EFFECT OF URBAN RUNOFF AND HUMAN ACTIVITIES ON SOME PHYSICO-CHEMICAL PARAMETERS OF RIVER LANDZUN, BIDA, NIGER STATE, NIGERIA

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MTech/SPS/2017/7123

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ABSTRACT

Urban runoff and human activities have become a major source of surface groundwater pollution sources most in developing nations where most of their domestic and toilet waste and deposited. The river landzum is located in Bida, Niger State, Nigeria which is the major river in Bida. The study assessed the effect of urban runoff and human activities or some physic-chemical parameters of lanzum Bida, Niger State, Nigeria. After triplicate determination in the three sampling locations of river landzum the result of physiochemical paramaters obtained from laboratory analysis indicated that the quality of river water in the study area varies in value from location is location which was due to non-point source such as domestic, agriculture, local industries and commercial activities activities. As a result non-point source river landzum is considered unsafe for human consumption direct. The laboratory analysis revealed the following results pH value 7.0 which is considered as best and ideal within the Nigerian Industrial Standard (NIS) compared to a lowest value of 646 obtained at Dokodza which is more acidic but slightly below the NIS standard. This reveals that the water may contain some ions which may be responsible at that point and it will be slightly sour if tested or drank. The study shows that the mean maximum temperature of (15.02±0.01C^{o}), minimum turbidity value of 3.2±0.01, total solids (108.51±0.01mg/l and dissolved oxygen value of 3.92±0.01 which is below the NIS standard of 5.0 NTU. Total solids (108.51±0.01mg/l) was obtained. Human activities such as urbanization, farming water withdrawal civic constructions, local industries, effluent from commercial settings, domestic waste the waste the mentioned washed down to the drainage which is triggered by torrential rainfall resulted to the pollution of the river. The effect of urban runoff on the environment rated as 39.4% account for loss of properties, 29.7% displacement of people 2.5% loss of lives and 28.2% for loss of live and properties which is much more pronounced at Laruta, Bangaie, Wanigi, Dokodza, Bangbara, Tuti-Jiba areas respectively. This often resulted diseases caused when consumed contaminated water to such as cholera, dysentery and diarrhea, more often the contaminated water contain dangerous or toxic substance and disease causing organisms. Though, the water is purpose such as irrigation, local industries, some domestic uses spiritual uses and animal consumption. As such Government, NGOs and all stakeholders should formulate mitgitable measures to check human activities and treat water from any source before use.

TABLE OF CONTENTS

Content

LIST OF TABLES

TABLE **Page**

LIST OF FIGURE

Figure

Page

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Urban runoff is a by-product of the land's interaction with rainfall, it remains on and moves along the land's surface, it is the most visible of the many forms into which rainfall is converted (Ajai *et al.,* 2011).Urban runoff has become a major source of surface and ground water pollution in most developing nations, where municipal waste streams are uncharacterized or segregated (Seiyaboh and Angaye, 2018).

Urban runoff as a contributing factor to poor river water quality of the river Landzun has been a source of concern to the inhabitants of Bida, Niger State. The characteristics of any water body may indicate its level of pollution (Abdullahi and Idabawa, 2012). According to Aliyu (2014), a great deal of information on river water quality may be evaluated from the climatic and geological conditions in the river basin. These two factors generally play a role in the quality of water available for use for different purposes. In most rivers, the normal or dry weather flow is made up primarily of water which seeps from the ground. However, most of the flow of a river is contributed during the high runoff or flood periods. During the period of high runoff, most rivers exhibit their most favourable chemical water characteristics. Ayobahan *et al.* (2014), suggests that although the river may contain extremely large amounts of suspended matter, the concentrations of dissolved substances are usually low, often only a fraction of that present during dry weather. However, there are some instances where high runoff may cause deterioration in water quality. For instance, if rain falls selectively on the watershed of a tributary which contributes poor-quality water to a comparatively good-quality river system, the water contributed may cause a transitory deterioration of the water quality in the system.

As stated by Strahler and Strahler, all rainfall, wherever it occurs carries with it a variety of ions, some introduced into the atmosphere from the sea surface, some from land surfaces undisturbed by man and some from man-made sources. The ions and other substances carried into the streams or rivers via rainfall may result to pollution. (Seiyaboh *et al.*, 2018).

The pollution of water bodies from pollutant transport through surface runoff and uncontrolled discharge of untreated and partially treated sewage has been reported severally by Ige and Olasehinde (2008). Some of the identified effects of runoff water on such water bodies include nutrient enrichment, deterioration of the water qualities, destruction of spawning grounds for aquatic and marine life and generally killing of fish. Urban runoff carries contaminants, such as litter, food, human and animal waste, automobile fluids, industrial pollutants, fertilizers and pesticides to the beach creating health risks for people, killing marine life and contributing to localized flooding and beach closures (Mahmud *et al.*, 2007).

Urban runoff is a major cause of urban flooding, the inundation of land property in a built-up environment caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers which triggered by events such as flash flooding, storm surges, overbank flooding, or snow melt, urban flooding is characterized by its repetitive, costly and systematic impacts on communities are located within designated flood plains or near any body of water (Jena and Mohanty, 2005).

Water running off these impervious surfaces tends to pick up gasoline, motor oil, heavy metals, trash and other pollutants from roadways and parking lots are major sources of polycyclic aromatic hydrocarbons (PAHs) which are created as combustion by products of gasoline and other fossil fuels, as well as of the heavy metals nickel, copper, zinc, cadmium,

and lead (Angaye *et al.,* 2015). Roof runoff contribute high levels of synthetic organic compounds and zinc from galvanized gutters. Fertilizers use on residential lawns, parks and golf courses is a measurable source of nitrates and phosphorus is urban runoff when fertilizer is improperly applied or when turf is over-fertilized (Nwidu *et al.,* 2009).

Water plays a significant role in maintaining the human health and wealth: clean drinking water is now recognized as a fundamental right of human beings (Olatunji, *et al*., 2011). Around 780 million people do not have access to clean and safe water and around 2.5 billion people do not have proper sanitation. As a result, around 6-8 million people die each year due to water related diseases and disasters. Therefore, water quality control is a top-priority policy agenda in many parts of the world (Tubonimi, *et al.*, 2010).

A number of scientific procedures and tools have been developed to assess the water contaminants. These procedures include the analysis of different parameters such as pH, turbidity, conductivity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Organic Carbon (TOC), and heavy metals. These parameters can affect the drinking water quality, if their values are in higher concentrations than the safe limits set by the World Health Organization (Ogwueleka, 2012) and other regulatory bodies. Pollution of a river first affects its chemical quality and then systematically destroys the community using the water and disrupting the delicate food web. Diverse uses of the rivers are seriously impaired due to pollution and even the polluters like industry suffer due to increased pollution of the rivers (Jay *et al.,* 2007). River pollution has several dimensions and effective monitoring and control of river pollution requires the expertise from various disciplines. Pollution of river is a global problem (Arimieari *et al.,* 2014).

The indiscriminate and large scale deforestation and over grazing in the watershed areas of river basins have caused soil erosion resulting in considerable silting of dams and shrinkage of river flows. This leads to the flooding of the rivers at the time of excessive rains. The disposal of waste leads to contamination of river and lakes chronically affecting the flora and fauna (Akpan, *et al.*, 2012). According to surveys carried out on selected stretches of important rivers, it has been found that most of the rivers are grossly polluted. The domestic sewage discharged from a population of about two million gives rise to numerous water-borne diseases like typhoid, cholera, dysentery, poliomyelitis and cysticercosis, thereby affecting the human health and deterioration of the water quality (Laah, 2018).

1.2 Statement of the Research Problem

River Landzun in Bida, Niger State has witnessed a lot of changes both in the river channel, river bank and water contents which was induced by urban runoff and human activities. It is in view of this objectives of these research work and the assessment of this task (research work) that the bed wilder factor to this broad field urban runoff and human activities draw its problem statement from the previous research work which depict a gap that arouse my interest to fill.

Egereonu, (2004) conducted a research on Landzun river, revealed that both in rural and urban areas lack access to surface water i.e large proportion of it is untreated safe which is usually consumed direct or indirectly which he attributed to seasonal variation induced by both anthropogenic activities and natural processes as culprits responsible for the contamination of streams and rivers. It also revealed that untreated state of landzun river is beyond the set standard by Adnan *et al.* (2010) for drinking water. The intake of untreated surface water is a vehicle for potential water-borne diseases and allergies.

According to the data by the World Health Organization (WHO), the indicator is a measure of the extent to which drinking water is contaminated by chemical contaminants and microbiological organisms and thus it can serve as a mechanism for warning or situations that require further in-depth investigation and actions necessary for the improvement of drinking water quality. The quest for unhindered access to safe and potable water for mankind takes priority on the agenda of many international organizations and developed countries. The United Nations Organization during its 2010 general assembly unequivocally reiterated that everyone is entitle to adequate, uninterrupted, safe, acceptable, physically accessible, and affordable water for personal and domestic purposes (Manjare *et al.*, 2010).

Musa *et al.* (2013) opined that almost virtually developing nations lack regular monitoring of the physicochemical parameters of water bodies. According to the studies carried out by WHO, 2006, revealed that developing nations experienced limited studies of water quality and pollution status of rivers. Due to these above vaccum pointed out by Emitimi and Sylvester (2017); WHO (2006) and Basavara (2011) and other researchers that trigger my interest to come in so as to provide a solution to fill the gap, so as to come up with policy framework that will guide against water pollution and consumption of contaminated water.

1.3 Aim and Objectives

The aim of this research is to assess the effect of urban runoff and human activities on some physic-chemical parameters of river landzun, Bida, Niger State, Nigeria.

Objectives

i. To examine the socioeconomic impacts of river Landzun.
ii. To identify the pollution sources of river Landzun.
iii. To analyze some physic-chemical parameters of river landzun.

iv. To examine the health implication of consuming contaminated water in the study area.

1.4 Scope and Limitation of the Work

The area under study is River Landzun in Bida, Niger State. The study focused on effect of urban runoff and human activities on some physicochemical parameters of River Landzun. Three locations will be chosen; such as Dokodza, Tako Landzun as well as Wanigi areas respectively. One factor limiting this research was most of the health facilities lack departmental databases on drinking water quality and comprehensive records on water related diseases.

1.5 Significant of the Study

The significant of this study is to assess the effect of urban runoff and human activities in river landzun in Bida, Niger State, river landzun had been a source of water used for market garden or micro-farm, small scale industrial activities and domestic uses faced with a lot of alterations which was traced to human activities and runoff from the environment.

The study aimed to determine some physic-chemical parameters, how these parameters affects landzun river. Three locations will be chosen spatially along the water course to reflect a consideration of all possible human activities that are capable of affecting the quality of river landzun, the water samples collected will be analyzed for physicochemical parameters which include temperature, PH, electrical conductivity, turbidity, dissolved oxygen, biochemical oxygen demand, total solids, total dissolved solids, alkalinity and hardness of these selected sample points.

Another significance of this research is work to examine the socio-economic impact of landzun river, such as recreational, water supply for industrial uses, fishing, agriculture,

domestic uses etc. in other to assess landzun river with emphasis on runoff and human activities, identification of a alteration source, its highly appreciated such as urban waste disposal, agricultural runoff, animal waste, domestic waste etc. are all channel into the river channel. In view of the above, this study finds proper solution for runoff water and pollution of Landzun River.

