.DPHHS, 2005). Heavy metal intake has also been reported to be essentially due to drinking contaminated water and ingestion of contaminated food (Idodo-Umeh, 2002; FEPA, 2003; Asonye *et al*, 2007).

Heavy metals such as copper, iron and nickel are essential metals since they play important roles in biological systems, whereas Mercury, cadmium and lead are non-essential metals, as they are toxic, even in trace amounts (Fernandes *et al.,* 2008). However, these essential metals canalso produce toxic effects when the metal intake is excessively elevated (Tüzen, 2003). Heavy metals are taken into biological systems via inhalation, ingestion and skin absorption. If they enter and accumulate in body tissue faster than the body's detoxification pathways can dispose of them, a gradual build-up of these toxins will occur and result in toxicity. High concentration exposure however, is not necessarily required to produce a state of toxicity in the body tissue as overtime low concentrations can also reach toxic levels (Prusty, 1994). Heavy metals such as chromium, cadmium, zinc and lead at higher concentrations can damage vital organs and retard growth (Afshan et al 2014).

However, once a saturation point is reached, the body's mechanisms that maintain balance no longer operates. None of the metals is biodegradable, although they can change forms from solid, to liquid, to dust and gas; they never completely disappear. The ones that are toxic even in the minutest amounts create instant cellular destruction in any of their forms.

It's against this background that this study on the impact of water pollutants as they affect cat fish in Gubi dam was carried out. Catfish was chosen because it the most popular fish species among fishermen and the general public who are the consumers.

Review of Some Heavy Metals

Physical Properties of Heavy Metals

Metals in general have high electrical conductivity, thermal conductivity, luster and density and the ability to be deformed under stress without cleaving (Mortimer and Charles, 1975).While there are also several metals that have low density, hardness, and melting points, these (the alkali and alkaline earth metals) are extremely reactive, and are rarely encountered in their elemental, metallic form. Optically speaking, metals are opaque, shiny and lustrous (Mortimer and Charles, 1975).

Chemical Properties of Heavy Metals

Chemically, the metals differ from the non-metals in that they form positive ions and basic oxides and hydroxides. Upon exposure to moist air, a great number of metals undergo corrosion, i.e., enter into a chemical reaction; e.g., iron rusts when exposed to moist air, the oxygen of the atmosphere uniting with the metal to form the oxide of the metal. Aluminium and zinc do not appear to be affected, but in fact a thin coating of the oxide is formed almost at once, stopping further action and appearing unnoticeable because of its close resemblance to the metal. Tin, lead, and copper react slowly under ordinary conditions. Silver is affected by compounds such as sulphur dioxide and becomes tarnished when exposed to air containing them (Columbia Encyclopedia, 2007).

Lead

The abundance of lead in the Earth's crust is estimated to be between 13 and 20 parts per million. It ranks in the upper third among the elements in terms of its abundance. Lead rarely occurs as a pure element in the earth. Its most common ore is galena, or lead sulfide (PbS). Other ores of Lead are anglesite, or lead sulfate (PbSO4); crosstie, or lead carbonate (PbCO 3); (Earnshaw and Green, 1997).Lead is one of the few elements known to ancient people and throughout history; Lead has been used to make water and sewer pipes; roofing; cable coverings; alloys with other metals; paints; wrappings for food; tobacco and as an additive in gasoline. In spite of its vast application, Lead is number two on the ATSDR's (Agency for Toxic Substance and Disease Registry; Atlanta, USA.) ‗Top 20 List‘‘(ATSDR, 2001ToxFAQs).

Sources of Lead

Lead occurs naturally in all soils, generally at the rate of 15-40 parts per million depending on the location of the soil sample taken. Since it never disintegrates, it is much higher in older cities; where large quantities of dust from leaded paint have mixed with the soil. Lead is the most ubiquitous heavy metal on the planet and can be found in lead paint dust, car exhaust, and industrial waste. In addition, over four (4) million tons of lead are liberated from the earth‘s crust each year so that manufacturers can use it in their products (ATSDR, 2001). It is contained in such diverse things as insecticides, glass, heavy duty greases, certain plastics, cisterns, lead wires, metal alloys, roof coverings, solder, storage batteries, and varnishes. Another major source of lead is recycled car batteries. It can also found in sewerage systems.

