INVESTIGATION OF HEAVY METALS AND SEDIMENT IN WATER AND SOIL FROM IKPOBA RIVER

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BEING A PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING, FACULTY OF ENGINEERING, UNIVERSITY OF BENIN, BENIN CITY,

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR DEGREE (B.ENG) IN CHEMICAL ENGINEERING

DECEMBER, 2022.

CERTIFICATION

This is to certify that this research project was carried out by **EBUSHI EMMANUEL ALAMU** of the Department of Chemical Engineering at the University of Benin, Benin City, Edo State, Nigeria.

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DEDICATION

This project is dedicated to God Almighty for His love, protection and so much more all through this journey. I also dedicate this work to my parents, Mr. and Mrs. Ebushi for their financial and moral support throughout the duration of my study.

To all those who have faced questionable moments in life and thought of giving up at some point in time, this is for you as well.

ACKNOWLEDGEMENT

This project has come a long way in becoming a reality. I am most grateful to God Almighty for his love, mercy and grace upon my life and for making it possible for me to acquire a bachelor's degree in Engineering.

I also express my profound gratitude to my supervisor **Engr. A.I. NEWTON** for his efficient and untiring effort which made this work a required quality.

A special appreciation to my friends and course mates for their moral supports, may the good Lord bless and favour us all with long life in Jesus name Amen.

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ABSTRACT

Ikpoba River is the major recipient for municipal waste and industrial effluent in Benin City, samples of water were collected at five different locations in the river for some selected heavy metal analysis in order to determine the extent of pollution. Samples were collected in August to December 2021. Chemical analyses of samples river water and Dam was collected at predetermined sampling points were undertaken, the observations obtained were subjected to ANOVA and correlation analysis. Results obtained showed that each point source has its relative contribution to the overall degradation of the river water quality. The heavy metals were determined with atomic absorption spectrophotometry (AAS). From river water and dam the heavy metal concentration were found to be in the increasing order, fe>zn>cu> pb>Cd for all the five samples point collection as show in the result analysis. It also shows that the lead was not present in one of the point and Cadmium were not also detection in all of five sample. The analyses carried out also show the level of phosphate, nitrate, magnesium, pH, BOD,DO, electrical conductivity and turbidity in all the five stations and the turbidity was also notice to be relatively high. Most of the heavy metal determine were below the maximum permissible limit set by FEPA and WHO.

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND OF STUDY

Effluent discharges into the environment have been on the increase in Nigeria since 1960 due to active industrialization and urbanization and the accompanying increase in commercial activities. Copious amount of wastes is produced due to human activities and the capacity of the environment to absorb these wastes is limited. On the other hand, waste or effluent management has remained under developed and very unsatisfactory leading to environmental pollution, depletion, global warming, deforestation, shoreline erosion or degradation of natural ecosystems (Ibrahim M.S, 2008). Consequently, many potential pollutants have found their way into ground and surface waters causing harm to the environment, and also, to man, plants and animals.

Human activities which may be industrial or agricultural are the major cause of environmental pollution varieties of pollutants (wastes) which are indiscriminately discharged into the environment (Bello-Osagie I.O, 2012). Rapid population growth, urbanization and industrialization and poor sanitary conditions among rural dwellers are the contributing factors of environmental pollution Different aquatic organisms often respond to external contamination in different ways, where the quantity and form of the element in water, sediment, or food will determine the degree of accumulation. The region of accumulation of heavy metals within fish varies with route of uptake, heavy metals, and species of fish concerned. Their potential use as biomonitors is therefore significant in the assessment of bioaccumulation and biomagnification of contaminants within the ecosystem. Waste generated from industrial, human and anthropogenic activities are either useful or hazardous to plants, animals and human beings (the end-user).

The soil which is a natural sink for various pollutants is naturally made up of varieties of minerals, organic constituents and broken rocks which are altered by environmental reactions. (Edori and Iyama, 2017). Pollutants that find their way into the soil interacts and changes the chemical and physical properties of the soil.

Soil has a limited capacity to contain pollutants. However, when such threshold is exceeded, the soil's ability to remove impurities, destroy disease-causing agents (pathogens) and degrade contaminants may be lost. The soil provides plant's physical support, air, water, temperature moderation, nutrients and protection from toxins. It also absorbs oxygen and methane and releases carbon dioxide and nitrous oxide. It also aids the conversion of dead organic matter into nutrients for plants and animals.

Environmental pollution alters the soil's ability to perform optimally thereby leading to soil pollution. Water as an essential component of life on earth contains minerals that are extremely important in human nutrition. Human activities are a major factor determining the quality of surface and underground water. Through atmospheric pollution, effluent discharges, oil exploration, use of agricultural chemicals and eroded soils into water bodies, water loses its purity. The level of physic-chemical parameters of water will determine the purpose with which the water could be best used for with little or no treatments. Variability in physicochemical parameters is responsible for the distribution of organisms in different freshwater habitat according to their adaptation, which allows them to survive in a specific habitat (Obasohan E.E, 2006) Major shifts in the stream bed composition and processes can alter species distribution, productivity and even change the production of greenhouse gases. Temperature, dissolved oxygen (DO), carbon (iv) dioxide (CO2), pH, conductivity, Total Dissolved Solids (TDS), transparency and current among others and their regular and irregular fluctuations in water have been identified as determinants in river ecology (Blaber, 2000). It is, therefore, the aim of this research to evaluate heavy metals and physicochemical parameters of oil contaminated soil and river tributary from Bonny.

Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate. There are various sources of heavy metals; some originates from anthropogenic activities like draining of sewage, dumping of Hospital wastes and recreational activities. Conversely, metals also occur in small amounts naturally and may enter into aquatic system through leaching of rocks, airborne dust, forest fires and vegetation. As heavy metals cannot be degraded, they are continuously being deposited and incorporated in water, sediment and aquatic organisms thus causing heavy metal pollution in water bodies. Increasing level of heavy metals in the environment from various anthropogenic sources has become a source of concern for environmentalists. As a result there is a need for increasing awareness of the emergency created by environmental pollution caused by human activities. Unlike the toxic organics compounds that in many cases can be degraded, the metals that are released into the environment tend to persist indefinitely, accumulating in living tissues through food chain. Many dangerous chemical elements, if released into the environment, accumulate in the soil and sediments of water bodies the lower aquatic organisms absorb and transfer them through the food chain to higher trophic levels, including fish. Under acidic conditions, the free divalent ions of many metals may be absorbed by fish gills directly from the water. Hence, concentrations of heavy metals (HM) in the organs of fish are determined primarily by the level of pollution of the water and food Under certain conditions, chemical elements accumulated in the silt and bottom sediments of water bodies can migrate back into the water, i.e. silt can become a secondary source of heavy metal pollution.

1.2. PROBLEM STATEMENT

The problem associate with heavy metals in the environment cannot be over emphasis. This is dangerous to both human and aquatic life which to an extend has been a source of worry especially to the health of both human and aquatic life. More worrisome is the manners and ways untreated effluent water high level of heavy metals are been discharge into water bodies such as rivers, sea and oceans which pose a treat to the aquatic life such as fish and which eventually get back to human through various sources such as consuming the fishes and drinking the water.

Rivers, lakes and oceans have become the outlet for sewage and many other pollutants, particularly industrial waste and detergents. In textile industries high level of COD and colour is experienced in effluent. However, waste water is becoming increasingly difficult to view of large scale pollution caused by industrial, agricultural and domestic activities. These activities generate waste water which contains both organic and inorganic pollutants. Some of the common pollutants are phenol, dyes, detergents, insecticides, pesticides and heavy metals. The treated waste water is still unable to meet the local discharge limit especially in terms of COD and color. Color is the first contaminant to be removed from the waste water before it is discharged into the water body or onto the land

1.3. AIM AND OBJECTIVES

AIM

The aim of this study is to determine the level of heavy metals contain in the water and sediment in Ikpoba River and Dam

OBJECTIVES

The objectives of these studies are as followed

1. To determine the amount of heavy metals in water and sediment in Ikpoba River and Dam.
2. To collect samples of water from Ikpoba River and Dam for analysis.
3. To determine the physio-chemical parameter of the water.
4. To also make necessary recommendations.

1.4. SCOPE OF STUDY

The scope of this study is to determine the amount of heavy metal present in water from Ikpoba River and Dam. The procedure is to collect samples of the water to determine the heavy metals and other contaminant present in them by using atomic adsorption spectrophotometer.