1.6 Description of the study Area

1.6.1 Geographical location of the study area

Bida is located in the Niger valley in Niger State Nigeria within latitudes 9^0 and 9^0 9^0 North of the equator and longitude 5^0 56^0 and 6^0 04^0 East of Greenwich Meridian. The town has a projected population of 283,400 (NPC, 2017) and occupying a total land area of 37.545446km^2 (Stark *et al.,* 2000).

The Landzun river stream is 8.86km long, and about 5km lies within the city of Bida, with an overall west to east flow pattern and estimated the flow rate of 22.21m3s between 2010 and 2018 (Stark *et al.,* 2000). Bida is a residential with little agricultural practice and trading, the town is also the main collection centre for the swamp rice cultivated in the flood plains of the Niger and Kaduna rivers.

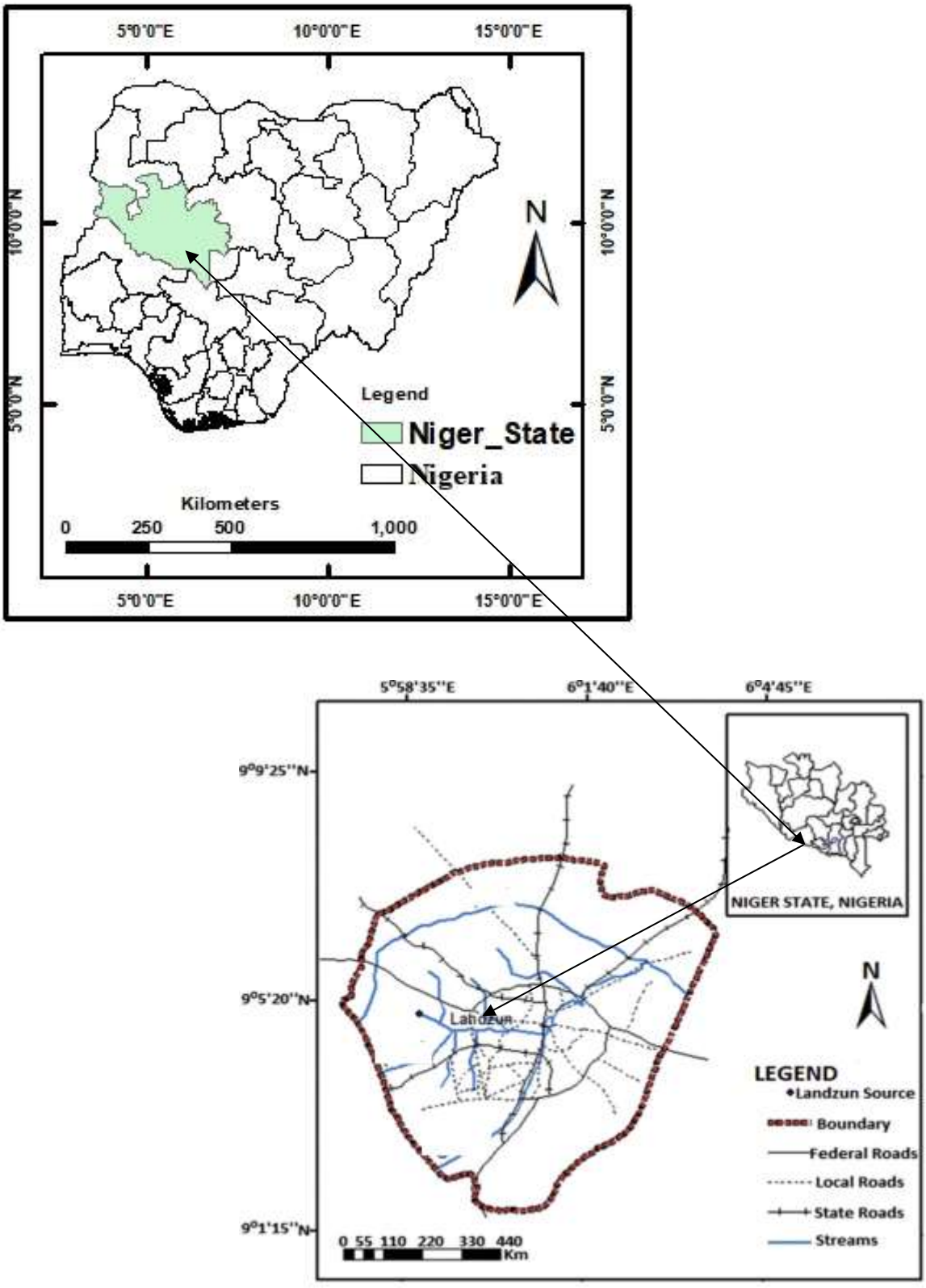


Figure 1.1: Map of Landzun River Bida, Niger State Nigeria

1.6.2 Climate

The climate of Bida is the result of general atmospheric circulation of air masses over the earth modified by surface topography and elevation (Ojonigu and Sawa, 2009).

1.6.2.1 Rainfall

Between 1999 and 2019 in Bida is estimated to be 3.31mm, with the highest rainfall recorded in between August and September annually during normal raining year (Adebola *et al.*, 2014).

1.6.2.2. Temperature

The middle Niger basin which Bida is located experiences high temperatures all the year round. The mean maximum temperature increases northwards from about 30^0C in Ilorin to about 37^{0c} in Zaria north of the basin (Ojonigu and Sawa, 2009).

1.6.3 Vegetation

Vegetation of the region lie in an ecological zone termed by plant geographers the northern Guinea Savanna, a designation which implies a wood land vegetation type dominated by Isoberliniadoka, i. tomeutosa, and undisturbed. Much of the vegetation cover has suffered profound anthropogenic modification. The main plant or physiographic communities now found in the area, in order of importance, are

i. Tree Savanna/cultivation park land,
ii. Shrub Savanna,
iii. Woodland and Savanna woodland,
iv. Fadama grassland
v. Riparian forest,
vi. Inselberg vegetation

The communities are largely an expression of climatic and edarphic factors which have been modified by man's activities. Jaiyeoba and Essoka (2009).

1.6.4. Geology and topography of the study area

Geologically, the study location sits on the northern hemisphere of the cretaceous mid-Niger, Bida or Nupe Basin, as it is locally referred to among Nigerian geologist Bida township falls on the northern section of the southern mid-Niger Basin, (Etim *et al.*, 2013). Bida basin is made up of two distinct groups of rocks. These are the Precambrian Basement complex rocks and the cretaceous sedimentary rocks (Iguisi, 2009).

The basin is believed to be segmented into two sub-basins, the northern part called the Bida sub-basin and the southern part known as the southern. The landzun stream occupies part of the Northern Bida sub-basin. This sub basin is strategraphically made up of four geological units, Bida sand stone, Sakpe ironstone, Enagi siltstone and Batati ironstone. The Bida sandstone lies unconformably in the basement complex. Although, the contact between the formation and the basement is not clear, its estimated thickness in the Bida area (where the Landzun stream drains) is put at 2000-3000m based on airborne magnetometry. The study area topography is characterized by insulating landscape formed by dissected hills characteristic of the basement complex that make up the geology (Iguisi, 2009).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Conceptual Framework

2.1.1 Urban runoff

Urban Runoff is either wet weather (rainfall) or dry weather (water waste) flows from urban landscapes into the rivers drain systems that lead to the beach. Unfortunately, urban runoff is now the single largest threat to the health of both human beings and aquatic habitat (Kuta, 2014). Urban runoff carries contaminants, such as litter, food, human and animal waste, automobile fluids, industrial pollutants, fertilizers and pesticides.

2.1.2 Human ACTIVITIES

Our water resources face a host serious threat all of which are caused primarily by human activity. They include sedimentation, pollution climate change, deforestation, landscape changes, urban growth, water withdrawal, urban waste disposal, irrigation, industrial uses, regular use of river banks and other related civic constructions (Moshood, 2008).

2.2.2 Physico-chemical Parameters

2.1.2.1 Temperature (TP)

Temperature is a factor of great importance for aquatic system, as it affects the organisms, as well as the physical and chemical characteristics of water (Chris *et al*., 2010).

2.1.2.2 pH

Water PH indicates the intensity of the acidic or basic character of a solution and is controlled by the dissolved chemical compounds and biochemical processes in the solution. It is usually

monitored for assessments of aquatic ecosystem health, irrigation and drinking water sources industrial discharges and surface water runoff (Radwan and Atalla, 2015).

2.1.2.3 Electrical conductivity

Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts (Otufale and Coster, 2012).

2.1.2.4 Turbidity (TB)

Turbidity in water arises from the presence of very finely divided solids which are not filterable by routine methods. The existence of turbidity in water will affect its acceptability to consumers and it will also affect markedly its utility of waters and in the of the disinfection process the consequences could be gravel.

2.1.2.5 Dissolved oxygen (DO)

Dissolved oxygen refers to the level of free, non-compound oxygen present in water of other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water (Owhonda *et al.,* 2018). Non-compound oxygen, or free oxygen (02), is oxygen that is not bonded to any other element.

2.1.2.6 Biochemical oxygen demand (BOD)

Biochemical Oxygen Demand or biological oxygen demand, is a measurement of the amount if Dissolved Oxygen (DO) that is used by aerobic microorganisms when decomposing organic matter in water (Arimoro, and Ikomi, 2008).

2.1.2.7 Total solids (TS)

This parameter refers to matter suspended or dissolved in water or wastewater, and is related to both specific conductance and turbidity. Total solids also referred to as total residue is the term used for material left in a container after evaporation and drying of a water sample (Ojutiku *et al.,* 2014).

2.1.2.8 Total dissolved solids (TDS)

TDS are the inorganic matters and small amounts of organic matter, which are present as solution in water (Heydari and Bigdoll, 2012).

2.1.2.9 Total suspended solids (TSS)

This includes all particles suspended in water which will not pass through a filter. Suspended solids are present in sanitary wastewater and many types of industrial wastewater. There are also nonpoint sources of suspended solids, such as soil erosion from agricultural and construction sites are present (Chindah and Braide, 2011).

2.1.2.10 Total hardness (TH)

Total hardness is the property of water which prevents the lather formation with soap and increases the boiling points of water. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. Based on hardness, water classified into three different categories, soft water (0 to 75 mg/L0, moderately hard water (76 to 150 mg/L) and hard water (151 to 300 mg/L) (Ogedengbe and Akinibile, 2004).

2.2 Review of Related Literatures

Water is an abundant natural resource, crucial for the sustenance in all aspects of life and it is a valuable resource that needs to be well-cared-for (Sarabject and Luke, 2003). About 75% of the earth's surface is covered with water but fresh water accounts only less than 2.7% (Ohwo

and Abel, 2014). The increasing human population has exerted massive pressure on the water all over the world especially in developing countries as a source of provision for safe drinking and irrigation purpose (Umeh *et al.,* 2005). Water is vital to life, well-being, food security and socio- economic development of mankind. The challenge of water quality has become a global issue. In many developing countries, it has become a critical problem of great concern to many families and communities relying on non-public water supply system (Okonko, *et al.,* 2008).

Water is used for domestic, industrial and agricultural purposes by a human. The sources of water supply in nature include ground and surface water-lakes, ponds, rivers, streams, springs and rain (Adetoro and Popoola, 2014). Access to safe drinking water become imperative; hence, water needs to be conserved and valued. Despite that it is an essential commodity; access to safe drinking water in many parts of the world has been threatened basically due to the contamination of water by human activities (Adesuyi *et al.,* 2015).