Cadmium

Cadmium can mainly be found in the earth's crust. It always occurs in combination with zinc. Most cadmium is obtained as a by-product from zinc refinement. Cadmium and zinc melt at different temperatures, providing one way of separating the two metals. As a liquid mixture of zinc and cadmium are cooled, zinc becomes a solid first. It can be removed from the mixture, leaving liquid cadmium behind (Cotton et al., 1999). Cadmium also exists in the industries as an inevitable by-product of zinc, lead and copper extraction. Naturally, a very large amount of cadmium is released into the environment, about 25,000 tons a year. About half of this cadmium is released into rivers through weathering of rocks and some cadmium is released into air through forest fires and volcanoes. The rest of the cadmium is released through human activities, such as manufacturing. Cadmium presents a threat to the environment because of its many applications (ATSDR, 2001).Eight naturally occurring isotopes of cadmium exist. They are cadmium-106, cadmium-108,cadmium-110, cadmium-111, cadmium-112, cadmium-113, cadmium-114, and cadmium-116. About 20 radioactive isotopes of cadmium are known (Cotton et al., 1999).

Sources of Cadmium

Cadmium due to its wide application is found in almost all environmental matrices. It is found in the air we breathe as an industrial contaminant. Acidic water leaches metal water from pipes. It is in black polyethylene, black rubber, burned motor oil, dental prosthetics, ceramics, evaporated milk, fungicides, rust proofing paint, organ meats such as kidney and liver, oysters and other sea foods, paint pigments, pesticides, plastic tape, polyvinyl plastics, processed foods, rubber carpet backing, rubber tires, silver polish, solders, and super phosphate fertilizers (Cotton et al., 1999).In terms of industry, it is prevalent in the jewelry making industry, marine hardware manufacturing, paint manufacturing, ceramics manufacturing, and fungicide manufacturing, and electroplating metals. One cannot discuss the sources of cadmium without talking about cigarette smoking, for there is an immense amount of it in tobacco leaves, which are sprayed with cadmium fungicides. Each cigarette averages 1.4 micrograms of cadmium (Gschneidnerand Eyring, 1999). Besides smoking, cadmium is found in food as it is a natural part of the earth crust. However, modern practices of processing often remove the zinc that could keep the cadmium from harming us. For example, there is one-part cadmium to 120 parts zinc in wheat. Refining reduces this ration to 1-part cadmium to 12 parts zinc. The same is also true for rice (Earnshaw and Greenword, 1997).

Chromium

Chromium with the chemical symbol Cr and atomic number 24 is a transition metal found in the centre of the periodic table. It belongs to group 6 or VIB and has an atomic mass of 51.996. The abundance of chromium in the Earth's crust is about 100 to 300 parts per million. It ranks about number 20 among the chemical elements in terms of their abundance in the earth. Chromium does not occur as a free element. Today, nearly all chromium is produced from chromite, or chrome iron ore ($FeCr_2O_4$) (Cotton et al., 1999).

Sources of Chromium

About three-quarters of chromium produced today are used in alloys, including stainless steel. An alloy is made by melting and mixing two or more metals. The mixture has different properties than the individual metals. Chromium is also used to cover the surface of other metals. This technique protects the base metal and gives the surface a bright, shiny appearance at a low cost. Chromium can also be obtained by passing an electric current through its compounds. Sometimes chromite is converted directly to an alloy known as ferrochromium (or ferrochrome). Ferrochromium is an important chromium alloy. It is used to add chromium to steel. All chromium compounds are sources of chromium (Livelonger cleanse, not dated).

Zinc

Zinc is a bluish-white, lustrous metal. It is brittle at ordinary temperatures but malleable at 100 to 150°C. It is a fair conductor of electricity, and burns in air at high red heat with evolution of white clouds of the oxide. In addition, it is a fairly reactive metal that will combine with oxygen and other non-metals, and will react with dilute acids to release hydrogen. Zinc can be obtained by roasting its ores to form the oxide and by reduction of the oxide with coal or carbon, with subsequent distillation of the metal. Other methods of extraction is possible. Naturally occurring zinc contains five stable isotopes. Twenty-three other unstable isotopes and isomers are recognized. The metal is employed to form numerous alloys with other metals. Brass, nickel silver, typewriter metal, commercial bronze, spring brass, German silver, soft solder, and aluminium solder are some of the more important alloys (Cotton et al., 1999).