1.5. RELEVANCE OF STUDY

The adverse effect of heavy metals cannot be over emphasis especially lead ion to the environment both land and water bodies, this affect human health and every other living things in the river, sea and oceans which include fishes . This study will help to determine the levels of heavy metals present in the water in Ikpoba River and dam in other to know if is above or below the WHO standard.

CHAPTER TWO

LITERATURE REVIEW

Water pollution is a serious problem globally, involving the discharge of dissolved or suspended substances into ground water, streams, rivers and oceans Bello-Osagie I.O 2012. Surface waters are usually exposed to microbial contamination from run-off inputs, soils, and any waste deliberately or inadvertently dumped into such waters. These can result to pollution, increase in microbial load, eutrophication, visible aesthetic nuisance and loss of recreational amenities. A major source of pollution in developing countries is industrial activities and this has gradually increased the problem of waste disposal. Increased industrial activities have led to pollutional stress on surface water both from industrial, agricultural and domestic sources. However, the quantity of waste discharge from industries depends on the activities and usage of water. Breweries for example are known to consume water of about 4 to 8 cubic meters per cubic meter of beer produced. Brewery plants have also been known to cause pollution by discharging effluent into receiving stream, ground water and soil Dankoul *et al.,* 2012). Untreated wastes from processing factories located cities are discharged into inland water bodies resulting to stench, discoloration and a greasy oily nature of such water bodies. These wastes pose a serious threat to associated environment, including human health risks and several researches have confirmed the negative effects of industrial effluent discharge on rivers (Ndimele, 2008). There is therefore the need to control the pollution of surface and ground water since the health and wellbeing of the people have a directly dependent on the availability of good water. Ikpoba River is a fourth order stream located in Benin City, Edo State in South Western Nigeria. The river serves as a source of water for domestic purposes (including drinking and cooking). Also, fishing and other human activities (such as bathing, swimming, washing, etc.) take place in the river. According to Ekhaise and Anyansi, the Ikpoba River receives a variety of wastes ranging from industrial, agricultural, domestic and natural sources and these wastes introduce foreign microorganisms, organic and inorganic matter, in addition to indigenous microflora. The Oregbeni community flanks the river on one side behind Guinness Nigeria Plc. and Bendel Breweries Ltd. The products of the brewery operations include large volumes of wastewater, conveyed over a distance of 2.5km by an underground tunnel and discharged into the receiving river. This study is aimed at determining the effects of Guinness Nigeria Plc. effluent discharge on the microbiological qualities of Ikpoba River and the surrounding borehole waters, which is the major source of drinking water for people in that locality.

Different aquatic organisms often respond to external contamination in different ways, where the quantity and form of the element in water, sediment, or food will determine the degree of accumulation. The region of accumulation of heavy metals within fish varies with route of uptake, heavy metals, and species of fish concerned. Their potential use as biomonitors is therefore significant in the assessment of bioaccumulation and biomagnification of contaminants within the ecosystem.

2.1. DESCRIPTION OF STUDY AREA

The study was done along a stretch of the Ikpoba River, a fourth order stream situated within the rainforest belt of Edo State, Southern Nigeria (6.50N, 5.80E). The river takes its rise from the northern ishan plateau and flows in a southwesterly direction in a sleepy incised valley through sandy areas before passing through Benin City and joining Ossiomo River (Ohagi 1983).

Basically, the catchment area is a dense rain forest where allochtonous materials of organic matter are derived from the vegetation through surface runoff into the basin. The study area is geologically characterized by coarse sand interspersed with lignite and patches of laterite and sandy clay.

2.2. RIVERS AND POLLUTION FROM LAND BASED ACTIVITIES

Aquatic ecosystems such as rivers, dams and lakes are sources of livelihood to many rural communities in Africa. However, in the recent past, they have been subjected to various forms of degradation due to pollution arising from domestic wastes, industrial effluent, agricultural run offs and bad fishing practices (Ndimele, 2008).

Many studies have indicated that surface waters are majorly polluted by land based activities as compared to ground water. Rivers are conduits and channels for the transportation and movement of water to the ocean. Rivers tend to collect impurities and other materials as they move as a result of activities that occur and are conducted along their course of flow, this may reduce the capacity of the river and also the availability of its waters for various uses as it travels downstream. The bulk of the pollutants come from activities related to man though natural sources also play part. It has been studied that the intensity of land uses and activities that are carried alongside a river's channel is directly related to the pollution status of that river, this is explained that the amount of waste discharged tends to increase with increasing water demand.

Studies by Kithiia (1992, 2006), Okoth and Otieno (2000) and Mavuti (2003) reveal degradation trends in water quality within the river system due to changes and intensity in land use activities.

2.3. HEAVY METAL AND POLLUTION

The contamination of ground, stream and river water ecosystem by heavy metals is a worldwide environmental problem. The public has become more concern over the potential accumulation of heavy metals in various ecosystems (Wong et al., 2002). Global chemical pollution has been a great concern with the increase awareness of the public towards environmental issues (Mathiranan et al., 2005).

Pollution of ground water and surface water systems is a major environmental issue throughout the globe (Hutchison et al., 1993: WHO, 1998). Land based activities have a major impact on natural resources including water, soil and plants. Heavy metals in rivers are contributed by both natural and anthropogenic sources. Heavy metals have been accumulating for years in sediments, water and biota of lakes and streams, (Fakayode, 2005) stated that heavy metals may heavy effects on the ecosystem as greater than those of more common pollutants. Heavy metals and their salts are also found in industrial wastes and agricultural runoffs.

Heavy metals always gain access into the river systems from both natural and anthropogenic sources and these get distributed in water and sediments in the course of their transportation. The spatial distribution and the temporal behavior of metals is essential information for environmental research (Marvin et al., 2002; Obiajunwa et al., 2002).

Copper concentrations as low as 1-2 µg/L have been shown to have adverse effects on aquatic organisms. Copper can affect the reproduction, physiology and behavior on a variety of aquatic organisms. Moreover, high intakes of copper have been associated with liver failure and gastrointestinal problems in humans (WHO, 1998, Förstner and Wittmann, 2012).

Iron is one of the most abundant elements in the world. It is found in a number of minerals, rocks, sediment and soil. It is an essential mineral to all organisms. However, iron has been associated with acute poisoning in young children (30lb) who took 5-9 iron supplement tablets of 30 mg each. Iron is absorbed rapidly once ingested and becomes corrosive. Iron poisoning targets organs like liver, kidneys and cardiovascular system (Baby et al., 2010).

2.4. SOURCES OF HEAVY METAL POLLUTION IN RIVERS

Heavy metals always gain access into river systems from both natural and anthropogenic sources, these get distributed to sediments and biota as they move from one level to another. An area that naturally contains mineralized rocks usually contains an elevated level of metals, the trace metal level of river water is always controlled by the abundance of metals in rocks of the river's catchment area and their mobility (Olajire and Imeokparia, 2000).

Natural sources are, soil erosion, primarily rock weathering and dissolution of water soluble salts. Naturally occurring metals always move through aquatic environments usually without detrimental effects. They move independently of human activities (Garbarino et al., 1995). Degrading environmental conditions and growing reliance on agrochemicals have led to an increasing public concern over the potential accumulation of heavy metals and other contaminants in agricultural soils (Nriagu, 1988; Alloway, 1990; Pendias, 1995).

Heavy metals are released to a river from various sources, they enter the ecological systems through anthropogenic activities such as sewage sludge disposal, organic fertilizer and pesticide application and also through atmospheric deposition (Haiyan and Stuanes, 2003). Anthropogenic activities like mining, ultimate disposal of treated and untreated waste effluents containing toxic metals as well as metal chelates from different industries (Amman, *et al*.,2002) and also the use of heavy metal containing fertilizers and pesticides in agriculture indiscriminately resulted in deterioration of water quality rendering serious environmental problems posing threat on human beings (Lantzy and Mackenzie, 1979; Nriagu, 1979;Ross, 1994) and sustaining aquatic biodiversity (Ghoshand Vass, 1997; Das, *et al*., 1997)

Some fertilizers and pesticides are known to contain various levels of heavy metals including Cd and Cu (Kabata-Pendias, 1992). There is therefore a possibility that the continuous and heavy application of agrochemicals and other soil amendments can potentially exacerbate the accumulation of heavy metals in agricultural soils over time (Siamwalla, 1996; Chen et al., 1999).