Water is essential for maintenance of life by drinking pure water. Health due to consumption of contaminated water affects humanity especially in the developing country. Water is not only a vital environmental factor to all forms of life, but it has also a great role to play in socioeconomic development of human population (Adekunle and Eniola, 2008). Water is said to be polluted when is contains micro-organisms of human or animal dug, poisonous chemical substances, industrial or domestic sewage, organic and in organic substances. Water is said to be pure when it is colorless, free from turbidity and abnormal tests and smell. Water pollution is the contamination of natural water bodies by chemical, physical, radioactive or pathogenic microbial substances (Aremu *et al.*, 2011). Adverse alteration of water quality

presently produces large scale illness and deaths, accounting for approximately 50 million deaths per year worldwide, most of these deaths occurring in Africa and Asia.

The challenges of continuing population growth and urbanization, rapid industrialization and expanding food production are all putting pressure on water resources. A couple of these facts is the increasing unregulated or illegal discharge of contaminated water within and beyond national borders (Babnyera *et al.*, 2010).

The sources of water supply in nature include ground and surface water-lakes, ponds, rivers, streams, springs and rain. Absolutely, pure water is unavailable in nature. The impurities in water vary from dissolved gasses and chemical compound to suspended matter such as disease, organisms and dirt. However, these impurities are acquired through contact with the environment and exist in solution, colloid and suspension forms. Impurities in water depending on the method of detection can be characterized as biological, physical and chemical while the pathogenic presence describes biological characteristics of such water (Akpan and Ajayi, 2016).

Rivers are the most important freshwater resource for man. Apart from its function as a source of freshwater for drinking, domestic and industrial uses; freshwater resources serve multiple functions most of them being critical to human settlement and survival (Ayobahan, *et al*., 2014). Polluted water is an important vehicle for the spread of diseases. Adequate supply of safe and sanitized freshwater is an inevitable factor for human and economic development. Reports by Food and Agricultural Organization (FAO) revealed that in African countries, particularly Nigeria, water related diseases had been interfering with basic human development (FAO, 2007).

The common sources of water that are available to local communities in Nigeria are fast being severed by a number of anthropogenic factors, of which pollution remain the most dominant problem. Water abstraction for domestic use, agricultural production, mining, industrial production, power generation, and forestry practices can lead to deterioration in water quality and quantity that impact not only the aquatic ecosystem, but also the availability of safe water for human consumption (Babayemi and Dauda, 2009). Water is indispensable natural resources on earth. All life including human beings depends on water. Water is essential for the development and maintenance of the dynamics of every facet of the society. Freshwater is a finite resource, essential for agriculture, industry and even human existence (El-kabbany *et al.,* 2000). Without freshwater, fish has no life as it support the different phases of fish life that is, fish lives and carry out activities in water such as breeding, movement, respiration. Physical and chemical parameters of water are very important for fish growth and production.

Water is the essence of life and soft drinking water is basic human right essential to all and also essential for the well- being of mankind and for sustainable development. According to the importance of water ranges from cooking, drinking, agricultural and industrial processes, human recreation and waste disposal. The availability of good water is an indispensable feature for preventing diseases and improving quality of life (Saeed and Mahmud, 2014). Water quality deals with the physical, chemical, and biological characteristics in relation to all other hydrological properties. Reported that, the quality of ground water depends on various chemical constituents and their concentration, which a mostly derived from the geological data of the particular region. According to Yakubu *et al.* (2014), over 1 billion people lack access to safe drinking water worldwide. The situation is worse in developing countries where many people especially the poor have opted to using the ground drinking

water sources like boreholes, shallow wells, springs, as a source of drinking water and for other domestic use. It was observed by that, the cost of environmental degradation due to water changes i.e pollution is relatively high with serious health and quality of life consequences; as well as measuring the severity of water scarcity problems. WHO (2006) noted that increasing water pollution does not only cause deterioration of water quality but also threatens human health, balance of aquatic ecosystems, economic development as well as social prosperity.

Groundwater contamination has become a great problem due to rapid population growth, industrialization and urbanization rate in the metropolitan cities all over the world. The source of contamination may be due to land disposal of sewage effluents, Sludge and solid waste, septic tank effluents urban runoff, agricultural, mining and industrial practices (WHO, 2006). Groundwater can also be contaminated through organic wastes, infiltration, of irrigation water, pits, lagoons and ponds used for storage. Therefore, it is of paramount importance to assess both physical and chemical standard of groundwater as it is the only source of drinking water within the study area, to improve awareness educate, and reduce the incidence of diseases transmission (Laah, 2018).

Water as a universal solvent has the capability to dissolve many substances including organic and inorganic compounds. This outstanding property of water can be ascertained to the inconceivability to take in water in its pure form. The quality of water generally refers to the component of water present at the optimum level for suitable growth of plants and animals. Aquatic organisms need a healthy environment to live and adequate nutrients for their growth; the productivity depends on the physicochemical characteristics of the water body. The maximum productivity can be obtained only when the physical and chemical parameters are present at optimum level. Water for human consumption must be free from organisms and

chemical substances and such large concentrations may affect health. The pollution of water is increased due to human population, industrialization, the use of fertilizers in agriculture and man-made activity. Parameters such as temperature, turbidity, nutrients, hardness, alkalinity, dissolved oxygen, etc. are some of the important factors that determines the growth of living organisms in the water body. Hence, water quality assessment involves the analysis of physico-chemical, biological and microbiological parameters that reflect the biotic and abiotic status of the ecosystem (Omoigberale and Ogbeibu, 2005).

Water is essential for the survival of all forms of life and the availability of good quality water is an indispensable feature for preventing diseases and improving the quality of human life. Rivers play a major role in integrating and shaping the landscape, and moulding the ecological setting of a basin (Ogbeibu and Anagboso, 2003). They are key in controlling the global water cycle and are the most dynamic agents of transport in the hydrological cycle. Water resources are of high importance for human life and economy and are the main source to fulfill drinking water needs, irrigation of lands and for industry. Therefore lack of water is considered as socio- economic obstructive factor of a country (Smitha *et al.*, 2007).

Industrial development and modern urbanization have resulted in the formation of large urban zones, industrial zones and intensive development of agriculture. This has not only increased the need for water, but also growth of urban and industrial waste discharges to the rivers with no prior treatment at the same time, decrease the ability of water to self-cleanse/auto purify (Umeh *et al.*, 2005). Pollution of a river first affects its chemical quality and then systematically destroys the community disrupting the delicate food web and many rivers become short-lived and end up drying.

Today, the need for clean water is considered as one of the biggest environmental global problems. Currently, more than 1.2 billion people in the world have no access to drinking water and 3 billion people have inappropriate sanitary services and more than 200 diseases have been linked to contaminated water. About 6,000 people die daily from diarrhea diseases. According to WHO (2006), it is estimated that every year around 5 million people die due to consumption of contaminated water and based on current trend of urbanism in the world until 2025, around 3 billion people will need water supply and more than 4 billion people will need access to sewerage services (Adefemi and Awokunmi, 2010).

Water quality can be monitored either by direct measurement of both the physical and chemical parameters of water or by analyzing the inhabiting biota thus quality of an aquatic ecosystem is dependent on the physico-chemical qualities of water and the biological diversity of the system. The physico-chemical monitoring approach includes the analysis of different parameters such as pH, turbidity, conductivity, total suspended solids, total dissolved solids, total organic carbon, nutrients and heavy metals (Chindah and Braide, 2004). These parameters affect the drinking water quality, if their values are in higher concentrations than the safe limits set by the regulatory bodies. Therefore, there is need to investigate the quality of drinking water to ensure adequate access to clean and safe water by the growing human population (La'ah, 2018). The water resources of our planet are the most threatened aspect in life existence. Present estimation of consumable water levels is placed at 1% with ground water levels also threatened by pollution (Abulude and Akinnusotu, 2015). In Nigeria, one of the greatest challenges of environmental managers, hydrologists, and water resource analysts has been the problem of surface water pollution. Urbanization, domestic and industrial activities have greatly contributed to increasing scale of pollution of rivers and other water bodies (Ibeh and Mbah, 2007).

Landzun river is among the major rivers found in Bida, Zone 'A' Niger State Nigeria. As surface water in a developing country, and in accordance to Ayemi *et al*. (2011), it may be predisposed to pollution due to high population growth and indiscriminate waste disposal. Some industries may also discharge their waste water into the river. The regular use of the river banks for agricultural activities can cause the washing of agrochemicals during heavy rainfall into the river.

Water is one of the most important and abundant compounds of the ecosystem. All living organisms on the earth need water for their survival and growth. As of now only earth is the planet having about 70 % of water. But due to increased human population, industrialization, use of fertilizers in the agriculture and man-made activity it is highly polluted with different harmful contaminants (Maureen, 2018). Therefore it is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. It is difficult to understand the biological phenomenon fully because the chemistry of water revels much about the metabolism of the ecosystem and explain the general hydro - biological relationship (Ogaga *et al*., 2018).

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water contains different types of impurities are introduced in to aquatic system by different ways such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials (Maitera *et al.,* 2011). The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the

water run-off. Also faucal pollution of drinking water causes water born disease which has led to the death of millions of people (Adefemi and Awokunmi, 2010).

People on globe are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of air, water and soil. These are related to animal and plants and finally affecting on the environment. (Kapla-Tharanga and Wang, 2012). Industrial development (Either new or existing industry expansion) results in the generation of industrial effluents, and if untreated results in water, sediment and soil pollution (Muhammad *et al.*, 2015).

Having mainly excessive amounts of heavy metals such as Pb, Cr and Fe, as well as heavy metals from industrial processes are of special concern because they produce water or chronic poisoning in aquatic animals (Omowaye and Audud, 2012). High levels of pollutants mainly organic matter in river water cause an increase in biological oxygen demand (Arokoyu and Ukpero, 2014), chemical oxygen demand, total dissolved solids, total suspended solids and fecal coli form. They make water unsuitable for drinking, irrigation or any other use (WHO, 2006).

The quality of ground water depends on various chemical constituents and their concentration, which are mostly derived from the geological data of the particular region. Industrial waste and the municipal solid waste have emerged as one of the leading cause of pollution of surface and ground water. In many parts of the country available water is rendered non- potable because of the presence of heavy metal in excess. The situation gets worsened during the summer season due to water scarcity and rain water discharge. Contamination of water resources available for household and drinking purposes with heavy elements, metal ions and harmful microorganisms is one of the serious major health

problems. The recent research in Haryana (India) concluded that it is the high rate of exploration then its recharging, inappropriate dumping of solid and liquid wastes, lack of strict enforcement of law and loose governance are the cause of deterioration of ground water quality (Gupta and Sharan, 2009).

There are various determinants of water pollution on the major causes is population (Laah, 2018). Suggested that population growth brings environmental deterioration through development, such as large scale farming, urbanization and industrialization. Another factor of water pollution is human activities. Of all human activities, the main sources of water pollution are domestic wastewaters (Entimi and Sylvester, 2017). Domestic wastewater comes from residential sources including toilets, sinks, bathing laundry and industrial wastewater is discharged enterprises (Entimi and Sylvester, 2017).