Copper

In the periodic table, copper is found in group IB that includes transition metal elements such as silver and gold. The abundance of copper in the Earth's crust is estimated to be about 70 parts per million. It ranks in the upper quarter among elements present in the Earth's crust. Small amounts (about 1 part per billion) also occur in seawater. At one time, it was not unusual to find copper lying on the ground. However, this is no longer true. Today, copper is obtained from minerals such as azurite, or basic copper carbonate ($Cu_2(OH)_2CO_3$); chalcocite, or copper glance or copper sulphide (Cu_2S); chalcopyrite, or copper pyrites or copper iron sulphide ($CuFeS_2$); cuprite, or copper oxide (Cu_2O); and malachite, or basic copper carbonate
($Cu_2(OH)_2CO_3$). There are two naturally occurring isotopes of copper, copper-63 and copper-65. Nine radioactive isotopes of copper are known also (Cotton et al., 1999).

Copper is a component of more than 30 enzymes, some of which are involved in collagen synthesis. It is necessary for connective tissue, nerve coverings, and bone. It is also involved in iron and energy metabolism. Copper is a metal used by people who lived in prehistoric times. Jordan, Egypt and Israel have copper smelting locations that date back to 4500 B.C. The people who lived in that historical period combined copper with iron or tin to produce an alloy called bronze. Another alloy of copper is brass. Brass and bronze are stronger than copper; hence, it was used to make weapons such as spear tips, hammers, axes and so on. Copper occurs in nature mixed with other elements in a number of compounds. It is responsible for the green pigmentation in turquoise, malachite, and azurite. It is the third most widely used metal in the world after aluminum and steel, and has therefore been mined for centuries. Being a natural substance that is part of the earth's crust, like all metals it is found in air, soil, water, and other organisms (Gschneidner and Eyring, 1999).

Effect of heavy metals on fish

The toxic effects of heavy metals can affect the individual growth rates, physiological functions, mortality and reproduction in fish. Heavy metals entre in fish bodies by three possible ways: by gills, by digestive track and body surface. The gills are considered as the significant site for direct uptake of metals from the water though the body surface is normally estimated to take minor part in uptake of heavy metals in fish (Afshan et al 2014).

Chromium

Some species of fishes have poisonous effect of chromium as echoed in the blood changes such as anemia, eosinophilia and lymphocytosis, bronchial and renal lesions. Chromium known for its lesser accumulation in fish bodies while the higher concentrations of chromium damages the gills of the fish which lead to respiratory problems (Afshan et al 2014).

Cadmium

At higher concentration cadmium damage the kidney and produced signs of chronic toxicity, including impaired reproductive capacity and kidney function (Afshan et al 2014).

Zinc

At higher concentrations, Zinc produced adverse effects in fish by structural damages, which affects the growth, improvement and survival of fish. Zinc accumulates in the gills of fish and this designates a depressing effect on tissue respiration leading to hypoxia which results in death. Zinc pollution also tempts changes in ventilator and heart physiology. Sub-lethal levels of zinc have been known to unfavourably affect hatchability, existence and hematological structure of fish (Afshan et al 2014).

Lead

Lead enters in water systems through runoff, industrial and sewage waste streams. Increasing levels of lead in the water can cause generative damage in some aquatic life and cause blood and nervous changes in fish (Afshan et al 2014).

Materials and Methods

Description of Study Area

Gubi dam is a storage dam constructed in 1979 to impound water from the upstream side of river Gubi during the periods of excess supply. It has a top water level of about 577M and 3KM long. It is located in the northern part of Bauchi town, Nigeria. It lies within the boundary of longitude 10025/N to 10026/N and latitude 9051/E to 9052/E (Fig. 1). The region is classified as tropical and the rainfall in the dam basin ranges from 970mm to 1400mm with about 50 to 60% of this rainfall occurring between