Copper is the active ingredient in some pesticides applied to agricultural crops to inhibit fungal growth (Mcneely et al., 1998). Copper is generally present in only trace levels in natural surface waters up to a concentration of 0.005 mg/l and higher levels are usually associated with anthropogenic sources (Mcneely et al., 1998). Ground and surface water is threatened by the excessive use of fertilizer and pesticides in agricultural activities (Hariprasad and Dayananda, 2013). Agricultural runoff containing heavy metals reaches natural water bodies affecting aquatic species and in turn ecosystems (Hariprasad and Dayananda, 2013). Heavy metal contamination of soil in agricultural areas is linked to the use of fertilizers, pesticides and herbicides by farmers (Mingorance *et al.,* 2007; Yang *et al.,* 2005; Dankoul *et al.,* 2012). The use of agrochemicals such as pesticides and fertilizers may have resulted in undesirable accumulation of trace elements such as arsenic, cadmium, copper, lead and zinc in soil (Merwin *et al.,* 1994; Van Gaans *et al.,* 1995; Harris *et al.,* 2000).

Metal mining activities release huge amounts of tailing and waste containing heavy metals which pose a serious threat to water sources and the environment (Jung 2001; Ezeh and Chukwu, 2012). Heavy metals can also be introduced into soils from various sources, including atmospheric deposition of metal/ metalloids bearing particles.

2.5. HEAVY METALS AND WATER POLLUTION IN DAM

Water pollution is a major threat to human population and dumping of pollutants into water body resulted in rapid deterioration of water quality and affect the ecological balance in the long run. Pollution refers to any direct or indirect alteration of physical, thermal, biological or chemical property of water or water source so as to make it less fit for any beneficial purpose for which it is expected to be used or make it harmful or potentially harmful to the welfare, health or safety of human beings, any aquatic or non-aquatic life and property or the environment (Goel, 2000: Kinchella and Hyland, 1993).

Water pollution has been suggested to be the leading worldwide cause of deaths and diseases (Pink, 2006) and it accounts for the deaths of more than 140,000 people daily (West, 2006).

Current concerns in environmental protection are majorly focused on water due to its importance in maintaining human health and ecosystem health (Mahananda *et al.,* 2010).

Water will always contain minerals and organisms that it collects from materials it comes into contact with due to its chemical properties. Depending on the type and the concentration, these constituents may be toxic and therefore harmful to human beings (Elinge *et al*., 2011).

Recently however, increased concern over the concentration of heavy metals in water has developed as the public becomes more aware of their toxicity and impact on human health. Many metals occurring in nature are not harmful at trace concentrations and some such as iron, copper, cobalt, Manganese, Zinc and Chromium are even essential for proper functioning of the human body (Ismail *et al*., 2011; Amartey *et al*., 2011). All metals however are toxic at higher concentrations, with their toxicity being linked to chronic diseases such as renal failure, liver cirrhosis, hair loss and chronic anemia (Salem *et al*; 2000). Heavy metal pollution has received huge worldwide concern owing to its persistence, toxicity, accumulation in the ecological system and risk to human health (Chang, 2003; Varol and Sen, 2012).

Heavy metals find their way to the waters through underground seepage of effluents arising from human activities, runoff from farms and industries, leaching and dissolution of metals occurring naturally in rock and soil. However, water pollution has been focusing on other aspects of water with a minimal interest in heavy metals. Heavy metal pollution has usually been relegated. It has only been brought to the fore if contamination due to anthropogenic sources such as poor waste disposal is suspected. In this respect, heavy metal content in water is given little attention in many rural areas due to fewer sources of pollution. This notwithstanding, heavy metal contamination of water in rural areas is still possible arising from obscure sources, fertilizers and the existence of mineral resources (Adegbola and Adewoye, 2012).

Among the inorganic contaminants of the river water, heavy metals are getting importance for their persistent nature and often accumulate through tropic levels causing a deleterious biological effect (Jain, 1978). Heavy metals exposure to human beings has been associated with development retardation, kidney damage, various forms of cancer and in some instances death.

2.6. HEAVY METALS IN SEDIMENTS

Contamination of sediments by heavy metals and other pollutants is considered by many regulatory agencies to be one of the major threats to aquatic ecosystems. The importance of sediments as a sink for a range of substances including nutrients, hydrocarbons, pesticides and heavy metals has been highlighted in many past studies (Baldwin and Howitt, 2007).

Sediments are indicators of environmental contamination of water bodies by heavy metals and toxic compounds. Sediments act as sink for pollutants hence their monitoring is important for tracing the spreading and impact of pollution related changes; sediments accumulate heavy metals from the surrounding geogenic and anthropogenic sources (Acero *et al.,* 2003; Casas *et al.,* 2003; Pekey, 2006). In a river, bed sands perform a container and carrier for settlement and conveying of heavy metals and heavy metal is a persistent pollutant (Gibbs, 1973; Luoma *et al*., 1981; Bettinetti *et al*., 2003; Hollert *et al*., 2003; Jiang *et al*., 2010). Sediments are sinks of heavy metals in aquatic environments (Monteiro *et al*., 2012). When favorable conditions occur, the heavy metals settled in the sediments could gradually be released in the water and this phenomenon is one of the critical problems facing aquatic environments. Given their toxicity and bio-accumulation, many studies have shown that high heavy metal content in sediments could impact significantly the health of aquatic ecosystems (Suresh *et al*., 2011; Keskin and Toptas, 2012).

Heavy metals in sediments are not permanently fixed, and can be released back to the water in case of changes in environmental conditions like pH, redox potential, and among others.

This is because sediment act as carriers of the heavy metals in aquatic ecosystems (Horstall *et al*., 1999;Forstner, 1981).

Many studies have found that sediments in aquatic ecosystems habour persistent and toxic chemicals more than the water column (Casper *et al*., 2004; Linnik and Zubenko, 2000). Monitoring of sediments is therefore very important in tracing the spreading and impact of pollution related changes.

2.7. HEAVY METAL POLLUTION IN NIGERIA RIVERS

In Kenya heavy metal pollution monitoring is a prime area of research since the concentration of heavy metals in aquatic ecosystems affect the fish industry which is a major source of livelihood (Ochieng *et al*., 2008).Kenya faces serious problems of urbanization, vehicular pollution and industrial discharges that present serious health risks and exposure to the public (Abuor, 2011). In Nigeria; Lagos, Delta and Portharcourt are the most industrialized and populated towns, elevated levels of heavy metals have been reported in the soils of these cities (Onyari *et al*., 1991; Kamau, 2001; Makokha *et al*., 2008). Studies on heavy metal contamination have been conducted in Lake Victoria (Oyoo-Okoth et al., 2010), Winam Gulf and Rift Valley lakes (Ochieng *et al.,* 2007), Lake Naivasha (Kamau *et al.,* 2007), Port-reitz creek (Kamau, 2001). Most of these studies have reported the presence of heavy metal contamination in these aquatic ecosystems. However, fewer such studies have been conducted on rivers which are the main channels of water and suspended matter to the oceans and also lakes. The presence of heavy metals in rivers as a result of their use in modern society is a matter of ever-growing concern to politicians, authorities and the public in Nigeria (Kosgey *et al*., 2015). Oyoo-Okoth (2010) conducted a study of heavy metal pollution in Lake Victoria and found out that the concentration of Pb and Cu in water reflected anthropogenic pathways. In another study conducted by Abuor (2011) on the levels of heavy metals in scalp hair of people living in different places in Kenya, people from Msambweni District exhibited a high concentration of Pb and Cu.

Bottom sediment is an integral part of the abiotic components of aquatic ecosystem. It thus provides a living compartment to bottom dwellers which actively engage in its transformation (Tandyrak, 2005). Bottom sediment is to benthos what water column is to a vast array of non-benthos and also to a large extent characterizes the entire aquatic ecosystem due to the condition arising at the water-sediment boundary (Linnik and Zubenko, 2000).

Pollution of natural environment by heavy metals is a worldwide problem because these metals are indestructible and most of them have toxic effects on living organisms, when they exceed a certain concentration. Egborge (1991) related the heavy metal pollution of Warri River to industrialization. Jimoh, (2006} investigated the heavy metals content of IKpoba river. He reported that Fe was exceptionally high, although all parameters were within the set standard. Ogbeibu and Anagbose (2004) have observed that bottom sediment acts as sink to heavy metals releasing them at the slightest perturbation. Pollution of aquatic ecosystem with heavy metals is ecologically significant because they cannot be eliminated from the reservoir even in the process of self-purification. (Sharma, 2006).