Another human activity that causes water pollution is agriculture. Although agricultural activities are more active in rural area than in urban areas, agriculture is still important for urban cities. The main causes of water pollution from agriculture are pesticides, chemical fertilizers, intensive farming in certain areas and livestock manure (Estevez *et al.*, 2008). Drinking water sources many contain a variety of contaminants that, at elevated levels, have been associated with increased risk of a range of diseases in children, including acute diseases such as gastroin testinal illness, developmental effects such as learning disorders, endocrine disruption, and cancer.

Most of the rivers in the urban areas of the developing countries are the ends of effluents discharged from the industries. African countries and Asian countries experiencing rapid industrial growth and this is making environmental conservation a difficult task (Agarwal Animesh, 2011). Sea water contains large number of trace metals in very small concentration.

This is a challenging matrix for the analytical chemist due to the very low concentrations of many important trace metals (Egereonu and Nwachukwu, 2005).

Population explosion, uncontrolled urbanization and industrialization have caused a high rate of waste generation in Nigeria (Rosegrant, 2001). Ramakrishnaiah (2009) pointed out that aquatic pollution problem in Nigeria was increasing in scope and dimension. Gonfa *et al.* (2019) identified that regular, unregulated indiscriminate dumping of waste into water bodies worsen aquatic pollution. This study is intended to assess the impact of industrial effluents on the surface water at Asa Dam industrial estate and its environs. It also identifies common pollutants in the water. The impact is assessed in term of its physicochemical and bacteriological quality (WHO, 2004). All over the world, fresh water resources have been subjected to an increasing pollution load from contaminated runoff water originated from manmade activities like domestic and industrial (Stephen, 2016). The adverse effects of human impacts on the aquatics include water – borne diseases, alteration of aquatic biota composition, eutrophication and reduction or destruction of ecosystem integrity (Olomukoro and Egborge, 2004).

Human settlements, industries and agriculture are the major sources of water pollution. Globally, 80 percent of municipal wastewater is discharged into water bodies untreated, and industry is responsible for dumping millions of tons of heavy metals, solvents, toxic sludge and other waste into water bodies each year (Wogu and Okaka 2011). Agriculture, which accounts for 70 percent of water abstractions or withdrawals worldwide, plays a major role in water pollution. Farms discharge large quantities if agrochemicals, organic matter, drug residues, sediments and saline drainage into water bodies. The resultant water pollution poses demonstrated risks to aquatic ecosystems, human health and productive activities (UNEP,

2006). Farms discharge large quantities of agrochemical organic matter, drug residues, sediments and saline drainage into water bodies. Water pollution not only harms the aquatic beings but it also contaminates the entire food chain.

Waste management is a major problem in most developing nations of the world including Nigeria (Liu *et al.,* 2003). Indiscriminate disposal of municipal wastes remains a major threat to surface water pollution in Nigeria. In most cases, sewage and waste water from homes are routed into the rivers and streams (Osinbanjo *et al.,* 2011). Urbanization in most Nigerian cities has resulted in the concentration of large population in some areas living under poor sanitation conditions (Osinbanjo *et al.,* 2011). This invariably has led to increased waste generations with heaps of waste everywhere. During rainfall, some of these wastes and washed into the poor drainage systems and subsequently into nearby rivers (Osinbanjo *et al*., 2011).

Lack of town planning principles and strategies in Nigeria's cities and towns had aggravated the risks of urban run-off with resultant effect on surface water. The poorly managed drainage system in the country had caused the surface water impairment due to erosions during rainfall runoff carriers all sorts of pollutants from houses, industries, farmlands and dumping sites (Osinbanjo *et al.,* 2011).

Water is essential to all forms of life. It is indispensable for agriculture, manufacturing, transportation and many other human activities. Despite its importance, water is the most poorly managed resource in the world and contaminated by several sources. Due to increasing of various human activities and some natural processes, the quality of water is decreasing continuously and is posing a great threat to all forms of life including humans (Aisien *et al.,* 2010).

Point and non-point source pollution are major environmental problems affecting water quality. The situation is worsened by lack of treatment for domestic wastes. In farming areas, the routine application of agricultural fertilizers is the major source of contamination. In urban areas, the careless disposal of industrial effluents and other wastes may contribute greatly to the contamination and poor quality of the water.

Rivers are the main sources of both drinking water and irrigation for agriculture. They also play vital roles in transportation, maintaining soil fertility, the development of forest resources, and conservation of wild life. In urban areas, the inappropriate disposal of industrial effluents and other municipal wastes may contribute greatly to the poor quality of river water. Thus, most of the rivers in urban areas of developing countries are the end point of effluents discharged by industries and municipal discharges (Puyate and Rukeh, 2008).
Nowadays, developing countries including Nigeria are experiencing rapid urban and industrial growth and this makes environmental conservation a difficult task. Among this, Nigeria rivers are experiencing poor quality of municipal waste disposal techniques. Apart from natural factors influencing water quality, human activities such as domestic and agricultural practices impact negatively to the quality of river water. However, there are limited studies of water quality and pollution status of rivers in developing countries (WHO, 2006).

Water is the most valuable natural resource available to man, without which no life can survive. Therefore, adequate and safe water supply is a pre-requisite for significant socio-economic development of any community (Manjare *et al.,* 2010). Water bodies' pollution is the introduction of contaminants into water bodies. Water pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful substances (Jena

and Mohanty, 2005). Water pollution affects plants and animals living in these water bodies, and also, affects other aquatic biota. Globally, the most prevalent water quality problem is eutrophication -the introduction of nutrients (mainly phosphates and nitrates) into water bodies. Eutrophication substantially impairs beneficial uses of water (WHO, 2006).

Water quality refers to the chemical, physical, biological, and radiological characteristics of water (Okerenta *et al*., 2016). It is a measure of the conditions of water relative to the requirement of one or more biotic species, and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to access water quality relate to health of ecosystems, safely of human contact and consumption (WHO, 2006).

Water quality parameters are parameters in which the assessment of water quality is based. Water quality parameters are divided into three categories; physical parameters, chemical parameters and biological parameters (Rokade and Ganeshwade, 2006). Some of the physico-chemical parameters include turbidity, temperature, electrical conductivity (EC), total suspended solids (TSS), pH, dissolved oxygen (DO), nitrates, nitrites, phosphates, biochemical oxygen demand (BOD), etc. Water is adjudged safe if these parameters fall within certain range that is tolerable by human when consumed; and also tolerable by living organism within the aquatic environment (WHO, 2006). Water quality standard or guideline describes the quality parameters set for drinking water (Arokoya *et al.,* 2014). Despite the truism that every human on this planet needs water to survive, and that water may contain many harmful constitutions, there is no universally recognized or acceptable international standard for drinking water. Even where standards do exist, and are applied, the permitted concentration of individual constituents may vary by as much as ten times from one set of standards to another. Many developed countries specify standards to be applied in their own

country. In Europe, this includes the European Drinking water directives; and in U.S.A, the United States Environmental Protection Agency (Arokoya *et al.,* 2014).

Polluted water is one with impaired water quality. The use of such water by different life forms is hampered. This is due to the presence of anthropogenic contaminants. Anthropogenic contaminants are products of anthropogenic activity of man. It has been reported that water pollution is among the leading cause of death and diseases worldwide. The World Health Organization (WHO) noted that 80% of all sicknesses and diseases in the world are associated with water, either directly through contamination with microbes or associated with vectors or caused by metal contaminants that can be detrimental to life (Hari *et al.,* 2016).

The Nigerian coastal environment with diverse ecosystems, rich natural resources, and large human population is saddled with high anthropogenic activity, which results in generation of anthropogenic contaminants. These contaminants pollute water resources, and have been reported to pose a threat to both managements of ecosystems and public health (Gnana *et al.*, 2005). In recent times, the pollution of water resources in Nigeria by anthropogenic activity of man, especially surface water bodies have attracted public attention. Hence, attempts have been made to evaluate the pollution status of some surface water sources within Nigeria by assessment of their water quality. However, there are also others with unknown pollution status (Chavan *et al.,* 2005).

Water is an essential resource to biodiversity largely because all organism depend on water for survival and sustenance. As documented in literature, the quality of river water plays a vital role to the relative public health and sustenance of any given community or ecosystem. For instance, anthropogenic activities have the tendency to release toxic organic and

inorganic leachates from waste stream which are transported by urban runoff to contaminate water bodies (Abowei, 2010). Persistent inflow of waste stream from urban runoffs have largely affected the ambient water quality of aligning water bodies. It has been observed that in some communities of most developing countries surface water still serve as a means for waste disposal, especially in riverine communities. Persistent anthropogenic activities over a period of time may influence the contamination rate (Basavaraja *et al.,* 2011).

The contamination of water bodies from leachates of urban runoff due to unregulated and illicit dumping of unsegregated and untreated treated waste stream have been reported by several authors. Some of the envisaged adverse of such contaminated runoff water on such water bodies includes but not limited to; nutrient enrichment, deterioration of the water qualities, and destruction of spawning grounds for aquatic and marine life, general fish kill. Furthermore, the quality of any water body is largely dependent on its intended purpose. Even the spread of water-borne diseases like typhoid, cholera, diarrhoea from contaminated water have been documented in literature by several. Consequent upon the environmental hazards associated with organic and inorganic leachates of waste streams associated with urban runoff and its toxicity to the ecosystem; it has become necessary to investigate the potential hazards associated with urban runoffs (Seiyaboh *et al.,* 2013).

Water is the most essential resource to both man and other living organisms. And as such the importance of water cannot be over- emphasized. Historically, it has been an important factor in determining the settlements of people. Water is available in large quantity as can be seen in oceans, sea, rivers, springs, lakes, ponds. However, lack of quality precludes their uses for many purposes as a result of pollution. It is known as a universal solvent because it easily

dissolves most solvent to form a solution. The unique property enables it to be used, in a wide range of important activities (Ezekiel *et al.,* 2011).

Apart from air, water is the most important element to man. It is essential to humanity and the largest source of fresh water lies underground. It constitutes the largest part of most living matters. The human body takes from 55% to 70% water depending on body size to function properly (Premlata, 2009). Water is universally accepted as one of the principal element of life and may also pass the test of a limited renewable resource (Yonnana *et al.,* 2015). Public water supply depends on the population of people living in the required area. These include homes, schools, hospitals, workplaces, commercial and some industrial activities and firefighting. The total water demand on a municipal water supply system is the sum of all the individual demands (from toilet flushing, lawn watering, industrial cooling, and street washing) during a stated period. Demand is not constant but varies during the day, night and with season. Consequently, water demand in a particular community is normally specified in terms of average daily demand (Yisa and Izuogu, 2015).

Over the years a considerable amount of time and efforts have been devoted to the improvement of water quality in rivers employing a combination of heuristic and material techniques. Generally, rivers are known to have multiple uses in every sector of development like agriculture, industry, transportation, public water supply etc. conversely they are used as sites for waste disposal. Waste from industries, domestic sewage and agricultural practices find their way into rivers resulting in large scale deterioration of the water quality. Most often, the discharge of these wastes results into levels that are of health threat to the surrounding environment and even man (Yisa and Izuogu, 2015).