July and August. The dam receives its water from Tatimari (Shadawanka, Dinya) Larkarina, Suntum and Kumi tributaries. The dam is used for *drinking*, irrigation and fishing by settlers around the dam (BASWB, 1990, Agya, 2002). Bauchi state is one of the states in the northern part of Nigeria that span two distinctive vegetation zones, namely, the Sudan savannah and the Sahel savannah. The Sudan savannah type of vegetation covers the southern part of the state. Here, the vegetation gets richer and richer towards the south, especially along water sources or rivers, but generally the vegetation is less uniform and grasses are shorter than what grows even farther south, that is, in the forest zone of the middle belt. The Sahel Savannah type is characterized by relatively sparse vegetation fewer trees grasses. At least about eight months of the are dry rainfall confined to a short season with an average of 100mm-200mm..

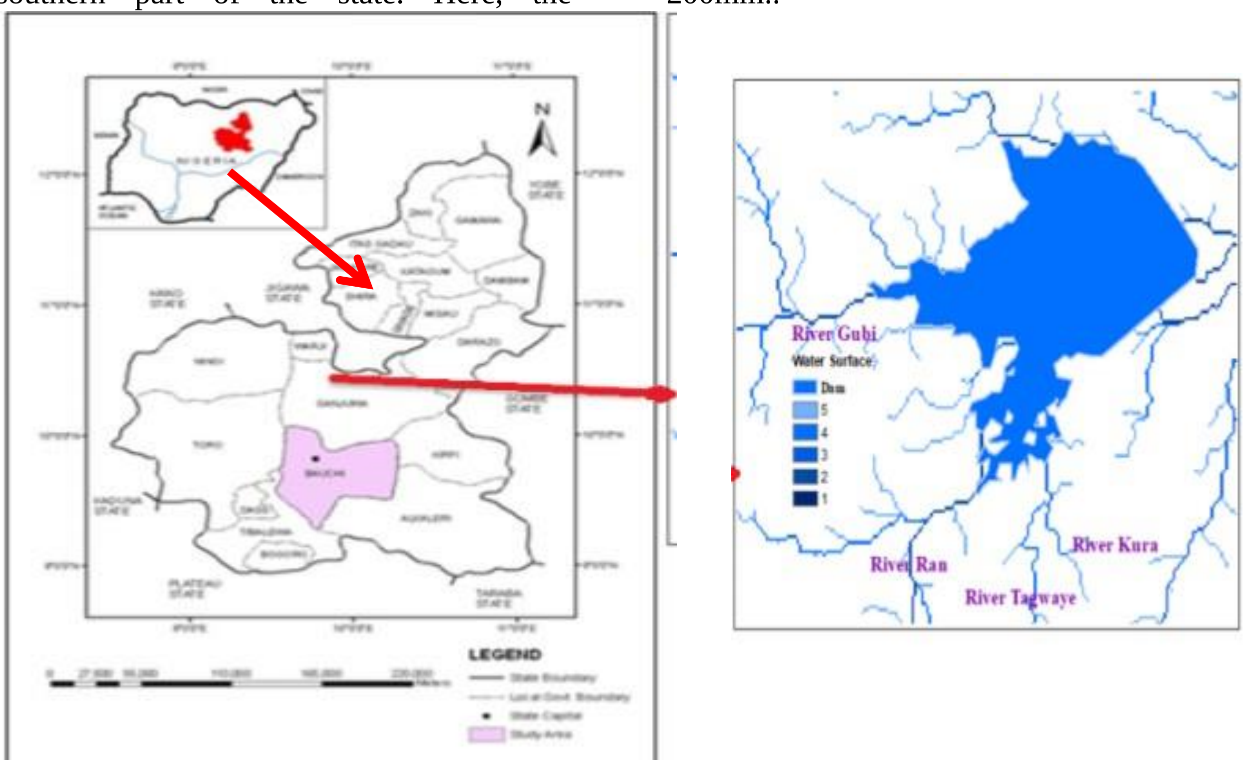

Figure 1: Location of Study Area

Data Collection and Analysis

Water samples were collected from three sampling stations at the interval of 20meters (20m) from Gubi dam in bottles. All containers used for sampling and storage were thoroughly washed with solution of detergent and distilled water.

Data Collection

Collection and Storage of Fish Samples

Samples of *Clarias gariepinus* (catfish) were collected from Gubi Dam with the assistance of local fishermen for the assessment of heavy metals and stored in amber bottle, placed on ice and taken to the laboratory.