2.7.1. Causes of Contaminated Rivers and Dam

Waste water refers to any liquid waste or sewage that comes from households, hospitals, factories, and any other structure that uses water in its facilities. This water is often discharged into a body of water like the rivers but there are many instances when current waste water treatment method are not enough to make it safe for the environment Rivers, lakes and oceans have become the outlet for sewage and many other pollutants, particularly industrial waste and detergents. In textile industries high level of COD and colour is experienced in effluent.

These contaminants may be as a result of stagnant water or proximity of latrines, industrial wastes etc. to water sources like lakes, rivers, streams and any form of water reservoir.

2.7.2. Effects of Contaminant in Rivers and Dam

The most immediate effect of waste water on the environment is when it contributes towards the contamination and destruction of natural habitats and the wildlife that live in those habitats by exposing them to harmful chemicals that would otherwise not be present over the natural course of things.

Pollutants which contaminate these water bodies include any chemical that drains: paints, solvents, hormones, oil, herbicides, human waste, industrial waste etc. A combination of all these products poses risk to both humans and wildlife alike because an improper, absent, inadequate or inappropriate managed water and sanitation services would expose individuals to preventable health risk.

Contaminated water causes the following effects and diseases on humans;

- DIARRHEA: There is high mortality rate due to the unsafe drinking of water. One of the symptoms of both cholera and hepatitis A is diarrhea. It is a watery stool that occurs frequently than usual.
- HEPATITIS A: A highly contagious liver infections. Usually preventable by vaccine
- TYPHOID: Typhoid is responsible for approximately 200,000 deaths per year throughout the world. It’s a bacterial disease that is spread contaminated food and water or close contact.
- CHOLERA: This is a bacterial disease causing severe diarrhea and dehydration.
- DYSENTRY: An inflammation of the intestine accompanied by bloody diarrhea often caused by shigella bacterial(Shigellosis) or an amoeba.
- POLIO: A virus disease that may cause paralysis and is easily preventable by the polio vaccine.

These diseases could be avoided if only people had access to clean water. Unfortunately this problem does not have an easy solution. For decades, organizations have tried countless methods of easing this need.

The most immediate effect of waste water on the environment is when it contributes towards the contamination and destruction of natural habitats and the wild life that live in those habitats by exposing them to harmful chemicals that would otherwise not be present over the natural course of things. Waste water causes the following effects and diseases on wildlife and plants;

- **Soil Degradation**: Chemicals that are harmful to crops may find their way to the soil when the waste water isn't properly treated. These chemicals will cause the soil to yield fewer fewer crops at a slower rate. Considering the fact that these crops will eventually be eaten, this is equally harmful to humans.
- **Death to wildlife:** The composition of waste water may include heavy metals, pathogens, salts, toxic chemical, sludge, acids and bases, toxic organic and inorganic materials etc. This effluent poses numerous hazards for animals and the environment as a whole.
- **Death of Aquatic Ecosystems**: Waste water disrupts aquatic lives when a large amount of biodegradable substances end up in the water, organisms will start to break them down and they are use to a lot of dissolved oxygen. Dissolved oxygen is critical for marine life to thrive, and as it becomes depleted, it can be life-threatening for fish.

Fig 2.1: Underground Waste Water

2.8. DYES AS AN EFFLUENT FROM TEXTILE INDUSTRY INTO RIVERS

Effluent is the liquid waste from Textile Industries where fabrics are made flowing out of a factory or industry, farm commercial establishment, or a household into a water body such as river, lake, lagoon or a reservoir (Yusuff and Sonibare, 2004). Rivers lakes and Oceans have become the outlet for sewage and many other pollutants, such as phenols, dyes, detergents, pesticides, insecticides and metals. The waste water from domestic and industrial processes increases due to the increase in population and industrial expansion.

The dye in industrial water is a visible pollutant that is difficult to treat due to their complex molecular nature which is harmful to the aquarium and microbes and unhealthy for drinking as. These living which are part of the ecosystem might go into extinction if the contaminated water is not properly treated or disposed.

2.9. TYPES OF WASTEWATER

Waste Water comes in three main types namely; Black Water, Gray Water and Yellow Water;

- **Black Water**

  This is wastewater that originates from toilet fixtures, dishwashers, and food preparation sinks. It is made up of all the things that you can imagine going down the toilets, bath and sink drains. They include poop, urine, toilet paper and wipes; body cleaning liquids, anal cleansing water and so on. They are known to be highly contaminated with dissolved chemicals, particulate matter and very pathogenic

Fig 2.2: Waste Water from Toilet and Bathroom

- **Gray Water**

  This is wastewater that originates from non-toilet like the industries (textile industry) and food fixtures such as bathroom sinks, laundry machines, spas, bathtubs and so on. Technically it is sewage that does not contain poop or urine. Gray water is treated very differently from Black water and is usually suitable for re-use. Example of which is waste water from the textile industry where fabrics are made. The waste water in the fabric industry contains dye which is a harmful effluent to the environment.

- **Yellow Water:**

  This is basically urine collected with specific channels and not contaminated with either blackwater or graywater.

2.9.1. Physico-Chemical Analysis of Water Sample

Water samples were analyzed according to standard methods [14] for physicochemical parameters such as pH, dissolved oxygen (DO), biological oxygen demand (BOD), phosphorus, chloride, electrical conductivity (EC) and Temperature. Total Solids, Total Dissolved Solids, Determination of Total Suspended Solids were determined by the method as reported by Ibrahim et al.2011.

2.9.2. pH and Conductivity Determination

The Physico-chemical properties of the soils were determined by using standard methods. The pH of the sample was determined using a Jewniary digital pH meter. Conductivity was determined using the CD303 conductivity meter.

Total Organic Carbon (TOC) was determined by the Walkley-Black dichromate wet oxidation method and the content of available phosphorus was determined using the method reported by Awe et al.2009. Total Petroleum Hydrocarbon of Soil was determined by the method described by Eniola et al 2013. Heavy metal analysis was done wet digestion method on Atomic Absorption Spectra (AAS).

2.9.3. Soil Chemical Parameters

These heavy metals components integrate themselves into the soil and surrounding environment such as water and increase the hydrogen ion concentration of the medium. Chloride is an essential micronutrient that regulates enzyme activities in the cytoplasm, is a co-factor in photosynthesis, acts as a counter anion to stabilize membrane potential, and is involved in turgor and pH regulation. According to Mahmood (2012), Some non-biochemical roles of chloride (for example, osmotic regulation) need higher concentrations of this element.

Unlike other micronutrients, chloride is not toxic when it accumulates to high levels in plants. The symptoms of chloride toxicity (higher concentrations) are associated with the osmotic effect of saline soils. Chloride toxicity is also associated with the activity of the nitrate reductase as nitrate and chloride have similar ionic properties and absorption mechanisms. When chloride uptake rises to the toxic level, it is easily converted to toxic compounds (like hypochlorites), before it can be detoxified with the nitrate reductase.

Trace amount of metals are naturally present in freshwaters from weathering of rocks and soils. However, anthropogenic activities like mining release huge amounts of tailing waste containing heavy metals which could pose serious threat to water sources, agricultural soils and food crops (Jung,2001; Ezeh and Chukwu, 2012). Heavy metals may be introduced and spread in the environment through combustion, extraction, agricultural runoff and transportation (Lars, 2003).

Agrochemicals introduced in the soil as soil nutrients to improve fertility contain metals which in most cases exceed the limits set for land application and their continuous use can exacerbate their accumulation in agricultural soils (Lim et al,. 2008; Hesterberg, 1998). The use of agrochemicals such as pesticides and fertilizers may result in undesirable accumulation of trace elements like Cd, Cu, Pb and Zn (Merwin *et al.,* 1994).

CHAPTER THREE

MATERIALS AND METHOD

3.1. LIST OF MATERIALS/REAGENT AND EQUIPMENT/ APPARATUS

Table 3.1 List of materials and reagent use for this study is show below

Materials	Uses
Mangnase sulphate	To determine BOD and DO test
Sulphuric acid	To determine BOD and DO test
Sodium thiosulphate	For titration
Phenolpthalein	As indicator
EDTA	To determine hardness
pH buffer	To calibrate pH meter

Table 3.1: List Materials/Reagent and their Uses

Table 3.2 List of equipment and apparatus use for this study is show below

Equipment/apparatus	Uses
Conductivity Meter	To test for conductivity of the sample
pH Meter	To test for pH of the sample
Turbidity Meter	To test for turbidity
DO Meter	To test for dissolved oxygen
BOD bottle	To samples for BOD test

Table 3.2: List of Equipment/Apparatus and their Uses.