Neha *et al*. (2013) reported that the pollution of a river could result to the spread of diseases like cholera, typhoid fever and diarrhea. Studies have shown that the consumption of highly contaminated water can cause injury to the human body. Toxins within water can harm or even kill aquatic and other animal that may have accidently or ignorantly feed on the infected organisms. The accumulation of wastes like urea, animal manure and vegetable peelings in water may lead to the growth of algae and other aquatic plants, the consequences is increase rate of microbial activities. This situation may result in depletion of dissolved oxygen causing the death of aquatic animals (Sawane *et al.*, 2006).

It was also reported that the increase in anthropogenic activities as well as natural processes such as precipitation inputs, erosion, weathering of crustal materials and degradation of surface waters have rendered most water bodies unsuitable for their multipurpose usage. The growing problem of degradation and human activities on river ecosystem has made it important for continuous monitoring of water quality of rivers to evaluate their state of pollution (Pawar *et al.*, 2006). Information obtained from such a study will help in preventing some common water borne diseases.

Water is an indispensable natural resource on earth. All life including human being depends on water. Due to its unique properties water is of multiple uses for living organism (Navneet and Sinba, 2010). Thus, water is a natural resource with limited and uneven distribution in time and space. All forms of life and all human activities are dependent on water (El-morhit, and Mouhir, 2014). Water resources are of great importance to human life and economy and are the main source of meeting the demand for drinking water, for irrigation of lands and industries (Kepuska, 2013). Lack of water is considered as a limiting factor of socio-economic development of a country (Agarwal *et al.*, 2011).

In the last few decades, there has been a tremendous increase in the demand for freshwater due to rapid growth of population and the accelerated pace of industrialization (Manjare *et al.,* 2010). Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and unsanitary conditions (Okeke and Igboanua, 2003). For instance, in most towns in Nigeria with rivers passing through them have converted such rivers into dump sites or latrines, with the consequence adverse effects on the health of down stream users. The recent documentary by WHO showing houses, public offices, schools not provided with latrines causing individuals to excrete anyhow in the bushes, rivers and open spaces is a pointer to the extent the Nigerian environment has been deterioted (Okeke and Igboanua, 2003). This is in addition to the general lack of sanitation by Nigerian Populace.

Globally water resources include surfaces water (i.e. rivers, creeks, streams, rivulets, ponds, creekletsetc which are fresh, brackish or marine water), ground water and rainwater. It is an indispensable resource needed for human existence and by all living organisms (Emmanuel and Ayeni, 2012). Water also serve as habitat to several biological species including some aquatic mammals, fisheries (both fin and shelled fish), reptiles and birds (Lukubye and Andama, 2017). Some other organisms such as tadpoles, mosquitoes and parasites that transmit diseases in human and other animals complete their life cycle in water.

- Of all the water types, freshwater is the least in abundance but is the most utilized water resources beside transportation activities. Some notable uses of freshwater includes recreational purposes e.g swimming, bathing, washing, cooking, drinking and even some industrial uses. These water resources exist in three forms including solid in the form of ice, liquid and gas in the form of vapour (Yelwa *et al.,* 2015).

- Water resource frequently gets contaminated by anthropogenic activities and to lesser extent through natural effects. Some notable human activities leading to pollution of water resources especially surface water include wastes disposal (municipal, solid and effluents) from several domestic and industrial area, human activities in the water such as dredging oil, and gas activities (Lukubye and Andama, 2017). Water could be contaminated by effluents from industries including pharmaceutical industries, fertilizer manufacturing, palm oil mill production, cassava processing, food processing and market activities.
- Due to the importance of this river landzun to the host communities, and the increasing and continuous use of this river and effect of urban runoff, agricultural runoff ad roof runoff, the water quality has been affected tremendously posing a serious threat on the people's livelihood and aquatic life at the downstream (Emmanuel and Ayeni, 2012).

River Landzu in Bida is of particular importance in the study of surface water pollution because effluents from cottage industries, municipal sewage and agricultural and urban run-off are discharged into the river bringing about considerable change in the water quality. These anthropogenic activities on the river Landzun pose a serious threat not only to organisms in the river but also the downstream water users. In addition, once the surface water is contaminated, its quality cannot be restored by stopping the pollutants from the source (Ramakrishnaiah *et al.*, 2009). It therefore becomes imperative to regularly monitor the quality of the water and to device ways and means to protect it (Adetoro and Popoola, 2014).

2.3 Factors Affecting Urban Runoff

2.3.1 Meteorological factors

- Types of precipitation (rain, snow and sleet)

- Rainfall amount
- Rainfall intensity
- Rainfall duration
- Distribution of rainfall over the watersheds
- Direction of storm movement
- Antecedent precipitation and resulting soil moisture
- Other meteorological & climatic conditions that affect evapotranspiration, such as temperature, wind, relative humidity and season.

2.4.4 Physical characteristics affecting urban runoff

- Land use
- Vegetation
- Soil type
- Drainage area
- Elevation
- Basin shape
- Slope
- Topography
- Direction of orientation
- Drainage network patterns
- Ponds, lakes, reservoirs, sinks in the basin, which prevent or alter runoff from continuing downstream (Abowei *et al.,* 2010).

2.4 Causes of Water Pollution

- However, water is one of the basic needs of human being. As years passed, the population began to grow, and bodies of water become polluted. Water pollution

occurs when huge bodies of water like the groundwater, oceans, rivers and lakes are contaminated with harmful chemicals and bacteria. This is due to the waste product directly thrown into the water.

- Indeed, water pollution is one of the major crisis that the world faces today, and it affects billions of people who don't have access to clean drinking water. These are some of the causes of water pollution.

  Rapid Urban Development, Improper Sewage Disposal, Use of Toxic Chemical for the Plants, Dumping of Chemical Wastes, Discharge of Radioactive Wastes, Oil Spills, Throwing of Plastics in the Ocean, Introduction of Alien Species in the Marine Environment, Global Warming, Acid Rain, Industrial Treatment, Sewage and Wastewater, Mining Activities, Accidental Oil Leakage and Animal Waste.

2.5 Water Related Diseases

Of the various terms for disease linked to water, water related disease is the most comprehensive. Water related disease is defined as any significant or widespread adverse effects on human health, such as death, disability, illness or disorders, caused directly by the condition, or changes in the quantity or quality of any waters.

The following are some of the water related diseases.

Table 2.2: Water related diseases and most common sources

DISEASE	MOST COMMON SOURCES
Aeromonas and marine vibrion infection	Swimming area
Adenovirus	Drinking water, swimming pool
Amoebiasis	Drinking water
Arsenicosis	Drinking water
Ascariasis	Drinking water
Blastocystis hominis infection	Drinking water
Campylobacteriosis	Drinking water
Camytobacter	Drinking water
Cholera	Drinking water
Cyanobacteria	Recreational water
Cercarial dermatitis	Outdoor swimming and bathing area

Cryptospori diosis	Drinking water, swimming pool
Dengue	Swimming pool and bathing
Dracunculiasis	Drinking water, swimming pool
E.coli diarrhea	Drinking water, swimming pool
Enterohemorrhagic	Drinking water, swimming pool
Enterotoxigenic	Drinking water, swimming area
Gastroenteritis – viral	Drinking water
Gidardiasis	Drinking water
Gastroenteritis	Drinking water
Hepatitis a	Drinking water sauna
Humidifier fever	Drinking water
Jaundice	Drinking water
Legionollosis	Drinking water heater, cooling tower
Leptospirosis	Drinking water recreational area
Listeriosis	Drinking water recreational area
Mycobacteriosis nontuberculous	Swimming pool
Norovirus	Drinking water
Onchocerciasis	Drinking water
Paratyphoid	Drinking water
Rotativirus	Drinking water
Scabies	Swimming pool and bathing
Schistosomiasis (billiarzia	Swimming pool and bathing
Shigellosis	Drinking water
Swimmer's itch	Swimming pool and bathing
Trachoma	Drinking water
Typanosomiasis	Drinking water
Tularaemia	Drinking water
Typhoid fever	Drinking water
West Nile fever	Drinking water
Yersiniosis	Drinking water

CHAPTER THREE

3.0 MATERIAL AND METHODS

The methodology employed for this research work consisted both primary and secondary.

3.1 Types of Data

This research employed the utilization of qualitative and quantitative data so as to uncovered trend in though and opinions, and dived deeper into research problems.

3.2 Sources of Data

The sources of data for this research exercise came from two sources i.e Primary and Secondary data respectively.

3.2.1 Primary sources of data

The primary sources provided direct or firsthand information about the problem under investigation, this involved using of questionnaires, conducting an interview, i.e open-ended and structured interviews and direct observations.

3.2.1.1 Questionnaire

Three hundred and ninety-nine copies of questionnaires were administered in the field, of which eleven copies was restricted to the health facilities to satisfied the objective three of this research i.e to examine the health implication of consuming contaminated water in the study area. Out of the administered questionnaires forty-eight copies could not be retrieved due to the nature of complicated society. However, three hundred and forty copies were also retrieved aimed for satisfying objective one and two of this research given a total retrieved three hundred and fifty-one.

3.2.1.2 Interviews

Interview information was obtained through inquiry and was recorded by the researcher (enumerator), structured interview will be performed by using survey forms and open-ended interview was also used.

3.2.1.3 Open-ended interview

This was also used to cover a variety of data gathering as follows:

Focus groups which consisted (few) individuals composed of representative members, purposely to obtained information concern the subject matter.

3.2.1.4 Structured interview

To improve data collection quality, structured interview used with a well-designed form which enables the researcher to validate the data as it collected.

3.2.1.5 Direct observation

The method used, provide ways to check for nonverbal expression, feelings and changes that has occurred on the Landzun river bank and its effects on the community such as displacement of people, loss of properties and submerged of farmland most especially during the heavy down-pour.

3.2.1.6 Reconnaissance survey

This was carried out on the field to ascertain some features and practices such as the displacement of people and flooded lands and also the vulnerable areas within the study area.

3.2.2 Secondary sources of data

For time saving and cost- efficient, secondary source of data collection techniques was used, thus, information was obtained from different sources.

Information collected through census or government departments like national population commission was also utilized.

3.3 Instrument of Data Collection

This research work was used the following instruments as a guide for data collection which include, observation, questionnaire, standardized interview, and laboratory analysis.

3.3.1 Field observation

This method involved watching and recording the behaviour of individual or groups, or the event that occur in a particular selected places with reference to the problem under investigation.

3.3.2 Questionnaire

Standard questionnaire was designed as part of instrument used which was administered randomly aiming to collect information on how to achieve the stated objectives of this research exercise.

3.3.3 Standardized interviews

Standardized or open-ended interview was also utilized, this approach had facilitated faster interview and information collected was more easily analysed and compared most especially public and private health facilities.

3.4 Sampling and Sample Size

The sample of this research exercise was determined by using Taro Yamane formula to calculate the sample size of the study area. The study used 2006 population figure of Bida and then Projected up to 2019 and sample was drawn using the above stated formula.