Data Analysis
The fish samples were put onto a dissection tray and dissected directly using stainless steel scalpels and Teflon forceps on a laminar flow bench. Dissection of the fish samples was carried out to separate liver, gill, skin and muscle tissues using the methods recommended by UNEP/FAO/IAEA/IOC (1984) and Bernhard (1976).
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Result and Discussion
Analysis of Heavy Metal Concentration in Water Samples
Table 1: Fish Sampling Station

Heavy metals	Concentration mg/l	WHO/2018	NSDWQ 2007
Lead	0.03	0.01	0.01
Cadmium	0.04	0.003	0.003
Chromium	0.02	0.05	0.05
Copper	0.01	1	1
Zinc	0.01	3	-

Source: Laboratory Analysis 2021.

The results of heavy metals concentrations in the raw water of the first sampling station are as follows: zinc, 0.01mg/l, lead 0.03mg/l, chromium0.0.2mg/l, cadmium 0.04mg/l, copper 0.01mg/l Table 1.

Table 2: Second Sampling Station

Heavy metals	Concentration mg/l	WHO/2018	NSDWQ 2007
Lead	0.05	0.01	0.01
Cadmium	0.06	0.003	0.003
Chromium	0.04	0.05	0.05
Copper	0.03	1	1
Zinc	0.03	3	_

Source: Laboratory Analysis 2021.

The results of heavy metals concentrations in the raw water in the second sampling station are as follows zinc, 0.03mg/l, lead0.05mg/l, chromium0.04mg/l, cadmium 0.06mg/l, copper 0.03mg/l. Table 2..

Table 3: Third Sampling Station

Heavy metals	Concentration mg/l	WHO/2018	NSDWQ 2007
Lead	0.07	0.01	0.01
Cadmium	0.07	0.003	0.003
Chromium	0.05	0.05	0.05
Copper	0.05	1	1
Zinc	0.04	3	_

Source: Laboratory Analysis 2021.

The results of heavy metals concentrations in raw water in the third sampling station are as follows .zinc, 0.04mg/l, lead0.07mg/l, chromium0.0.5mg/l, cadmium 0.07mg/l,. Copper 0.05mg/l Table 3.

Table 4**:** Heavy Metals Concentration in Fish Samples.

Heavy metals	**Tissues**	**Concentration mg/kg**	**FAO (1987) standard mg/kg**	**WHO (1985) standard mg/kg**	**FEPA (2003) standard mg/kg**
Lead	Liver	6.94			
	Gill	12.80	0.50 – 6.00	2.00	2.00
	Skin	7.17			
	Muscle	5.17			
Cadmium	Liver	1.23			
	Gill	0.62	0.05 – 5.50	2.00	
	Skin	0.47			
	Muscle	0.73			
Chromium	Liver	3.46			
	Gill	4.88	1.00	0.15	0.15
	Skin	5.45			
	Muscle	6.24			
Copper	Liver	168.82	10-100	3.0	1-3
	Gill	11.30			
	Skin	6.41			
	Muscles	6.58			
Zinc	Liver	233.42			
	Gill	137.03	30 -100	10 – 75	75
	Skin	96.72			
	Muscle	66.60			

Source: Laboratory Analysis 2021.

The results of the concentration of heavy metals in the tissues of catfish samples from Gubi dam are as follows:

Lead—liver 6.94mg/ kg, gill 12.80mg/kg, skin 7.17mg/kg, muscle 5,17mg//kg. Cadium—liver 1.23mg/kg, gill 0.62mg/kg, skin 0.47mg/kg, muscle 0.73mg/kg. Chromium—liver 3.46mg/kg,gill 4.88mg/kg, skin 5.45mg/kg muscle 6.24mg/kg. Copper—liver 168.82mg/kg, gill 11.30mg/kg skin 6.4mg/kg1 muscle 6.58mg/kg. Zinc—liver 233.42mg/kg, gill 137.03mg/kg, skin 96.72 mg/kg, muscle 66.60mg/kg.