3.2. METHOD

3.2.1. Study Area

The Ikpoba River originates from western high land in the region north and northeast. It flows from the east to the west before returning southward at Utekon and flowing to the eastern bank with Ekosodin, Ugbowo, Okhoro and New Benin following Ikpoba-Hill where it crossed along the Benin-Agbor Road, the river flow southeast after crossing Temboga and turning again, it moves to the direction of the nearby Ikpoba Okha L.G.A

3.2.2. Sample Collection

Water and soil samples were collected at five different locations from the river using 500ml clean sterile bottles with screw caps. The samples were collected from the month of August at the peak of the rainy season till December, during the harmattan or dry season. The water Samples were taken by lowering the container 25cm deep into the river facing the current flow direction and the soil sample was equally collected from bottom of the river.

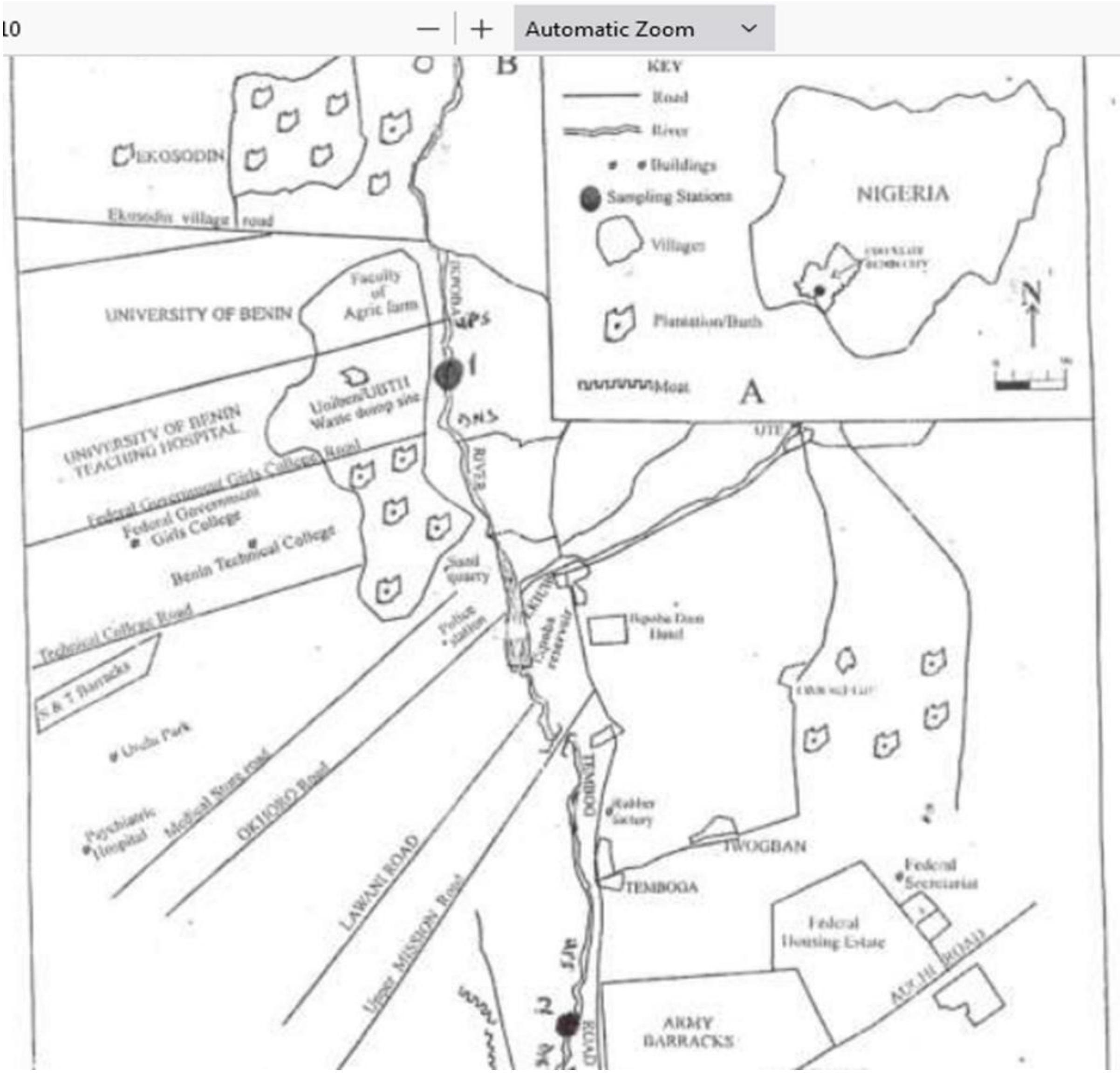

Fig. 3.1: The study area: (A) Map of Nigeria showing Edo State, (B) Map of Ikpoba River showing Sampling Stations

Water Sampling

Sampling strategy was designed to cover a wide range of physiochemical parameters and heavy metals at sampling sites in Ikpoba River. Water sampling was carried out during dry season (December). A total of 22 water samples were collected from five sampling stations. Sampling, preservation, and transportation of the water samples to the laboratory were as per standard method (APHA 1998).

3.2.3. Physiochemical Analysis of the Samples

3.2.3.1. Dissolved Oxygen Demand

The dissolved oxygen was determine using the modified winkles method. The water sample was carefully transfer into a clean 500ml BOD bottle with stopper. The BOD bottles were filled to the brim with the water sample. 2ml of manganese sulphate was introduced prior. The bottle was stopped with adequate care to avoid oxygen introduction.

A brownish cloudily precipitate formed which indicate the presence of oxygen. The precipitate was allow to settle at the base of the container, the sample was mixed by inverting the bottle several times and allowed to settle down. 2ml of conc sulphuric acid was added using a pipette. The sample was then carefully inverted several times with stopper on it. The sample is sore for 8 hours and titrate with sodium thiosulphate

3.2.3.2. Biological Oxygen Demand (BOD)

Biological oxygen demand was gotten using winklers method. Water sample was transferred into two bottles.300ml BOD was properly labeled as DO0 and DO5.

The Dissolved oxygen concentration was for DO3 using the winklers method for do determination. Water sample in the labeled container DO5 was incubated for 5 days at 20oc in the incubator. After the incubator period, the dissolved oxygen concentration was determine also using the winkler approached.

The biological oxygen concentration was obtain using the equation below

BOD5 = $\frac{Do-D3}{D5}$

Where,

BOD5 = Biological Oxygen Demand

D0 = Dissolved Oxygen of the sample before incubation period

D3 = Dissolved Oxygen of the sample after 5 days incubation period

3.2.3.3 Total Dissolved solid (TDS)

The total dissolved solid (TDS) was determine using gravimetric method. 200ml beaker was rinse with distilled water and oven dried at 103oC for one hour. The beaker was properly marked and weighed (W1). 100ml of the water sample was stirred thoroughly and filtered using a double layer filter paper. The beaker was placed in an oven maintained at 103oC for 24 hours. After oven drying, the waterhad evaporated to dryness. The beaker was cooled and weighed and this weight is W2

The total dissolved solids was calculated using the equation

$$TDS = \frac{W1-W2}{volume\ of\ sample} \times 1000$$

3.2.3.4. Hardness

The hardness of water test was carried out using colorimetric titration with EDTA solutions The samples was pour into a 250ml conical flask. 3ml of the pH 10 buffer solution and 1ml of calmagite indicator was added 30ml of the sample. The pH was checked to be sure it was above or equal to pH 10. Titration was done with EDTA and the end point was determined when stable blue colour with no was formed. The titration was carried out three times

The hardness was computed thus:

1mlof EDTA solution = 1mg CaCO3/l.