Taro Yamane formula was concerned with applying a normal approximation with a confidence level of 95% and a limit of tolerance level (error level) of 5% then, according to 2006 population census, Bida had a population figure of 188,181, therefore, to determined sample size, while, the population was projected up to 2019, given as follows:

$$P.F = P.P\left(1 + r/100\right)^n \quad (3.1)$$

Where:

P.F = Future Population (2019)

P.P= present population (188,181)

r= annual growth rate (3.2%)

n = difference (13 years)

therefore,

$$P.F = 188{,}181\left(1 + 3.2/100\right)^{13}$$

$$P.F = 188{,}181\ (1+ 0.032)^{13}$$

$$P.\ F = 188{,}181(\ 1.032)^{13}$$

P. F = 188,181 (1.5060)

P. F = 283,400

The 2019 projected population of Bida which was Two Hundred and Eight Three Thousand Four Hundred was used to determine the sample size, using Taroi Yamane Population sample size formula, given as:

$$n = \frac{N}{1+ Ne^2} \quad (3.2)$$

Where:

n = sample size

N = Projected population figure

E= limit of tolerance

n = sample size

N = projected population figure

e = limit of tolerance

$$n = \frac{274,556}{1 + 274,556\ (0.05)\ (0.05)^2}$$

$$n = \frac{283,400}{1 + 283,400\ (0.05)\ (0.05)^2}$$

$$n = \frac{283,400}{1 + 283,400\ (0.0025)^2}$$

$$n = \frac{283,400}{1 + 710}$$

$$n = \frac{283,400}{710}$$

n = 399

Therefore, 399 constituted the number of questionnaire administered

3.5 Method of Data Analysis

3.5.1 To examine the socio-economic impact of river Landzun

For the purpose of achieving this objective, the researcher used the descriptive statistics such as frequency and percentage table. This had helped in depicting the level of impact of river Landzun in the study area.

3.5.2 To identify pollution sources of river Landzun

To analyze this objective two questionnaires was administered and then retrieved for proper analysis.

3.5.3 To analyze the physic-chemical parameters of river Landzun

To achieve this objective, laboratory analysis and statistical analysis were conducted on the water parameters such as, temperature, PH, electrical conductivity turbidity, dissolved oxygen, biochemical oxygen demand, total solids, total dissolved solids, and hardness. The test of these parameters were conducted using water sample from three different sampling points i.e Dokodza, Tako Landzun and Wanigi areas respectively. The laboratory analysis was carried out at Jesil pharmaceutical company of Nigeria, Minna Niger State branch, used sophisticated machines for effective and efficiency.

3.5.4 To examine the health implication of consuming contaminated water in the study area

To satisfied and analyzed the objective four of this work, the researcher consulted eleven health facilities were consulted comprises private and public health facilities used two research tools i.e questionnaires and interview techniques, for further investigation. I liaised closely with one of laboratory scientist Maraba hospital now Usman/Aisha memorial hospital in Bida October 26, 2019. For further investigation.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 To examine the socio Economic Impacts of the River Landzun

4.1.1 Potential economic development of River Landzun

It was observed that providing clean drinking water and good sanitation facilities are essential to the enjoyment of life and to the right to health and also enhanced employment and improvement in economic development and growth of individual and communities respectively. The majority of the respondents which constituted the highest portion with 96% strongly agreed that clean drinking water and adequate sanitation was a determinants factor for the full enjoyment of life, economic growth, development and all human rights. This was in agreement with the study conducted by Aghoghovwia and Ohiman (2014) that water is a finite resource that is very essential for the human existence, agriculture, industry etc. without any doubt, inadequate quantity and quality of water have serious impact on sustainable development.

However, 4% constituted the lowest portion also agreed that waterway is life and economic development of any nation depends on availability, accessibility and affordability of water quality.

Table 4.1: Potentials economic of river Landzun

S/No	Respondents Opinion	Frequency	Percentage
1	Strongly agreed	327	96
2	Agreed	13	4
3	Strongly disagreed	0	0
4	Disagreed	0	0
	Total	**340**	**100**

4.1.2 Land river as a basic natural resource

Table 4.2 exhibit the level of response to Landzun river as a natural resource which is very essential for human, agricultural and local industries within Bida metropolis. However, from 340 retrieved questionnaires, virtually all respondents which constituted 100% strongly agreed that, river Landzun is a basic natural resources provided support for human needs, agricultural uses and also for local industries, this view, was in agreement with the research conducted in Nigeria by Sunday *et al.* (2014) revealed that water is the most basic natural and vulnerable resources, essential to maintain life, environment and development.

Traditionally, water resource management has been unidimensional, with actions designed to address single-purpose needs such as hydropower, irrigation, or navigation. Landzun river provided water virtually for those farmers who engaged in dry season farming around the river Landzun banks, its also useful for those who their primary occupation is market garden, places like Bangaie, Dokodza, Banyagi, Laruta, Gbongbofu, Lubasafugi, Masaga, Darchita, Bangbara, Edogifu are as respectively.

Table 4.2: Landzun River as a basic natural resources

S/No	Respondents Opinion	Frequency	Percentage
1	Strongly agreed	340	100
2	Agreed	0	0
3	Strongly disagreed	0	0
4	Disagreed	0	0
	Total	**340**	**100**

4.1.3 Farmland submerged during torrential rainfall

The table below depicted the position of the respondents will the respect to submergence of the farmlands along the bank of the river Landzun, the majority of the respondents i.e 86.2% represented the largest proportion strongly agreed that farmlands located along the bank of

Landzun river experienced floods as a result of heavy rainfall, while 11.2% agreed to such claimed and 2.6% disagreed upon such claimed as it is represented on the table 3 below. The implication of this table, shows that heavy rainfall in the study area have serious effect on farmland and that reduced the expected economic benefits of the farmers within the study area.

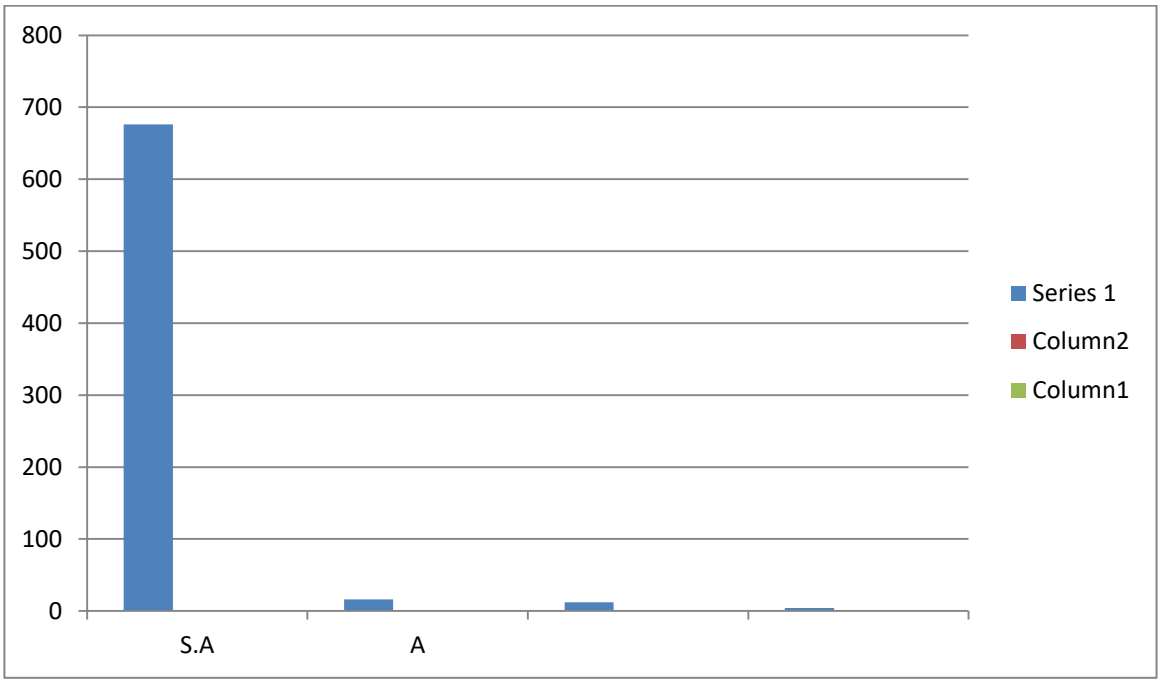
Table 4.3: Farmland submerged during torrential rainfall.

S/No	Respondents Opinion	Frequency	Percentage
1	Strongly agreed	293	86.2
2	Agreed	38	11.2
3	Strongly disagreed	0	0
4	Disagreed	9	2.6
	Total	**340**	**100**

4.1.4 Community views on dependence level on River Landzun

However, 261 which represent that majority of the respondents indicated that residents surrounding the Landzun river used the water for several domestic works such as washing, bathing, spiritual uses, building and also used to feed their domestic animals, this field investigation agreed strongly with a study carried out by FAO, (2017) revealed that the livestock sector provides a variety of goods and services to society, from food to income to social functions. However, 67.6% agreed, 12.1% strongly agreed, 16.2% disagreed while 4.3% strongly disagreed which represented the opinions of the respondents on the dependence on water from Landzun river.

Figure 4.1: Community views on dependence level of river Landzun



4.1.5 Respondents rating of human activities supported by river landzun

The perception of the respondents as rated from responses was a cleared indication that agricultural activities within the study had been supported by river Landzun, most especially during the dry season particularly irrigation farmers who engaged in production of vegetables which is a viable alternative solutions to food insecurity which is refers to as a lack of access to enough good health, and culturally appropriate food. This was in line with the study conducted by Federal Republic of Nigeria (Akinbile and Yusoff, 2011) opined that water has been a very important factor in settlement development where it usually serves as human settlement boundaries. The same Landzun River is also utilized for the processing of agricultural produce.

The local industries in Bida metropolis accounted for 24.1%, the second largest that depends on Landzun river for their production, such industries where block industries, located close to the banks of Landzun river, rice milling at Ciricco.

Domestic dependence on river Landzun was rated with 8.8%, shows that most domestic activities were supported through the utilization of the water, the principal domestic uses of water in the study aea most especially places located close to the water include drinking, washing, bathing, carwash, fishing, farming, livestock rising and irrigation which has the same opinion with a research conducted by (Kaizer and Osakwe, 2010) on water resources use, abuse and regulation in Nigeria. Activities supported by the river, fishing accounts for the least with 2.1%.

Table 4.4: Residents Rating of human activities support by river Lanzun

S/No	Respondents Opinion	Frequency
1	Farming	65
2	Industries	24.1
3	Domestic	8.8
4	Fishing	2.1
	Total	**100**

4.1.6 The nature of environmental problem occurred as a result of heavy rainfall

The response from the respondents on table 7 below indicated that 39.4% person who had happens to be captured randomly issued a response as regards to effect of torrential downpour always claimed or damaged properties most areas affected were Tako-Landzun, Laruta, Bangaie, Darachita, Wanigi areas etc, some of the properties lost were farmland, grassing land, river channel expansion, destruction of culverts, bridges along Darachita and Bangaie roads, etc. the 29.7% claimed that, the floods as a result of torrential downpour lead to

displacement of people, areas displaced were Wanigi and some structures in Tuti-Jinba area respectively.