Discussion

The result of the analysis of the concentration of heavy metals in raw water and catfish (*clarias griepinus)* as indicator in Gubi dam showed that the concentration of leads at first sampling station is 0.03mg/l, second sampling station is 0.05mg/l, third sampling station 0.07mg/l and the standard according to WHO/2018 and NSDWQ 2007 are 0.01 respectively therefore Lead concentration in all the three stations have exceeded the WHO and NSDWQ standard. the concentration of cadmium at first sampling station is 0.04mg/l, second sampling station is 0.06mg/l, third sampling station is 0.07mg/l and the standard level prescribed by WHO/2018 and NSDWQ 2007 are 0.03 respectively therefore Cadmium concentration in all the three stations have exceeded the WHO and NSDWQ standard. The values for chromium at first sampling station is 0.02mg/l, second sampling station is 0.04mg/l, third sampling station is 0.05mg/l while the standard levels prescribed by WHO/2018 and NSDWQ 2007 are 0.05 respectively therefore Chromium concentration in all the three stations have not exceeded the WHO and NSDWQ standard similarly the values for copper at first sampling station is 0.01mg/l, second sampling station is 0.03mg/l, third sampling station is 0.05mg/l and the standard level prescribed by WHO/2018 and NSDWQ 2007 are 1 respectively therefore Copper concentration in all the three stations have not exceeded the WHO and NSDWQ standard .the concentration of zinc at first sampling station is 0.01mg/l, second sampling station is 0.03mg/l, third sampling station is 0.04 and the standard prescribe by WHO/2018 is 3 and NSDWQ 2007 is not available therefore Zinc concentration in all the three stations have not exceeded WHO standard (tables I,2 and 3)

The fish samples collected from the Dam were also analyzed the concentration of lead in the fish tissues are, liver 6.94mg/k, gill 12.80mg/kg, skin7.17mg/kg, muscles5.17mg/kg and the values prescribed by FAO) is 0.50-6.00mg/kg, WHO) is 2.00mg/kg and FEPA is 2.00mg/kg. The concentration of cadmium are liver 1.23mg/kg, gill 0.62mg/kg, skin 0.47mg/kg, muscles 0.73mg/kg and the standard level as prescribed by FAO is 0.05-5.50mg/kg and WHO is 2.00mg/kg. The concentration of chromium are liver 3.64mg/l, gill 4.88mg/l, skin 5.45mg/l, muscles 6.24 and standard limit is FAO is 1.00,mg/kg WHO is 0.15mg/kg and FEPA is 0.15mg/kg..The concentration of zinc is liver 233.42mg/kg, gill 137.03mg/kg, skin 96.72mg/kg, muscles 66.60mg/kg and standard limit is FAO is 30-100mg/kg, WHO and FEPA are 10-75mg/kg and 75mg/kg respectively. For copper the values are liver 168.82mg/kg, gill 11.3mg/kg, skin 6.41mg/kgand muscles 6.58mg/kg , while the standard limits prescribed by FAO 10-100mg/kg, WHO 3.0mg/kg, FEPA 1-3 1-3mg/kg.(table 4). The analysis above revealed that the water pollution levels at Gubi dam are found to be within the permissible limits as prescribe by WHO/ Nigeria standards (Tables 1,2 and 3). However the study found out that the concentration of heavy metals in the tissues (liver, gill, skin, muscle) of the catfish had far exceeded the prescribed standards by WHO, FAO and FEPA (Table 4). Therefore while the water in Gubi dam is found to be relatively safe from heavy metals pollution, the fish due to bio-accumulation of heavy metals is highly polluted and therefore unsafe for human consumption.

Conclusion

The analysis of water samples revealed that Lead and Cadmium pollution levels are above the permissible levels Chromium, Copper and Zinc values are within the permissible limits as prescribed by WHO 2018 and NSDWQ 2007 standards. Therefore, there is lead and Cadmium pollution in Gubi dam water tables 12 and3. for fish samples showed that the concentration are above tolerable limits prescribed by FAO, WHO, FEPA. Therefore the fish is polluted and dangerous to human health if consumed.

Recommendations

Fisher men should be alerted about the danger of fishing in Gubi dam If possible fishing should be banned for now. Water at Gubi dam should be treated to remove Lead and Cadmium pollution. Another study should be carried out to determine at what period of fish growth is bio-accumulation exceeding permissible limits.

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