3.2.3.5. Alkalinity

Alkalinity of samples was obtain by titration. 100ml of the water sample was turn into a 250ml conical flask, a few drop of phenopthalein was added to the sample and a pink colouration (indicating the presence of hydroxyl ions) was form, the sample was titrated against 0.02N sulphuric acid until the pink coloration disappears. The value of this titre is called phenolphthalein alkalinity (V1), the titration continued after addition of a mixed indicator which turns the sample blue and titration continue until the solution turn red , the new titre value is noted as V2

The total alkalinity was obtained by

V1 + V2

Total alkalinity was computed with the formula

Total alkalinity = $\frac{Titre\ value \times Normality \times 1000}{Volume\ of\ sample}$

3.2.3.6. Turbidity

The turbidity of the water sample was determine using a turbidimeter. The sensor was first rinse with distilled water, dried and cleaned with alcohol. The sensor was then placed into the water sample, after obtaining a stable a stable reading, the turbidity value was ascertained.

3.2.3.7. Electrical Conductivity

The electrical conductivity was determined in-situ using a conductivity meter. The meter was inverted into the flowing river reading were taken at various points for the sake of precision

3.2.3.8. pH

The pH value was taken in-situ, using a pH meter with a range of 0-14. The pH meter was first calibrated using a pH buffer of 7, 4 and 9 before samples pH were taken.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. PHYSIO-CHEMICAL OF THE WATER SAMPLE

4.1.1. Analysis of Water Samples

The samples were analyzed for 22 parameters, namely , pH, electrical conductivity (EC), turbidity, suspended solid, alkalinity, hardness, sulphate, calcium, chloride, phosphate, manganese, nitrate , ammonium -N, dissolved oxygen (DO), biological oxygen demand (BOD), iron (Fe), zinc (Zn), copper (Cu), lead (Pb), Cadmium (Cd), magnesium. pH was measured on the sampling sites by pH meter model 370. EC were also determined in the field using conductivity meter model CON 2700. All other parameters were determined in the laboratory following standard protocols (APHA 1995). Fe, Cu, Pb, Cr, Cd, and Zn were analyzed using atomic absorption spectrophotometer. Each analysis was performed in triplicate, and the mean value was taken. The analytical data quality was guaranteed through the implementation of laboratory quality assurance and quality control methods, including the use of standard operating procedures, calibration with standards and analysis of reagent blanks

4.2. THE RESULT OF PCA ANALYSIS BETWEEN THE IKPOBA RIVER AND DAM

SAMPLE MATRIX: WATER

DATE ANALYSED: 26/8/2021

CLIENT: IKPOBA RIVER

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3	STATION 4	STATION 5
Ph	**-**	5.6	5.6	5.5	5.9	6.2
Electrical Conductivity	**µS/cm**	60	70	40	50	680
TDS	***mg/l***	30	35	20	25	340
Suspended Solid	***mg/l***	11	14	13	17	46
Turbidity	**NTU**	15	25	20	23	71
Dissovled Oxygen	***mg/l***	4.5	4.5	1.2	3.5	0.5
B.O.D	***mg/l***	2.9	3.1	3.0	2.7	4.9
Alkalinity	***mg/l***	10	16	16	16	62
Hardness	***mg/l***	14	14	20	24	28
Sulphate	***mg/l***	4	7	6	6	18
Nitrate	***mg/l***	0.211	0.199	0.189	0.201	0.221
Ammonium-N	***mg/l***	0.099	0.124	0.210	0.260	0.312
Phosphate	***mg/l***	0.049	0.161	0.165	0.141	2.976
Chloride	***mg/l***	7.06	14.12	14.12	21.18	14.12
Calcium	***mg/l***	1.60	1.60	1.60	2.41	4.01
Magnesium	***mg/l***	3.40	3.40	3.89	4.38	12.64
Iron	***mg/l***	0.551	0.528	0.673	0.463	0.488
Zinc	***mg/l***	0.211	0.116	0.167	0.121	0.110
Copper	***mg/l***	0.121	0.049	0.120	0.093	0.056
Lead	***mg/l***	ND	0.011	0.019	0.030	0.012
Cadmium	***mg/l***	ND	ND	ND	ND	ND
Manganese	***mg/l***	0.051	0.032	0.031	0.030	0.021

Table 4.1: Analytical result from Ikpoba River

SAMPLE MATRIX: WATER

DATE ANALYSED: 23/9/2021

CLIENT: IKPOBA RIVER

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3	STATION 4	STATION 5
pH	**-**	7.3	6.6	6.4	6.4	7.9
Electrical Conductivity	**µS/cm**	180	40	30	30	360
TDS	***mg/l***	95.4	21.2	15.9	15.9	190.8
Suspended Solid	***mg/l***	8	17	13	10	48
Turbidity	**NTU**	16	30	24	22	81
Dissovled Oxygen	***mg/l***	4.2	5.3	1.3	3.5	1.2
B.O.D	***mg/l***	2.1	3.2	4.1	2.1	2.9
Alkalinity	***mg/l***	8	10	12	12	184
Hardness	***mg/l***	18	22	28	36	62
Sulphate	***mg/l***	3	7	5	6	25
Nitrate	***mg/l***	0.241	0.305	0.224	0.271	0.282
Ammonium-N	***mg/l***	0.227	0.624	0.480	0.340	0.557
Phosphate	***mg/l***	0.069	0.152	0.180	0.143	1.476
Chloride	***mg/l***	7.06	14.12	14.12	21.18	14.12
Calcium	***mg/l***	1.60	3.21	1.60	2.41	4.01
Magnesium	***mg/l***	3.40	3.40	5.83	7.29	12.64
Iron	***mg/l***	0.654	0.528	0.673	0.463	0.488
Zinc	***mg/l***	0.241	0.196	0.217	0.168	0.132
Copper	***mg/l***	0.184	0.096	0.122	0.103	0.098
Lead	***mg/l***	0.034	0.016	0.023	0.022	0.017
Cadmium	***mg/l***	ND	ND	ND	ND	ND
Manganese	***mg/l***	0.051	0.042	0.058	0.036	0.027

Table 4.2: Analytical Result from Ikpoba River

SAMPLE MATRIX: WATER

DATE ANALYSED: 23/9/2021

CLIENT: DAM

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3
pH	**-**	7.4	7.1	6.6
Electrical Conductivity	**µS/cm**	40	40	30
TDS	***mg/l***	21.2	21.2	15.9
Suspended Solid	***mg/l***	13	18	15
Turbidity	**NTU**	23	18	18
Dissovled Oxygen	***mg/l***	3.2	3.4	2.4
B.O.D	***mg/l***	2.9	1.7	0.3
Alkalinity	***mg/l***	12	12	12
Hardness	***mg/l***	20	24	18
Sulphate	***mg/l***	9	12	9
Nitrate	***mg/l***	0.287	0.240	0.190
Ammonium-N	***mg/l***	0.753	0.804	0.665
Phosphate	***mg/l***	0.115	0.125	0.115
Chloride	***mg/l***	14.12	14.12	14.12
Calcium	***mg/l***	1.60	2.41	2.41
Magnesium	***mg/l***	3.89	4.38	2.92
Iron	***mg/l***	0.635	0.746	2.631
Zinc	***mg/l***	0.236	0.213	0.874
Copper	***mg/l***	0.136	0.116	0.254
Lead	***mg/l***	0.024	0.016	0.024
Cadmium	***mg/l***	ND	ND	ND
Manganese	***mg/l***	0.039	0.021	0.037

Table 4.3: Analytical Result from Ikpoba River

SAMPLE MATRIX: WATER

DATE ANALYSED: 27/10/2021

CLIENT: IKPOBA RIVER

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3	STATION 4	STATION 5
pH	**-**	5.4	5.6	5.6	5.6	5.7
Electrical Conductivity	**µS/cm**	20	20	20	30	30
TDS	***mg/l***	10.6	10.6	10.6	15.9	15.9
Suspended Solid	***mg/l***	181	82	78	38	35
Turbidity	**NTU**	296	135	127	53	52
Dissovled Oxygen	***mg/l***	4.7	5.8	5.2	4.0	2.6
B.O.D	***mg/l***	3.0	3.4	3.2	3.1	2.4
Alkalinity	***mg/l***	16	14	14	18	16
Hardness	***mg/l***	12	12	18	16	12
Sulphate	***mg/l***	8	5	7	5	4
Nitrate	***mg/l***	0.316	0.290	0.283	0.295	0.395
Ammonium-N	***mg/l***	0.836	0.710	0.710	0.654	0.591
Phosphate	***mg/l***	0.906	0.839	0.777	0.329	0.353
Chloride	***mg/l***	14.12	7.06	14.12	14.126	14.12
Calcium	***mg/l***	2.41	2.41	0.80	4.01	2.41
Magnesium	***mg/l***	1.46	1.46	3.89	1.46	1.46
Iron	***mg/l***	0.650	0.502	0.571	0.403	0.411
Zinc	***mg/l***	0.232	0.151	0.231	0.184	0.141
Copper	***mg/l***	0.180	0.091	0.132	0.110	0.095
Lead	***mg/l***	0.038	0.019	0.028	0.026	0.018
Cadmium	***mg/l***	ND	ND	ND	ND	ND
Manganese	***mg/l***	0.056	0.049	0.061	0.038	0.029