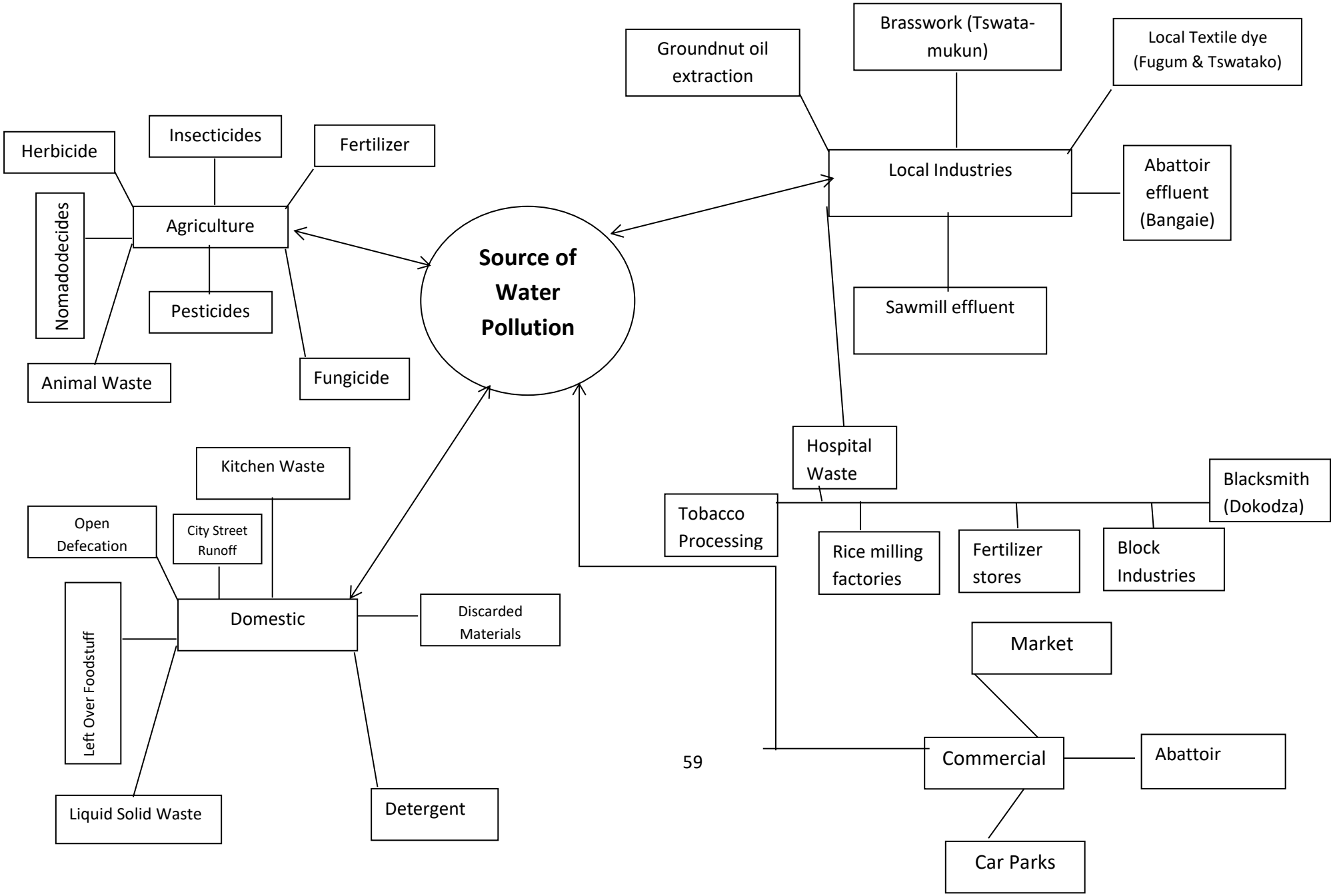
However, 28.2% responds, that the destruction does not only restrict to one direction, but, both lives and properties were also claimed, then 2.6% claimed that its only loss of lives which constitutes the minority viewed point.

Table 4.5: The nature of environmental problems occurred as a result of heavy rainfall

S/No	Respondents Opinion	Frequency	Percentage
1	Loss of properties	134	39.4
2	Displacement of people	96	29.7
3	Loss of lives	09	2.6
4	Loss of live and properties	101	28.2
	Total	**340**	**100**

4.2 To Identify the Pollution Sources of River Landzun

Figure 4.2 below shown the pollutions source of river landzun which is non-point source from different source which include Agriculture, local industries, commercial centres and also from the residential areas.


Source of Water Pollution
Agriculture
Herbicide
Insecticides
Fertilizer
Nomadodecides
Pesticides
Animal Waste
Fungicide
Local Industries
Groundnut oil extraction
Brasswork (Tswata-mukun)
Local Textile dye (Fugum & Tswatako)
Abattoir effluent (Bangaie)
Sawmill effluent
Hospital Waste
Tobacco Processing
Blacksmith (Dokodza)
Rice milling factories
Fertilizer stores
Block Industries
Domestic
Kitchen Waste
Open Defecation
City Street Runoff
Left Over Foodstuff
Discarded Materials
Liquid Solid Waste
Detergent
Commercial
Market
Abattoir
Car Parks

4.2.1 Human activities presumed as pollution sources of River Landzun

The table 4.6 below shows that expanded and intensified agricultural systems in the study area and environs represent majority with 40.3% was responsible for the pollution of river Landzun. This was in agreement with the study conducted by food and agriculture organization of the United Nations (2007), stated that agricultural pressures on water quality come from cropping and livestock systems and aquaculture which have all expanded and intensified to meet increasing food demand related to population growth and changes in dietary patterns. Farms discharge large quantities of agrochemicals, organic matter, drug residues, sediments, saline drainage into water bodies. The resultant water pollution poses demonstrated risks to aquatic ecosystems, human health and productive activities (FAO, 2007).

In the study area most of the agricultural land uses were located on the slope and whenever. There is torrential rain it washed down to the drainages and end-up their journey with their loads, into the river Landzun which eventually changed the water quality and rendered it unsafe for consumption and other domestic uses. Nevertheless, agricultural pollution, aggravated by increases sediment runoff is becoming an issue.

Local industries within the study area accounted for 29.7% pollution causes of the river Landzun such industries discharged their waste effluent into the water channels and then tun to the nearby river channel most especially during the rainy seasons such industries were Tobacco processing factor in Mokwala area, rice miling in Mokwala ciricco and many other locations within Bida metropolis, groundnut oil extraction factories, Masaga glasswork, Tswata-Mukun Tswatako brasswork and Gbongbofu areas, Dokodza, Banyagi and Edogifu blacksmith factories, block industries discharged their by-products and waste into the river channels (Landzun) and most the industries were located close to the river in the study area.

Washing and bathing as an activity contributed to the pollution of Landzun river account for 18.5% of the responses from the audience, with respect to that many people irrespective of age, sex and religious affiliation uses this water for bathing and washing using different detergent most especially during the heat period. Furthermore, some carwash workshops were located close to the river bank where they discharged their waste into the river channel. Moreso, the abattoir sited in Bangaie area also contributed to the pollution of the river, hence they discharged their waste directly into the river and it accounted for 11.5%.

However, in agreement with objective two of this research seek to find out the pollution sources of river Landzun, from the reconnaissance surveyed, observation, interviewed and response from the questionnaires shows that pollution sources of Landzun river was a non-point source.

Table 4.6: Human activities presumed as pollution source of river Landzun

S/No	Respondents Opinion	Frequency	Percentage
1	Agriculture	137	40.3
2	Local industries	101	29.7
3	Washing and bathing	63	18.5
4	Abattoir effluent	39	11.5
	Total	**340**	**100**

4.3 To analyze the Physico-chemical Parameters of River Landzun

4.3.1 Physicochemical parameters of water obtained from river landzu

The results of the physicochemical analysis of river water samples after triplicate determination in the three sampling locations of river landzu are presented in the table 4.7 below. The result shows that the pH was 6.72±0.01, 6.89±0.01 and 6.46±0.01 for TKL, WNG and DKZ sampling points respectively. The turbidity measured obtained were 4.91±0.01, 4.93±0.01 and 3.24±0.01 NTU for TKL, WNG and DKZ sampling points respectively. While

the temperature includes 11.70±0.01, 14.02±0.01 and 15.02±0.01 ^{o} C for TKL, WNG and DKZ sampling points respectively. The electrical conductivity was 80.01±0.01, 110.02±0.01 and 40.02±0.01 µS/cm for TKL, WNG and DKZ sampling points respectively. The dissolved oxygen measured was 3.81±0.01, 3.67±0.01 and 3.92±0.01 mg/L for TKL, WNG and DKZ sampling points respectively. The BOD recorded was 1.70±0.01, 1.87±0.01and 1.32±0.01 mg/L for TKL, WNG and DKZ sampling points respectively. The total hardness was 270.01±0.02, 140.02±0.01 and 100.02±0.01 mg/L for TKL, WNG and DKZ sampling points respectively. The TDS were 53.61±0.01, 73.71±0.01 and 26.81±0.01 mg/L for TKL, WNG and DKZ sampling points respectively. The TSS obtained were 30.42±0.01, 34.87±0.07 and 20.81±0.01 mg/L for TKL, WNG and DKZ sampling points respectively. The TS includes 84.02±0.01, 108.51±0.01 and 47.61±0.01 mg/L for TKL, WNG and DKZ sampling points respectively. However, the parameters tested were not significantly different ($p<0.05$) from each other.

Table 4.7: Physicochemical Analysis of Water Obtained From TKL, WNG and DKZ

	PARAMETERS									
SAMPLING POINTS	**pH**	**TP (^{O}C)**	**TB (NTU)**	**EC (µS/cm)**	**TH (mg/L)**	**TDS (mg/L)**	**TSS (mg/L)**	**TS (mg/L)**	**DO (mg/L)**	**BOD(mg/L)**
TKL	6.72 ± 0.01^{b}	11.07 ± 0.01^{a}	4.91 ± 0.01^{b}	80.01 ± 0.01^{b}	270.01 ± 0.02^{c}	53.61 ± 0.01^{b}	30.42 ± 0.01^{b}	84.02 ± 0.01^{b}	3.81 ± 0.01^{b}	1.70 ± 0.01^{b}
WNG	6.89 ± 0.01^{c}	14.02 ± 0.01^{b}	4.97 ± 0.01^{c}	110.02 ± 0.01^{c}	140.02 ± 0.01^{b}	73.71 ± 0.01^{c}	34.87 ± 0.07^{c}	108.51 ± 0.01^{c}	3.67 ± 0.01^{a}	1.87 ± 0.01^{c}
DKZ	6.46 ± 0.01^{a}	15.02 ± 0.01^{c}	3.24 ± 0.01^{a}	40.02 ± 0.01^{a}	100.02 ± 0.01^{a}	26.81 ± 0.01^{a}	20.81 ± 0.01^{a}	47.61 ± 0.01^{a}	3.92 ± 0.01^{c}	1.32 ± 0.01^{a}
NIS STANDARD	6.5- 8.5	Ambient	5.00	1000	150	500			5.0	10

Results represent mean ± standard error of mean in triplicate determination. Values with the same superscript in the same column are not significantly different at $p<0.05$

KEY:

TKL: Tako Landzu
WNG: Wanigi
DKZ: Dokodza
NTU: Nephelometric Turbidity Unit
TP: Temperature
TB: Turbidity
EC: Electrical Conductivity
TDS: Total Dissolved Solids
TSS: Total Suspended Solids
TS: Total Solids
TH: Total Hardness
DO: Dissolved Oxygen
BOD: Biochemical Oxygen Demand

4.3.2 Discussion

Rivers are vital freshwater systems that are necessary for the sustenance of wildlife and ecological health. The variation in water quality in a given environment is often influenced by geological formations and anthropogenic activities (Verma *et al.*, 2012). The results indicate that the quality of river water for the study area varies from location to location. The pH value of a water source is a measure of its acidity or alkalinity. For most reaction as well as for human beings, pH value 7.0 is considered as best and ideal. However, the study shows that the highest value of pH obtained was 6.89 at Wanigi (WNG) sampling point but was within the Nigerian Industrial Standard (NIS) standard (6.5-8.5) compared to a lowest value of 6.46 obtained at dokoza (DKZ) which is more acidic but was slightly below the NIS standard. This reveals that the water may contain some ions which may be responsible for its acidity at that point. This water will be slightly sour if tasted or drank. It may also be partly due to high content of humic acids in the solids. There was not much variations recorded in pH values (Table 4.1). This is in agreement with the study carried out by Reasoner (2004). It also correlated with the study conducted by Murugesane *et al.* (2006). Highly acidic or alkaline water can also release pollutants from sediments which can also harm aquatic organisms. Acidity in waterways is influenced by rock and soils, as well as human sources such as industrial and car emissions, mining, and agricultural runoff. Low pH (acidic) can cause toxic metals such as aluminium and copper to dissolve into the water from bottom sediments.