Table 4.4: Analytical Result from Ikpoba River

SAMPLE MATRIX: WATER

DATE ANALYSED: 27/10/2021

CLIENT: DAM

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3
pH	**-**	7.1	6.6	6.1
Electrical Conductivity	**µS/cm**	50	40	40
TDS	***mg/l***	26.5	21.2	21.2
Suspended Solid	***mg/l***	15	19	16
Turbidity	**NTU**	20	17	16
Dissovled Oxygen	***mg/l***	4.1	3.8	3.5
B.O.D	***mg/l***	2.5	2.1	1.5
Alkalinity	***mg/l***	10	12	12
Hardness	***mg/l***	20	14	24
Sulphate	***mg/l***	5	8	7
Nitrate	***mg/l***	0.280	0.271	0.161
Ammonium-N	***mg/l***	0.711	0.815	0.760
Phosphate	***mg/l***	0.117	0.120	0.111
Chloride	***mg/l***	14.12	14.12	14.12
Calcium	***mg/l***	1.60	1.60	0.80
Magnesium	***mg/l***	3.89	2.43	5.34
Iron	***mg/l***	0.611	0.715	1.531
Zinc	***mg/l***	0.215	0.211	0.774
Copper	***mg/l***	0.130	0.115	0.224
Lead	***mg/l***	0.022	0.017	0.021
Cadmium	***mg/l***	ND	ND	ND
Manganese	***mg/l***	0.036	0.026	0.034

Table 4.5: Analytical Result from Ikpoba Dam

SAMPLE MATRIX: WATER

DATE ANALYSED: 26/11/2021

CLIENT: IKPOBA RIVER

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3	STATION 4	STATION 5
pH	**-**	4.1	4.4	4.5	4.6	4.9
Electrical Conductivity	**µS/cm**	60	60	50	80	90
TDS	***mg/l***	31.8	31.8	26.5	42.4	47.7
Suspended Solid	***mg/l***	11	14	15	7	12
Turbidity	**NTU**	11	21	20	14	14
Dissovled Oxygen	***mg/l***	3.1	3.6	5.2	4.0	2.9
B.O.D	***mg/l***	0.9	1.9	4.1	3.3	5.9
Alkalinity	***mg/l***	6	10	12	8	10
Hardness	***mg/l***	14	12	18	16	18
Sulphate	***mg/l***	5	5	6	4	5
Nitrate	***mg/l***	0.624	0.686	0.701	0.860	0.895
Ammonium-N	***mg/l***	0.041	0.071	0.053	0.139	0.105
Phosphate	***mg/l***	0.079	0.127	0.149	0.360	0.190
Chloride	***mg/l***	14.12	14.12	7.06	14.126	14.12
Calcium	***mg/l***	3.21	1.60	1.60	5.61	2.41
Magnesium	***mg/l***	0.49	0.49	2.43	1.95	2.94
Iron	***mg/l***	0.646	0.514	0.499	0.412	0.420
Zinc	***mg/l***	0.244	0.162	0.271	0.190	0.149
Copper	***mg/l***	0.176	0.090	0.130	0.990	0.092
Lead	***mg/l***	0.034	0.013	0.026	0.022	0.014
Cadmium	***mg/l***	ND	ND	ND	ND	ND
Manganese	***mg/l***	0.059	0.052	0.067	0.035	0.029

Table 4.6: Analytical Result from Ikpoba River

SAMPLE MATRIX: WATER

DATE ANALYSED: 26/11/2021

CLIENT: DAM

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3
pH	**-**	5.0	4.9	5.0
Electrical Conductivity	**µS/cm**	80	70	70
TDS	***mg/l***	42.4	37.1	37.1
Suspended Solid	***mg/l***	11	9	8
Turbidity	**NTU**	13	20	11
Dissovled Oxygen	***mg/l***	3.6	5.5	4.8
B.O.D	***mg/l***	2.1	2.8	3.5
Alkalinity	***mg/l***	10	6	10
Hardness	***mg/l***	22	20	20
Sulphate	***mg/l***	4	4	4
Nitrate	***mg/l***	0.750	0.901	0.904
Ammonium-N	***mg/l***	0.331	0.261	0.650
Phosphate	***mg/l***	0.110	0.109	0.110
Chloride	***mg/l***	7.06	14.12	14.12
Calcium	***mg/l***	3.21	3.21	3.21
Magnesium	***mg/l***	3.40	3.40	3.40
Iron	***mg/l***	0.410	0.511	0.830
Zinc	***mg/l***	0.202	0.211	0.441
Copper	***mg/l***	0.125	0.110	0.218
Lead	***mg/l***	0.021	0.016	0.020
Cadmium	***mg/l***	ND	ND	ND
Manganese	***mg/l***	0.039	0.028	0.039

Table 4.7: Analytial Result from Ikpoba Dam

SAMPLE MATRIX: WATER

DATE ANALYSED: 17/12/2021

CLIENT: IKPOBA RIVER

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3	STATION 4	STATION 5
pH	**-**	6.9	6.7	6.7	6.9	6.4
Electrical Conductivity	**µS/cm**	40	30	30	60	30
TDS	***mg/l***	20	15	15	30	15
Suspended Solid	***mg/l***	7	9	10	9	10
Turbidity	**NTU**	0	7	0	2	10
Dissovled Oxygen	***mg/l***	6.1	6.2	4.8	3.3	3.8
B.O.D	***mg/l***	3.8	3.1	2.9	2.1	1.9
Alkalinity	***mg/l***	6	14	12	40	42
Hardness	***mg/l***	10	10	14	22	14
Sulphate	***mg/l***	1	9	7	2	7
Nitrate	***mg/l***	1.333	1.248	1.252	1.282	1.063
Ammonium-N	***mg/l***	0.041	0.071	0.053	0.139	0.105
Phosphate	***mg/l***	0.083	0.134	0.157	0.380	0.253
Chloride	***mg/l***	14.12	14.12	7.06	14.12	14.12
Calcium	***mg/l***	2.41	2.41	2.41	6.41	1.60
Magnesium	***mg/l***	4.37	4.86	1.95	6.81	2.43
Iron	***mg/l***	0.315	0.270	0.250	0.242	0.220
Zinc	***mg/l***	0.201	0.112	0.210	0.190	0.185
Copper	***mg/l***	0.160	0.045	0.130	0.190	0.115
Lead	***mg/l***	0.034	0.013	0.026	0.022	0.014
Cadmium	***mg/l***	ND	ND	ND	ND	ND
Manganese	***mg/l***	0.051	0.047	0.050	0.039	0.037

Table 4.8: Analytical result from Ikpoba River

SAMPLE MATRIX: WATER

DATE ANALYSED: 17/12/2021

CLIENT: DAM

PARAMETERS	UNITS	STATION 1	STATION 2	STATIION 3
pH	**-**	5.2	5.1	5.0
Electrical Conductivity	**µS/cm**	70	60	60
TDS	***mg/l***	37.1	31.8	31.8
Suspended Solid	***mg/l***	10	7	5
Turbidity	**NTU**	10	12	9
Dissovled Oxygen	***mg/l***	3.3	5.0	4.1
B.O.D	***mg/l***	1.9	2.4	3.1
Alkalinity	***mg/l***	10	10	12
Hardness	***mg/l***	18	18	20
Sulphate	***mg/l***	3	3	2
Nitrate	***mg/l***	0.610	0.591	0.541
Ammonium-N	***mg/l***	0.131	0.211	0.250
Phosphate	***mg/l***	0.122	0.121	0.117
Chloride	***mg/l***	14.12	14.12	7.06
Calcium	***mg/l***	2.41	2.41	3.21
Magnesium	***mg/l***	2.92	2.92	3.40
Iron	***mg/l***	0.318	0.477	0.601
Zinc	***mg/l***	0.202	0.211	0.441
Copper	***mg/l***	0.129	0.117	0.117
Lead	***mg/l***	0.010	0.010	0.014
Cadmium	***mg/l***	ND	ND	ND
Manganese	***mg/l***	0.034	0.021	0.031

Table 4.9: Analytical Result from Ikpoba River

4.3. PHYSICOCHEMICAL ANALYSIS

4.3.1. pH Analysis for both River and Dam

From the result in sample one it was seen that the pH value varies from between 4.1 to 7.9 for the rivers and the Dam was between 4.9 to 7.3. The pH show that the water sample was slightly acidic although at acceptable. The pH variation in mainstream water and its tributaries were 4.1 to 7.9 and 4.9to 7.3 respectively. This confirms that it is slightly acidic in nature. This is attributable to the HO - ion concentration, which is relatively high in the river as result of effluent from industries than the Dam (Table S1). Higher pH values of 4.1 station 1 for River and 4.9 at station 2 for Dam respectively.

4.3.2. Turbitity Analysis for both River and Dam Water Sample

The turbidity in the river and dam shows the ambiguity of the water due to the presence of suspended matter of clay, silt, waste and other particulate materials in both Ikpoba River and Dam, the water at the sampling stations from the Dam was found to be the most turbid, between 10 NTU – 81 NTU while the water at sampling station from the river exhibited the lowest turbidity values which was between 9NTU and 71 NTU respectively. In the middle and downstream of the river, the contribution to turbidity is mainly due to the disturbance of the topsoil by agriculture and other processes such as sand mining, as rivers usually move downwards from hilly areas . Contaminated runoff from industry, agriculture, markets and roads is the main reason for the high turbidity values of these stations (Fig. S2), which are located around urbanized cities

4.3.3. Electrical Conductivity (EC)

The electrical conductivity (EC) of water is also affected by temperature of the water, electrical conductivity is an assessment of dissolved solids in water. The average EC values in the water samples from the Ikpoba River from the various sample was between 20us/m and 80us/cm depending on the station and the prevailing temperature while the water samples from the Ikpoba Dam was between 30us/cm and 80us/cm depending on the station and prevailing temperature respectively. As can be seen from Fig. above S2(c), in the case of Ikpoba river, the highest EC values are 80 μS/cm and 80us/m for the Dam respectively. The values of EC shows an increasing pattern from the river, this may be due to the presence of inorganic dissolved solids such as Cl- , NO3 - , SO42-, and PO4 3- resulting from industrial effluent discharge and agricultural runoff.

4.3.4. BOD Analysis for Sample in Ikpoba River and Dam

BOD5 determine the level of organic pollution in Dam and rivers. BOD5 defines the biodegradable fractions. BOD5 values in the water collected from the Ikpoba River ranged between 0.9 and 5.9 mg/l for the various stations while that of the Dam was between 0.3 and 3.5 mg/l respectively. However, It can be seen from Fig.6 station5 above that the BOD5 values from the river increase significantly, which may be due to the high effluent discharge from storm drainage, industries and flushing of sewage directly into the river by urban settlements. The sampling from the Dam also experience high increase in values of BOD5, which may be due to the presence of industries and thermal power plants in the vicinity of these sampling sites.

4.3.5. DO Analysis for Water Sample in Ikpoba River and Dam

The intensity of non-compound, free oxygen present in the river water is called dissolved oxygen (DO). It is an important parameter for investigating water quality because of its impact on organisms living in water. Too low or too high level of DO can affect water quality and endanger aquatic life. The DO values from the water sample collated from Ikpoba River the various stations ranging between 0.5 mg/L to 6.1 mg/L and the DO value from the Dam in the various station was between 2.1 mg/L to 5.5 mg/L respectively. However it can be seen from station1 in (Fig. 2 has the highest value of DO. The values fall within acceptable standard. This indicates that water quality is not harmful to the aquatic environment.

4.4. ANALYSIS OF METAL ION IN THE SAMPLE FROM IKPOBA RIVER AND DAM

Concentration of major ions and its possible sources of the elements are found in nature mostly in the clay fraction of the soil, potable water, surface water, groundwater and marine waters as well [48]. In surface waters, the assessment of Li+ concentration is often overlooked because it naturally exists at low concentration (usually < 0.04 mg/L; [49, 50]). The concentration of Ca+ ranged from 1.611 mg/L to 2.64 mg/L, in the Ikpoba River. However, in the case of Dam, the range was between 0.820 mg/L to 3.21 mg/L. The higher variation in the values of Ca+ concentration from River and the Dam that the difference in sampling location has a major control over the Ca+ content. Weathering of rocks such as sandstone and limestone may be responsible for the concentration of Ca+ in the River. Through the weathering processes, Ca+ andmg+ are washed away from the soil and rocks in the catchment area. Rivers generally contain about 9 mg/L and 2-3 mg/L of Ca+ and mg+, respectively; however, these concentrations may fluctuate due to geological conditions and wastewater contamination . The concentration of Ca+ and mg+ in the Ikpoba River ranged from 2.41 mg/L to 6.41 mg/L and 0.49 mg/L to 12.64 mg/L respectively. As seen from the Fig. 1 to 8, the concentration of Ca+ and mg+ in the the river and is not very high and may be dissolved through weathering processes.

4.5. CONCENTRATION OF HEAVY METALS

Heavy metal pollution in the river water and Dam is one of the most important concerns of rural and urban communities in developing nations. The entry of these toxic heavy metals into the environment may lead to bioaccumulation and biomagnifications . Heavy metals pollution in the riverine environments has received global attention due to its persistence, abundance and environmental toxicity. To observe the concentration of heavy metals in the Ikpoba River and Dam. Some of the metals such as Pb, cd, Mg, Fe, Zn, and Mn in the collected water samples were analysed in AAS. The analysis showed that all samples contained Fe, Zn and Mn, including the river and Dam. The samples from the river and Dam shows there is no cadium why there was presence of lead in all the sample except the sample from fig 1. Fig. 1 to 8 show the concentration of Fe,Pb, Zn and Mn in the Ikpoba River and Dam. As can be seen from the figure, the concentration of mg in the river and Dam is slightly high compare to other metals present in the various samples. The concentration of Fe ranges from 1.95 mg/L to 12.451 mg/L in the Ikpoba River. In the case of Dam, the concentration of mg was from 2.95 mg/L to 3.652 mg/L which that it was higher than the concentration of the river. In case of the Ikpoba River, the concentrations of Zn was between 0.111 and 0.321 mg/l respectiely and Mn ranges from 0.021 mg/L to 0.058 mg/L while Fe was from 0.222 mg/L to 0.650 mg/L and Cu was from 0.095 to 0.432mg/l respectively. However, in the case of Dam, they are in the range of 0.211 mg/L to 0.774 mg/L and 0.034 mg/L to 0.039 mg/L, 0.311mg/l to 2.631mg/l, respectively.

As can be seen from Fig. 1 t0 8 the concentrations of Pb,Zn and Mn show an increased in the River and Dam. The River Fe concentration is mainly from natural sources, which may be due to the presence of silicate rock weathering in the basin. Both the Ikpoba river and dam are contaminated with medium to high heavy metals at several locations, which may be the results of the dense population and high industrial and agricultural activity in these surrounding the Ikpoba river.. The primary anthropogenic sources are the discharge of partially treated and untreated industrial wastewater and sewage containing toxic metals. In addition, it comes from the widespread use of metal chelates in a wide range of industries and pesticides and fertilizers containing heavy metals in the agricultural sector . However, the Fe, Pb,cd and Mn concentrations in River and Dam show high values from the drinking limits recommended by WHO.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. CONCLUSIONS

The study was designed to assess the water quality parameters of the ikpoba River and Dam The sampling points location of both the river and Dam shows the concentration of heavy metal, non metals and other parameters such as DO, BOD, Turbidity, pH, Electrical conductivity. The water sample from the river and dam shows that some of the were high and others were not present. One-way ANOVA clarified turbidity and Ca^+ are parameters having considerable variation between the Ikpoba River and Dam. However, NO_3^-, Na^+, Ca^+ and Mg^+ are parameters that show significant variation between each location of the Ikpoba River. Turbidity, Pb, Cu,Fe, and Mn are the most important parameters affecting the water quality of the Ikpoba river. The potential sources of contaimination in the Ikpoba River is pollution mainly due to the human influence as the catchment area in between is densely populated.

5.2. RECOMMENDATION

This work can be used as a case study to further strengthen the research findings of river water quality.

Further work should be carryout from time to time monitor the level of all of these parameters.

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