Furthermore, the study shows that the mean maximum temperature of (15.02±0.01 ^{O}C) was obtained at DKZ sampling location which was within the ambient temperature of the NIS as compared with 11.70± 0.01 ^{O}C obtained at Tako Landzu (TKL) sampling location which was also within the ambient temperature of the NIS. The maximum value of temperature at point

DKZ might be due to increasing rates of pollution and wastewater discharged at DKZ which may be as a result of anthropogenic activities such as cutting of shade trees, disposal of refuse in the run-off water. Also, the low value of temperature obtained at TKL may also be due to the season and time the sample was taken and because the survey was carried out mainly during raining season and could also be attributed to strong land sea breeze and precipitation. A similar result was observed by Adetoro and Popoola (2014). They agreed that temperature is a stable environmental factor in the shallow brackish environments of West Africa, and it is most unlikely that this variation in temperature constitutes an important ecological factor in this area. This was in line with the work carried out by Masese (2009) that made the same assertion. Elevated temperature can also directly degrade valuable uses such as recreational fishing, boating, and commercial salmon fishing. However, temperature is known to influence the pH and DO concentration in the water (Essien, *et al.*, 2010).

The study reveals that maximum turbidity was obtained at WNG sampling point (4.93 ± 0.01 NTU) as compared with location DKZ with a minimum turbidity value of 3.24± 0.01 NTU. The both values obtained were below the NIS standard of 5.0 NTU. The low value may be due to the low presence of silt, sand and mud, bacteria and other germs present in the water at that sampling point, the method and time of sampling. This could also be attributed to presence of organic matter pollution, other effluents, run-off with a high suspended matter content and heavy rain fall. This result agrees with the work carried out on river landzu by Sunday (2014). Usually, rivers full of mud and silt is impossible to see through the water (high turbidity). Turbidity of water is an important parameter in water quality because it influences the light penetration inside water and consequently affects aquatic life (Etim *et al*., 2013).

Furthermore, the study shows that the highest value of Total Solids (108.51 ±0.01 mg/L) was obtained at WNG sampling point as compared with DKZ where 47.61±0.01 mg/L was obtained. Higher values of Total Solids were obtained from WNG sampling location may imply that there is more pollution due to discharge of sewage and sludge round that area. While a lower value implies that there are little pollutants in solid forms that is either dissolved or suspended. The total solids is the sum total of total suspended solids and total dissolved solids. The effect of the presence of Total Solids is due to silt and organic matter (Etim *et al*., 2013). This result complies with the study carried out by Yonanna *et al*. (2015). The observed high concentration of dissolved solids in the surface water is an indication that there are intense anthropogenic activities along the course of the river and run-off with high suspended matter present.

However, the study also shows that the dissolved oxygen (DO) was high at location DKZ with a value of 3.92±0.01 which may be due to low turbidity and increased photosynthetic activity of the green algae found on the stones and pebbles inside the water but lowest at location WNG with a value of 3.67±0.01 which may be due to high load of pollution caused by higher temperature, oxygen demanding wastes, inorganic reluctant and seasonal variations. However, the values obtained were not significantly different from each other for the three locations. Furthermore the values obtained for the sampling locations were below the NIS standard of 5.0 mg/L. This implies that there should be continuous monitoring of the river at these locations so as to control the level of pollutants deposited into these River Landzu by the surrounding communities. This will also help to protect the health of the people in the surrounding communities where the urban run-off are located and promote the use of water that is safer.

The highest value obtained at sampling location DKZ also indicated that the study area is more deoxygenated compared to other sampling points and this is in agreement with the work of Halder and Islam (2015). This may be attributed to flood water dilution and reduced resident time of polluted waters. The low DO concentration could be ascribed to waste discharges high in organic matter and nutrient along the course of the river and probably as a result of the increased microbial activity (respiration) that usually occurs during the degradation of the organic matter and also the presence of water released from cottage industries around river landzu. This assertion agrees with the previous study carried out on river landzu by Yisa and Jimoh (2010). High DO is very vital for aquatic organisms as it is required for the metabolism of aerobic organisms and organic matter decomposition (Yonnana *et al.*, 2015).

The total dissolved solids (TDS) and Electrical conductivity were found to be moderate in all sampling points (TKL, WNG, DKZ). The maximum electrical conductivity (110.02±0.01) and TDS (73.71±0.01) was obtained in WNG sampling point (table 4.1). While the minimum electrical conductivity (40.02±0.01) and TDS (26.81±0.01) was obtained in DKZ sampling point. However, the both values were below the NIS permiisible limit of 1000µS/cm for conductivity and total dissolved solids 500mg/L respectively. The high conductivity in WNG sampling point is likely due to the prolonged and extensive agricultural practices such as irrigation in conjunction with the inherent geological conditions leading to high concentrations of dissolved minerals. This is in agreement with the work of Seiyaboh *et al*. (2013) who obtained similar results. The total dissolved solids may possibly increase as a result of daily anthropogenic activity like boating, fishing, bathing and washing. Water withdrawals and wastewater from local industries, fertilizer applications, mining and oil drilling, and repeated use of irrigation water contribute to high levels of salts. This can be

minimized by discouraging people from the use of de-icing salts where they may be washed off into waterways, storm drains and ditches. However, (Yonnana *et al.,* 2015) earlier reported the levels of sulphate, TS and TSS to be above the NIS permissible limit in the sampled in the study conducted by him on waterholes of Old Oyo National Park, Southwest Nigeria.

The study shows that the maximum total hardness (TH) was 270.00±0.02 mg/L obtained at TKL which was higher than the NIS standard (150 mg/L). While the DKZ sampling point which has the minimum value (100.02±0.01mg/L) was below the WHO standard. Also, the TH of the three different sampling locations of river Landzu shows that the values were not significantly different during the period of the study. This was in accordance with the results obtained by Etim *et al.* (2013) who reported that seasonal variations can affect the total hardness. This may be due to poor dilution owing to low precipitation rate. In addition, the study also revealed that river landzum at TKL sampling point was slightly hard. Consequently, the high concentration of total hardness in water samples may be due to dissolution of polyvalent metallic ions from sedimentary rocks, seepage and run off from soil. However, water hardness has no known adverse effects but leads to more consumption of soaps and detergents at the time of cleaning or washing and some evidence indicates its role in heart disease (Seiyaboh *et al*., 2013). According to Mashood *et al*. (2008), it is an important criterion for determining the usability of water for domestic, drinking and for industrial uses.

Excess hardness is undesirable mostly for economic and aesthetic reasons (Chris *et al*., 2010). Hardness of water causes chocking and clogging troubles of pipelines, causes formation of scales in boilers leading to wastage of fuel and the danger of overheating of boilers

(Egereonu, 2004). The hardness of natural waters depends mainly on the presence of calcium and magnesium ions in the water.

The BOD values ranged from 1.32±0.01 to 1.87±0.01 mg/L. The BOD, which is an indicator of organic load in water, was observed to be far below the NIS permissible limit (10 mg/L) as well. The highest value was obtained in WNG sampling point while the lowest was obtained in DKZ sampling points. The high value of BOD may be as a result of high value of dissolved oxygen. This means that the water is slightly polluted because there is a reasonable amount of oxygen for the aquatic life and for anaerobic organisms to use. The low value of BOD obtained was due to insufficient oxygen for the aquatic organisms. This may also be due to the high rate of pollution caused by disposal of refuse on the water run-off. The result obtained in this study is comparable to the one obtained by Herero *(*2008) and Halder and Islam (2015) who also reported similar variations in their respective studies. Consequently, the dissolved oxygen concentration in natural waters such as river depends on the physical, chemical and biological activities in the water body; it is required for the survival of aquatic life and can be used to evaluate the degree of freshness of a river.

4.4 To examine the Health Implication of Consuming Contaminated Water in the Study Area

However, 283 (83.2%) constituted the majority of respondents from the health facilities which comprises the public and the privates, which indicated that the most prevalent water related diseases often reported to their facilities were diarrhea, dysentery and cholera respectively. It was recognized that infectious diarrhea is a major world leading cause of morbidity and mortality especially children in developing countries (Idris *et al*., 2013). This was also in line with the work of Owhonda *et al*. (2018) conducted in Nsukka which revealed that diarrhea is one of the top causes of childhood mortality in sub-Sahara Africa. Also

related to a work of Ifabiyi (2008) opined that adverse alteration of water quality presently produces large scale illness and deaths of humans and aquatic life.

Table 4.8: Prevalent Water Related Disease (WRD) in the study area.

S/No	Rating	Frequency	Percentage
1	Diarrhea	283	83.2
2	Typhoid	39	11.5
3	Dysentery	12	3.5
4	Cholera	6	1.8
	Total	**340**	**100**

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, water quality parameters can vary significantly due to different environmental conditions and ecosystem. Agricultural run-off of pesticides, plant and animals wastes is also a major contributing source of organic pollution to water bodies in Nigeria. The work of Agarwa *et al.,* (2011) linked the pollution of water run-off to the use of phosphate fertilizers from nearby farms in addition to cow dung washing from the watershed into the water bodies. Water pollution through surface run-off has been reported in previous literatures with subsequent effects on nutrient enrichment, water quality impairment, marine lives spawning ground destruction and fish kill (Abowei, 2010).

The variations observed were probably due to various factors such as trace metal contents, environmental pollutions due to organic pollutant and domestic usage. Finally, the result was concluding that the surface running water was contaminated at few sampling sites by anthropogenic activity. It was discovered that from the study, natural sources that influence acidity in waterways are the surrounding rock and soils, and processes such as decay of plants.

Human activities that can result in acidity include agriculture (animal feedlots), use of agro allied chemicals, urbanization and industry (emissions from vehicles and coal-fired power plants leading to acid rain, and mining. Although high water temperature does not directly affect human health, it can speed up the growth of waterborne bacteria or toxic algae that can harm people or their pets if swallowed or contacted.

5.2 Recommendations

The following recommendations were made at the end of the study:

1. There should be environmental education and public awareness programs so that people should be able to know the implications of indiscriminate waste disposal.
2. Proper urban planning and implementations should be seriously be considered to avoid urban flooding
3. There should be environmental sanitation and legislation against indiscriminate dumping and the erection of buildings most especially in swamping and lowland areas like Eswa Nangi, Efu-yagi and wanigi areas respectively.
4. Water draws from the river Landzum should be subjected to proper treatment before use.
5. There should be credible law enforcement agencies saddle with responsibilities of monitoring pollution and profer credible solutions.

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